**REPORT OF THE WORKING GROUP ON
STATISTICS, ASSESSMENTS AND MODELLING**
(Bergen, Norway, 29 June to 3 July 2009)

CONTENTS

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INTRODUCTION

Opening of the meeting

1.1   The third meeting of WG-SAM was held in Bergen, Norway, from 29 June to 3 July 2009. The meeting was convened by Dr A. Constable (Australia) and local arrangements were coordinated by Mr S. Iversen (Norway). The meeting was opened by Mr T. Nepstad, Director of the Institute of Marine Research (IMR), Norway.

1.2   Dr Constable thanked Mr Nepstad for his warm welcome, and IMR for hosting the meeting. Dr Constable also welcomed the participants (Appendix A).

1.3   The Working Group conveyed its best wishes to Prof. C. Moreno (Chile), who had resigned from his position as Chair of the Scientific Committee in March 2009 due to ill health. The Working Group noted that Mr Iversen (senior Vice-Chair of the Scientific Committee) had agreed to take on Dr Moreno's role, with the assistance of Dr V. Bizikov (second Vice-Chair) in 2009.

Adoption of the agenda and organisation of the meeting

1.4   The Working Group agreed to restructure its draft agenda to better reflect the papers and information available at the meeting, along with items referred from other working groups for consideration by WG-SAM. Items 2 to 6 of the draft agenda were restructured as follows:

- use of data in assessments (new Item 2)
- assessments (new Item 3)
- management strategies and their evaluation (new Item 4)
- other advice for the Scientific Committee (new Item 5).

1.5   As there was no other business, Item 7 from the draft agenda was deleted.

1.6   The remaining items of the draft agenda were retained, and the agenda was adopted (Appendix B).

1.7   The Working Group noted the Secretariat's high translation workload and discussions at CCAMLR-XXVII (CCAMLR-XXVII, paragraph 3.13). The Working Group agreed to restructure its report in an effort to reduce the overall size of the report and subsequent translation. The new structure attempted to capture essential background, discussion and advice, while making full use of CCAMLR's archive of publications and meeting documents.

1.8   The Working Group agreed to place a two-page limit, where possible, for the reporting of each subitem of its agenda, and that each subitem would be reported as follows:

- task/objectives
- relevant references (papers, other material)
- background/justification
- discussion of outcomes of work
- conclusions, including notes, advice and recommendations.

1.9   While the report has few references to the contributions of individuals and co-authors, the Working Group thanked all the authors of the papers for their valuable contributions to the work presented to the meeting.

1.10   In preparing its report, the Working Group agreed to highlight text that provides advice to the Scientific Committee and its working groups without repeating it in full in Item 7, which now comprises only a summary of paragraph references.

1.11   Documents submitted to the meeting are listed in Appendix C; WG-SAM-09/12 was only available as an abstract.

1.12   The report was prepared by Drs D. Agnew (UK) and Constable, Mr A. Dunn (New Zealand), Drs C. Edwards (UK), S. Hanchet (New Zealand), R. Hillary (UK), C. Jones (USA), D. Middleton (New Zealand), D. Ramm (Data Manager), K. Reid (Science Officer), G. Watters (USA) and D. Welsford (Australia).

USE OF DATA IN ASSESSMENTS

Age–length keys

2.1   This item on the agenda discussed issues surrounding the use of ALKs for constructing catch-at-age data to be used in assessments.

   Ageing error

      Background and papers

2.2   WG-SAM-09/7 and 09/8 dealt with the question of how ageing error can be incorporated into stock assessments when using ALKs to construct catch-at-age data by appropriately accounting for the measurement error associated with otolith-based ageing techniques, and then using this information to inform estimates of the multinomial effective sample size.

      Discussion

2.3   WG-SAM-09/7 developed a model to predict the error structure around otolith-based age measurements. This is used to construct an ageing-error matrix which allows the

predicted catch-at-age to be compared to observed catch-at-age within CASAL. The statistical model attempted to account for inter-reader variability and the readability of the otoliths themselves in predicting error. To determine ageing error, the 'true' age was first obtained from the average age over repeated reads. Multiple readings of a reference set of otoliths were then used to quantify the frequency of integer ageing errors (0, 1, 2, 3, 4 and 5+ years) as a function of the nearest integer (NI) to the true age, accounting for average readability of the otolith.

2.4   The Working Group noted that trends in the proportion of negative errors with age may be an artefact of non-random 'tie' breaks (when the mean age is an integer plus exactly 0.5) which were always rounded up in the model as first presented; this was resolved by breaking ties randomly and a revised model featuring a cubic trend with age in the proportion of negative errors was presented during the meeting.

2.5   In WG-SAM-09/8 the ageing-error matrix was used further to inform estimation of the multinomial effective sample size for likelihood-based fitting to the catch-at-age data within CASAL. The error matrix was predicted using the model developed in WG-SAM-09/7 assuming a single otolith readability value.

2.6   The effect of incorporating different assumed otolith readabilities on the ageing-error matrix and assessment results is discussed further under Item 3.1.

2.7   Dr S. Candy (Australia) proposed that an advantage of this statistical modelling approach is that there is usually not enough data to construct the ageing-error matrix directly from pooled age samples and that a modelling approach should be considered for future work.

Future work

2.8   WG-SAM recommended further work to validate whether it is more appropriate to use a model, as opposed to an empirical estimate, of ageing error by directly comparing results from each approach. If the modelling approach is to be adopted, an issue that needs to be addressed is how to combine estimates from otoliths with different readability when constructing the error matrix.

Constructing catch-at-age data

Background and papers

2.9   This item dealt with the question of what is the 'best' way to construct catch-at-age data for use in assessment models: direct ageing or the use of ALKs applied to catch-at-length data. The Working Group considered when catch-at-age proportions would be better estimated from an ALK compared to using a direct age estimate that ignores any additional length-frequency data.

2.10   The Working Group noted that, although both ALK and direct ageing can provide adequate catch-at-age estimates, it may be more efficient to construct catch-at-age data using an ALK-based approach. The Working Group also noted that either approach is dependent on representative sampling, but the ALK-based approach can be applied to age data collected either by simple or length-bin random sampling. Although the ALK estimator has lower variance than the direct age estimator, the degree of improvement may only be slight in some situations.

Otolith sample size

2.11   The determination of an appropriate otolith sample size for estimating catch-at-age from direct ageing, a method that is utilised in the assessment presented in WG-SAM-09/13, was discussed under Item 5.1 'Observer sampling requirements'.

Spatial considerations for ALKs

Background and papers

2.12   As otolith data are sampled in a spatially disaggregated fashion from the Ross Sea, the Working Group considered whether it is better to use ALKs developed using data collected at the same spatial scale as the catch-at-length data when constructing catch-at-age data.

2.13   Mr Dunn raised the issue of whether this data should be combined to construct a single ALK for the entire Ross Sea or kept in a disaggregated form (WG-SAM-07/6). This is particularly relevant for population models that operate at a spatially disaggregated scale. He presented the catch-at-age distributions for the Ross Sea shelf, slope and north fisheries, and compared the age distributions constructed using a single aggregated ALK and those constructed from area-specific ALKs. For the shelf area, an area-specific ALK produced a catch-at-age distribution similar to that with an area-combined ALK. For the slope area there was an over-representation of the older age classes, while for the north area there was an under-representation of older age classes when using the combined ALK.

2.14   WG-SAM-09/9 compared integrated assessments using CASAL when separate ALKs were constructed for each fishery by year combination (disaggregated ALKs) to the alternative approach of constructing ALKs from length–age samples pooled across fisheries (aggregated ALKs). It was observed that the fit of the model to the catch-at-age proportions for the longline fishery improved significantly when the aggregated ALKs were used (see discussion under Item 3.1). It should be noted that the effective sample sizes (ESS) for the catch-at-age proportions applied in the assessment with aggregated ALKs overstate the amount of independent information in the fisheries-specific proportions-at-age data for estimation of parameters in the age-structured assessment model.

2.15   The Working Group recommended that it is appropriate to use ALKs constructed from data applied at the level of disaggregation that the model employs in analyses.

Tagging data

> Determine the most appropriate way of creating reliable
> tagging datasets for use in assessments

Background and papers

2.16   WG-FSA has asked WG-SAM to consider ways of incorporating unmatched tag-recaptures into assessments of toothfish that utilise mark–recapture data (SC-CAMLR-XXVII, Annex 5, paragraph 3.58).   WG-SAM-09/4 reported that within the Secretariat databases, linkage rates are variable between fishing areas and species.

2.17   Problems with the reliability of tag-release and recapture scanning have also been suspected in exploratory fisheries, and led to the selection of tags released and recaptured only by New Zealand vessels in the assessment of Subareas 88.1 and 88.2 in 2007, and the inability to use tag data in the assessment of Divisions 58.4.1 and 58.4.2 in 2008 (SC-CAMLR-XXVI, Annex 5, paragraph 5.99; SC-CAMLR-XXVII, Annex 5, paragraph 5.21). WG-SAM-09/19 presented a revised procedure for analysing the quality of data from individual vessel trips and proposed a method for using quality metrics to identify trips considered to have reliable tag-release and recapture data.

Discussion

2.18   During the meeting several sequences of unmatched tags were identified.   The relatively low proportion of matched tags in some fisheries may result from difficulties in the early stages of a tagging program, such as skate tagging prior to the Year-of-the-Skate. In the case of the skate tag returns, separation of tag-releases/recaptures before and after the Year-of-the-Skate is recommended. In some cases, national programs have identified matches for tags that are not apparent from the Secretariat database. Continued liaison between the Secretariat and those programs should fix many of the problems.

2.19   The Working Group recommended that when using mark–recapture within assessment models, the impact of unmatched tags (see paragraph 2.18) on the result should be minimised by undertaking the following procedure:

(i)   removing all tag-recaptures from non-standard tagging events;

(ii)   when tags are clearly derived from a single tagging program but cannot be matched exactly, matches should be made to the extent possible that are consistent with the assessment requirements (e.g. create a temporary link with a release event that matches by year of release, and length and/or sex where the assessment model requires length or sex);

(iii)   if there are still a large number of unmatched tags, simulation studies of the impact of these losses should be undertaken.

2.20   The approach adopted in WG-SAM-09/19 for selecting a tagging dataset used the following method:

(i)   a subset was created of all vessel trips in a single year whose tags were subsequently recovered at a rate above the median rate for all trips undertaken in that year;

(ii)   a subset was created of all vessel trips in a single year which recovered tags at a rate above the median rate for all trips undertaken in that year;

(iii)   all trips that met both criteria (i) and (ii) (the 'informative' initial dataset, 19 out of 103 trips) were analysed and the upper and lower bounds of data-quality metrics were established for them;

(iv)   any other trips that are within the established bounds for these data-quality metrics were added to the dataset of informative tag-release and tag-recovery trips to create a final subset of informative trips.

2.21   The method allowed for the inclusion of non-New Zealand vessels, both in the initial identification of reliable trips and the subsequent addition of trips according to the data-quality metrics. Individual vessels had, on occasion, trips that were included or excluded from the dataset depending on their data-quality metrics.

2.22   WG-SAM noted that although under the tag data selection method (paragraph 2.8) some of the New Zealand trips will be excluded from the final informative dataset, the addition of other trips should increase the total size of the dataset. WG-SAM recommended that the method in WG-SAM-09/19 be modified to include, in the 'informative' initial dataset, all trips which satisfied item 1 OR item 2. This will further increase the size of the dataset, which will be important to improve the precision of the assessment.

2.23   An important feature of using this dataset in assessments is that the trips in the dataset would be assumed to carry common values of tagging parameters, such as tagging mortality, tag loss and scanning efficiency. Although excluded trips might contain useful information, this assumption may not hold for them.

2.24   WG-SAM recommended that two assessments should be undertaken for Subareas 88.1 and 88.2 in 2009, the main assessment using the final reliable trip dataset following the recommended modifications to the methodology given in WG-SAM-09/19 and, as a sensitivity run, one using only the New Zealand vessels.

Future work

2.25   The Secretariat is requested to continue its liaison with national programs to link as many of the problem tags as possible and eliminate extraneous tagging events.

2.26   In the case of the skate tag returns, separation of tag-releases/recaptures before and after the Year-of-the-Skate is recommended (paragraph 2.18).

2.27   The Working Group noted that because the method described in paragraph 2.19 selects trips based on their performance relative to a population median, application of the method in future years may result in different trips from past years being included. This would change the mark–recapture estimates of population size over time. Further work is needed to address this issue.

Research longline data in estimating stock size

2.28   WG-SAM considered five items under this agenda item:

  (i)   estimating stock size of *Dissostichus* spp. in data-poor areas;

  (ii)   standardising CPUE for different longline fishing methods;

  (iii)   reviewing the longline research survey proposal by Japan;

  (iv)   reviewing the use of research hauls in the exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 completed as part of the Research and Data Collection Plan;

  (v)   estimating biomass using commercial longline data in Divisions 58.4.1 and 58.4.2.

2.29   Four papers were discussed under this agenda item. WG-SAM-09/10 summarised the results of a Japanese research survey completed in Divisions 58.4.4a and 58.4.4b in the 2007/08 season. WG-SAM-09/11 outlined a proposal for a Japanese vessel to carry out a research survey in Divisions 58.4.4a and 58.4.4b in the 2009/10 season. WG-SAM-09/6 summarised the implementation of research hauls in the exploratory fisheries for *Dissostichus* spp. in Subareas 48.6 and 58.4 in the 2008/09 season. WG-SAM-09/12 provided an abstract only of using an ASPM to estimate biomass in Divisions 58.4.1 and 58.4.2. Reference was also made to the recent work outlined in SC-CAMLR-XXVII (Annex 5 including the Fishery Report for Subarea 48.4 (Appendix Q) and Annex 7).

  Use of longline operations in assessing toothfish
  in data-poor areas

        Background

2.30   There is an ongoing need to develop robust stock assessments for *Dissostichus* spp. in new and exploratory fisheries in Subareas 48.6 and 58.4. Two sets of data have been used for this purpose to date: tag data and longline CPUE data.

2.31   At the WG-FSA-08 meeting it was recognised that in some SSRUs the number of tag-recaptures was very low and that it might take many years before sufficient tags were recovered to enable a stock assessment based on tag-recapture data.

2.32   It was also recognised that assessments based on longline CPUE data were problematic for a number of reasons, including the representativeness of the data in estimating fish abundance; standardisation of longline gear – both between methods (e.g. autoline, Spanish longline, trotline) and within methods (e.g. differences in the configuration of the trotline method between vessels), and estimating the catchability coefficient (q) between vessels.

Discussion

2.33   WG-SAM considered the question of what is the best way to estimate stock size (and stock status) in data-poor areas which are not currently being assessed (i.e. Subareas 48.6 and 58.4).

2.34   WG-SAM agreed that the best way to estimate current stock size in data-poor areas is to carry out a tagging program.   The tagging program would require a multi-annual commitment, including tag-release and recapture phases. Although two years is the minimum timeframe, experience has shown that a period of 3–5 years is often required.

2.35   The design of the tag-release phase would need to include consideration of the number of tags to be released, the size of fish to be tagged, the location of tag-releases, potential stock sizes and potential number of fish that could be scanned. The Working Group considered that:

(i)   the range of stock sizes could be derived using available information on CPUE and available habitat area (but note the need to standardise CPUE);

(ii)   the number of tags to be released could be determined using the approach followed in Hillary (2009) with a matrix showing the number of tags to be released across a range of stock sizes from above to achieve a target CV;

(iii) ideally, tags should be spread across the population in sufficient numbers to achieve a high probability of recapture;

(iv)   tags should be released at the highest possible rate dependent on likely survivorship characteristics of the animals concerned, and the length of tagged fish should be representative of the population in the area concerned. Because smaller fish tend to have lower rates of initial mortality, tag loss and tag shock (WG-SAM-09/13), it may be better to initially target areas containing a higher proportion of smaller fish;

(v)   tags should be spread evenly across the survey area because experience elsewhere has shown that toothfish typically move only short distances and that tagged fish may take several years to mix evenly across an area (this was a key component of the tagging program in Subareas 48.3 and 48.4);

(vi)   if the area is large and the probability of recapture is low, then it may be necessary to concentrate effort on a subset of the management area in year 1. In such a case it would be important to recognise that estimates of abundance

resulting from the work would be representative of the smaller area. The tagging effort might be extended more widely in future years, subject to review.

2.36   The design of the tag-recapture phase would need to include consideration of the location of fishing in year 2 and numbers of fish to be scanned. This should take into account the following:

(i)   fishing in the recapture phase should be spread widely across the experimental area;

(ii)   the number of fish needed to be scanned to achieve a target CV should be estimated;

(iii)   gear standardisation between the release and recapture phases is important to ensure tag mortality rates and selectivity, and other parameters which could influence assessments should be standardised as much as possible.

2.37   Other details of the release and recapture phases and other general issues associated with tagging programs are considered in the Research Data and Collection Plan (Conservation Measure 41-01).

2.38   Appropriate levels of retained catch should be calculated based on conservative estimates of available biomass, harvest rates that would not hinder recovery of a depleted stock and the requirements of the tagging and recapture plans. An estimate of the likely mortality rate of the scanned fish should be provided so that an estimate of the minimum retained catch could be obtained. If a high proportion of the scanned fish were tagged and released in good condition, then this would increase the pool of tagged fish in the population.

2.39   Other data would be required before a stock assessment could be carried out. This could include the reconstruction of the catch history (including both legal and IUU catch), the reading of any existing otoliths to determine growth rates and the age composition of the catch, and the collection of other ancillary biological data important to an assessment.

2.40   WG-SAM agreed that any research program be framed as a 3–5 year experiment with annual reviews, as has been carried out for Subarea 48.4. This should include a timeline for the work to be carried out and the anticipated numbers of tags to be released and recovered (under varying assumptions of biomass, tag-release and tag-recapture rates).

2.41   WG-SAM recommended that WG-FSA use the protocols provided in paragraphs 2.33 to 2.40 to review any future research proposals to develop stock assessments in data-poor areas, and that these be further evaluated through simulations.

2.42   WG-SAM also recommended that WG-FSA consider the feasibility of using this approach to develop stock assessments in Subareas 48.6 and 58.4.

Standardisation of CPUE for different longline fishing methods

Background

2.43   Preliminary assessments of toothfish for some of the exploratory fisheries in Subarea 58.4 have relied to a large extent on comparisons of CPUE between different areas. However, this has been problematic because of the representativeness of the data and the comparability of units of effort (e.g. number of hooks), both between methods (e.g. autoline, Spanish longline, trotline) and within methods (e.g. differences in the configuration of the trotline method between vessels).

Discussion

2.44   WG-SAM noted that the relative properties of the different longline gears were still very poorly understood. Such properties include catchability (relative attraction and efficiency), selectivity in relation to target catch, fish and invertebrate by-catch, size composition and condition of fish on capture.

2.45   Understanding these issues is important in being able to effectively standardise catch rates and other important parameters when carrying out stock assessments for *Dissostichus* spp.

2.46   WG-SAM welcomed the initial fishing trials of trotlines and Spanish longline systems conducted by Japan in Division 58.4.3b in January–February 2009 (WG-SAM-09/11) and recommended that the Scientific Committee request Members to undertake fishing trials between gear types so that their properties can be better understood.

Review of the Japanese longline research survey proposal

Background and papers

2.47   The directed fishery for *Dissostichus eleginoides* in Divisions 58.4.4a and 58.4.4b was closed in 2002/03 due to the Scientific Committee's concern regarding the low levels of the stock and the high level of IUU fishing (SC-CAMLR-XXI, paragraphs 4.106 to 4.108).

2.48   Japan carried out a research survey in these divisions in 2007/08. Japan also submitted a proposal to the Scientific Committee in 2008 to carry out a research survey in 2008/09 with the aim of determining stock status and, in particular, whether the stock has recovered since the fishery was closed in 2002/03.

2.49   The Scientific Committee requested that WG-SAM review the survey design (SC-CAMLR-XXVII, paragraphs 8.6 to 8.8). WG-SAM-09/10 and 09/11 were reviewed in this context.

2.50   WG-SAM considered three questions:

(i)   What should be the aims of the research?
(ii)   How would that best be achieved?
(iii) What impact would that have on the stock recovery?

2.51   WG-SAM agreed that it would not be possible to determine whether the stock had recovered based on the results of a single longline survey; a research program would need to be carried out over an extensive period to address this issue. It considered that the priority short-term aim for research in this division should be to determine current stock size and this would be best carried out using a tagging program. The tagging program would require a multi-annual commitment, including tag-release and recapture phases as outlined in paragraphs 2.35 to 2.40. It noted that, for this survey, particular focus should be made on the initial number of tagged fish, their length and release location, and gear standardisation.

2.52   The research program should adopt a phased approach which should concentrate effort on a subset of the management area in year 1 and may be extended more widely in future years, subject to review.

2.53   Other data required for a stock assessment should also be collated including the reconstruction of the catch history (including both legal and IUU catch), the reading of any existing otoliths to determine growth rates and the age composition of the catch, and the collection of other ancillary biological data important to the assessment.

2.54   WG-SAM recommended that WG-FSA consider both the general protocols detailed in paragraphs 2.30 to 2.40, as well as the specific advice detailed in paragraphs 2.50 to 2.53 when reviewing the Japanese proposal for research in Division 58.4.4.

2.55   WG-SAM recommended that WG-FSA consider how the research program could be further developed to determine stock status and be used to provide estimates of yield under the CCAMLR decision rules.

Use of research hauls in the exploratory fisheries for *Dissostichus* spp.

Background

2.56   There is a need to develop robust stock assessments for *Dissostichus* spp. in Subareas 48.6 and 58.4. The issue addressed here concerns whether CPUE data from research longline hauls can be used to help develop these assessments. Until 2007/08, vessels were required to complete 10 research hauls (each comprising 3 500–5 000 hooks and being separated by a distance of at least 5 n miles) on entering an SSRU in an exploratory fishery (Conservation Measure 41-01). For the 2008/09 season, each SSRU was divided into two strata (fished and non-fished/lightly fished) and vessels were required to carry out their research hauls at randomly allocated positions.

Discussion

2.57 WG-SAM considered that the aim of carrying out the research hauls in this manner needed to be more clearly defined. It noted that previous fishing in the SSRUs had often concentrated on quite localised areas within SSRUs. WG-SAM agreed that the main aim should be to develop a time series of background longline CPUE data for the non-fished/lightly fished strata.

2.58 In implementing this approach:

(i) the boundaries for the fished and non-fished/lightly fished strata should remain the same as were used for the 2008/09 season;

(ii) new locations for the research hauls for each strata should be randomised each year;

(iii) hauls completed in 2008/09 in fished and lightly fished strata should be added to the hauls available for bootstrapping in those strata. Locations for hauls in non-fished strata should be randomised on longitude as was done for 2008/09;

(iv) alternative randomised research haul locations may need to be provided for SSRUs where ice is a problem.

2.59 The number of research hauls required to achieve a target CV for this monitoring tool should be evaluated by WG-FSA and, if appropriate, the proportion of research hauls in the non-fished/lightly fished strata could be altered accordingly.

2.60 WG-SAM recommended that the research set allocation approach developed for use for the exploratory fisheries in 2008/09 be retained for the 2009/10 season with the implementation outlined in paragraph 2.58.

2.61 WG-SAM recommended that WG-FSA be more specific over how this may lead to, or improve, an assessment.

Estimating biomass using commercial longline data
in Divisions 58.4.1 and 58.4.2

Background

2.62 WG-SAM and WG-FSA have provided advice previously on estimating biomass using commercial longline data in exploratory fisheries in Divisions 58.4.1 and 58.4.2 (SC-CAMLR-XXVI, Annex 7, paragraphs 4.1 to 4.11; SC-CAMLR-XXVI, Annex 5, paragraphs 5.21 to 5.29). WG-SAM-09/12 provided an abstract only of using an ASPM to estimate biomass in these divisions.

Discussion

2.63 WG-SAM noted that it was not possible to determine whether the method was appropriate to be used in the absence of a paper detailing the application of the method. Dr K. Shust (Russia) presented background to the method used, which was based on the methods of WG-FSA-06/58.

2.64 The Working Group recalled the discussions on the application of this method contained in previous reports, including needing to understand how different datasets are included and weighted in the assessment (WG-FSA-06/6, paragraphs 2.83 and 2.84), needing the source code to determine how the method had been applied (SC-CAMLR-XXV, Annex 5, paragraph 4.33), and the sensitivity of the results to changes in length composition relative to CPUE (SC-CAMLR-XXVI, Annex 7, paragraph 5.5).

2.65 The Working Group noted that an assessment of toothfish biomass in Division 58.4.1 based on commercial longline data will be provided to WG-FSA this year. It encouraged the authors to provide details of the methods and results, including diagnostics and responses to issues in paragraph 2.64. The Working Group recommended that the process for validating models (see Item 5.3) be followed for reviewing this approach and assessment.

ASSESSMENTS

Age-based assessments

Review of updated methodologies proposed for use in the assessment
of toothfish in Subarea 48.3 and Division 58.5.2

Background and papers

3.1 In response to advice from WG-FSA in 2007, the assessments of toothfish in Subarea 48.3 and Division 58.5.2 have been modified. WG-SAM was asked to review the methodological aspects of these updates prior to the completion of updated assessments for these stocks. Two papers were presented related to this task: WG-SAM-09/9, updating the assessment for toothfish in Division 58.5.2 presented in Candy and Constable (2008), and WG-SAM-09/13, updating the assessment for toothfish in Subarea 48.3 presented in WG-FSA-07/29.

Updated assessment for Subarea 48.3

3.2 The Working Group noted that various length-related effects on tagged fish (mortality, tag loss, growth retardation) were investigated in the updated Subarea 48.3 assessment by discounting the number of tagged fish released in larger size classes and adjusting the proportion-at-length. This was considered a reasonable approach in a CASAL assessment.

3.3 Incorporating these effects did not obviously improve the trends in the residuals of tag-recoveries-at-length, although it was noted that this was not particularly easy to judge from the available plots, and resulted in no substantive changes on the model outputs.

3.4   A possible alternative explanation for the residual pattern is that this result arises from the method of conversion of length to age within the model.

3.5   The Working Group noted that WG-SAM-09/13 described the time series of survey abundance estimates used in the assessment. Most surveys occurred in January and the September surveys have not been useful for detecting juvenile toothfish. The Working Group agreed that the September surveys should be excluded from the series. However, catch-at-length data from all surveys should be retained in this assessment.

3.6   The Working Group noted that growth parameters were successfully estimated within the Subarea 48.3 assessment without the need to fix t_0.

Updated assessment for Division 58.5.2

3.7   The Working Group noted that much poorer fits to longline fishery catch-at-age arose in the Division 58.5.2 assessment when ALKs were applied by fishery and year, where available, than when ALKs were pooled across fisheries within a year. It was suggested that this was probably associated with the retention of catch-at-length data for fisheries where ALKs were not available.

3.8   Different ageing-error matrices, produced for various otolith readability scores, appeared to have substantial influence on the MPD estimates obtained for a number of important parameters.

3.9   It was noted that some of the calculated ESS for catch-at-length proportions exceeded the length-frequency sample size (WG-SAM-09/9, Tables A2.3 and A2.4). This arose as a result of the regression approach used in the estimation of the multinomial ESS.

General

3.10   The Working Group recommended that authors of assessments should routinely provide standardised residual plots or display confidence intervals on plotted estimates to assist WG-FSA in making a visual diagnosis of model fits (paragraph 3.3).

3.11   The updated assessment of toothfish in Subarea 48.3 had adequately addressed the matters raised by WG-FSA in 2007, and the revised model incorporating catch-at-age and survey data should be used for undertaking an assessment of the stock in 2009. It was noted that, while a sex-disaggregated model was successfully implemented for Subarea 48.3, the biomass trajectories estimated in the more complex model were similar to the aggregated model, and the sparse ageing data currently available probably do not justify the use of the disaggregated model.

3.12   The Working Group welcomed the incorporation of fishery and survey age data in the Division 58.5.2 assessment, and recommended the age-based assessment be considered by WG-FSA together with a number of model simplifications which may assist in fitting to longline catch-at-age data and exploring the influence of ageing-error assumptions (paragraph 3.7).

3.13   The Working Group noted that the use of either MPD estimates or MCMC estimates needs to be considered in assessments. While MCMC is preferred in characterising the uncertainty, computing and other constraints may result in the need to consider MPD estimates. In both cases, the Working Group noted that appropriate diagnostics would need to be presented to ensure that the estimates were appropriate.

3.14   The Working Group recommended that WG-FSA consider the choice of year classes to be estimated in each assessment, the years over which these year-class strengths (YCS) are assumed to have average recruitment, the first year of recruitment considered unknown in projections, and the years of observed recruitments to be resampled when doing projections. Further, it noted that the choice of YCS to be estimated, and the choice of YCS to be included in projections, should consider the information available from the data to allow these to be reliably estimated.

Future work

3.15   The Working Group suggested that a simulation exercise could be carried out to investigate whether trends in the residuals of tag-recoveries-at-length in the Subarea 48.3 assessment could arise as a result of length–age conversions in the CASAL model (paragraph 3.4).

3.16   The Working Group suggested investigating the removal of length observations from the Division 58.5.2 assessment model. It was considered that these observations may provide little information on cohort strength in addition to that provided by the available age data (paragraph 3.7).

3.17   It was also suggested that the recent (2002–2008) Division 58.5.2 trawl survey series be incorporated in the assessment as a biomass index and catch-at-age proportions, rather than as numbers-at-age or length, to allow fits to these data to be assessed separately. The Working Group noted that methods to incorporate uncertainty in survey q could also be revisited in the Division 58.5.2 assessment, now that age data are available.

3.18   The Working Group suggested that the effect of otolith readability and the resulting assumed ageing-error matrix could be considered further in a simpler model without length observations (paragraph 3.8).

3.19   Methods for estimating the ESS for data assumed to follow a multinomial distribution should consider the plausibility of an ESS which exceeds the number of fish sampled (paragraph 3.9; see also Candy, 2008), noting that model process error is likely to further modify these estimates.

Length-based assessments

Use of acoustic and net data to estimate abundance
and distribution of *Champsocephalus gunnari*

Background and papers

3.20   The Working Group recalled that varying headline height may change the proportion of the fish population that is susceptible to gear during surveys. Currently a constant adjustment factor of 1.241 is applied to biomass estimates from recent bottom surveys in Subarea 48.3 (SC-CAMLR-XXI, Annex 5, paragraph 5.103). WG-FSA-08 recommended the evaluation of the adjustment factor for icefish surveys using acoustic methods (SC-CAMLR-XXVII, Annex 5, paragraph 3.26), and WG-SAM-09/20 was presented to address this task.

Discussion

3.21   The Working Group noted that WG-SAM-09/20 showed that acoustic data reveals high spatial heterogeneity in the distribution of icefish that was not apparent in net data from surveys conducted in 2000 and 2002 in Subarea 48.3. The analysis of acoustic data further indicates that the headline height adjustment factor would vary across and between surveys due to this heterogeneity.

3.22   The Working Group further noted that spatial heterogeneity in the icefish distribution is an important source of uncertainty in the trawl survey biomass estimates and that acoustic data collected during trawl surveys can produce important information to investigate this spatial heterogeneity and evaluate the application of the adjustment factor for trawl headline height used in icefish surveys in Subarea 48.3.

3.23   The Working Group recommended that WG-FSA consider recent acoustic data in addition to those analyses presented in WG-SAM-09/20 when evaluating the survey design and adjustment factor used in assessments of *C. gunnari* in Subarea 48.3 and noted that the UK was undertaking some of this work.

Future work

3.24   The Working Group recommended the continued collection of acoustic data during icefish surveys, and the analysis of recent acoustic data collected during *C. gunnari* surveys in Subarea 48.3.

A length-based framework for assessing *C. gunnari*

Background and papers

3.25   The Working Group recalled that the current *C. gunnari* assessment procedure requires competency in CMIX and GYM, and that the current interface to these packages may not be robust to changes in operating systems. Decomposing length frequencies into cohorts using

CMIX for survey data from Subarea 48.3 has required additional user input due to issues with distinct length structures in strata around Shag Rocks as opposed to strata adjacent to South Georgia. WG-SAM-09/15 presented a new framework for conducting assessments of icefish, incorporating a length-based population model.

Discussion

3.26   The Working group welcomed the approach presented in WG-SAM-09/15, in which a single script in R is used for the *C. gunnari* assessment. The script can be used on any computing platform and requires less user input.

3.27   The Working Group noted that implementation of a length-based growth framework also has the potential to remove the need for decomposition of length-density data into cohorts, as well as having the potential to make MSE for icefish more straightforward.

3.28   The Working Group noted that the method produced comparable results to recent assessments; however, divergence was greatest between the two models in 2008. This divergence may result from the increased spread of length classes present in the 2008 survey (SC-CAMLR-XXVII, Annex 5, Appendix O, Figure 4).

3.29   The Working Group recommended the investigation of alternative methods of estimating the growth-transition matrix, including using data on the growth of icefish cohorts from survey and commercial catch time series.

3.30   The Working Group recommended investigation to account for the divergence between the estimates of the current method and the new method, particularly in 2008.

3.31   The Working Group recommended that WG-FSA consider using the new assessment framework, with the refinements suggested in paragraphs 3.29 and 3.30, to develop assessment advice for *C. gunnari* in Subarea 48.3.

Future work

3.32   The Working Group encouraged the use of similar frameworks to conduct MSEs for *C. gunnari*.

Abundance of seals and penguins

Standardising or estimating general abundance counts
of seals and penguins

Background and papers

3.33   A method to standardise or estimate general abundance counts of seals and penguins by accounting for availability bias, detection bias, and sampling fractions less than unity, was discussed (WG-SAM-09/16).

3.34   The Working Group noted that the developments towards standardising count data would be useful for other working groups. In particular, the Working Group noted that standardisation for factors such as availability, detection and sampling fractions is an important step in the development of regional abundance estimates (and possibly time series) for analysis.

3.35   The Working Group noted that ICESCAPE (Integrating Count Effort by Seasonally Correcting Animal Population Estimates) provides a useful approach for use to undertake standardisations for count data and uses a GAM and resampling algorithm. The Working Group did not undertake validation work at this meeting. It noted that such approaches require strong assumptions about the nature of relationships between observations and therefore caution is required in interpreting estimates that are based on such adjustment methods. Further, the Working Group noted that such methods are difficult and necessarily complex, and modelling assumptions will influence results. Nevertheless, the use of the resampling or other methods that allow quantification of appropriate levels of the uncertainty to be incorporated into count data are important.

3.36   The Working Group requested information from the authors of WG-SAM-09/16 for the rationale for resampling the convolutions without replacement rather than with replacement.

3.37   The Working Group noted that the GAM approach appeared to be a reasonable method to model the chronology of penguin abundance at breeding colonies as detailed in WG-EMM-09/38, but subject to the caution noted in paragraph 3.35.

MANAGEMENT STRATEGIES AND THEIR EVALUATION

Spatially structured population models

    Potential tools for use in spatial operating/assessment models
    for CCAMLR fisheries

        Background and papers

4.1   The Working Group recognised that the incorporation of spatially resolved data and processes in operating models used to test the robustness of current/future spatially aggregated assessments, or in spatially explicit assessments, is of key importance to CCAMLR. WG-SAM-09/17 provided a technical guide to the SPM package first presented last year and WG-SAM-09/18 presented a specific application of the SPM to the Ross Sea *Dissostichus mawsoni* fishery.

        Discussion

4.2   The Working Group noted that WG-SAM-09/17 was the first time that a technical manual had been presented for this model, which greatly facilitated the consideration of this

model. The Working Group also considered that having the flexibility to work with fine-scale or coarse-scale resolutions, as well as having wide or restricted areas, is a valuable attribute in developing operating models.

4.3   Recognising that environmental data, such as sea-surface temperature and primary production, can provide useful information relating to animal distribution, the Working Group noted that their inclusion in the covariate layers of the SPM would be useful to investigate in future applications.

4.4   The Working Group noted the differences in the model-predicted distribution of mature/spawning fish and those suggested in Hanchet et al. (2008) describing the potential life-cycle of *D. mawsoni* in the Ross Sea. Given the early stage of development of the model, the Working Group reiterated that being able to address these differences with this type of model further added to their usefulness, and that the Working Group fully supported future development work of the SPM in this regard.

4.5   The Working Group recommended that, given that the data were sufficiently well described by the model, and that the data were limited in terms of both being predominantly from commercial sources and spatially limited, the SPM package could be useful for guiding future decisions with respect to data collection. Furthermore, the model may also be a useful tool for exploring which Ross Sea SSRUs might be opened or closed and other aspects of spatial management for fishing in the future.

Future work

4.6   The Working Group recommended that the SPM model be developed further, considering the issues in paragraphs 4.2 to 4.4, along with different representations of movement.

Conserving VMEs

A review of methodological approaches to advise on management strategies for conserving VMEs

Background and papers

4.7   Conservation Measures 22-06 and 22-07 acknowledge the urgent need to protect VMEs from bottom fishing activities and require the Scientific Committee to advise the Commission on the effectiveness of management measures currently implemented this year. Previous discussions on VMEs are summarised in CCAMLR-XXVII (paragraphs 5.4 to 5.30) and SC-CAMLR-XXVII (paragraphs 4.207 to 4.284, Annex 4, paragraphs 3.21 to 3.44 and Annex 5, paragraphs 10.3 to 10.109).

4.8   WG-SAM-09/21 presented a simulation model (coded in R) for evaluating management strategies to conserve benthic habitats, and WG-SAM-09/P1 presented an impact assessment framework for bottom fishing.

Discussion

4.9   The Working Group noted that impact assessment frameworks like that presented in WG-SAM-09/P1 can help Members submit preliminary assessments of the 'known and anticipated impacts' of bottom fishing as required by Conservation Measure 22-06. The methods described in WG-SAM-09/P1, which largely summarise expert opinion, were discussed at the last meeting of WG-FSA and have been accepted for publication in *CCAMLR Science*. The results presented in WG-SAM-09/P1 are based on the assumption that fishing effort and VMEs are independently and randomly distributed throughout the fishable area, and the Working Group noted that this assumption may not be appropriate for some VME indicator taxa. The Working Group noted that two methodological issues should be addressed in future applications of the framework; these have been identified as areas of future work. The Working Group also noted that information in WG-SAM-09/P1 might be used to inform the parameterisation of fishing impacts within the model described in WG-SAM-09/21.

4.10   Noting that the process to evaluate complex models takes some time (see Item 5.3), while acknowledging that there is a need to provide advice related to the conservation of VMEs in the short term, the Working Group started to familiarise itself with, and evaluate the implementation of, the model presented in WG-SAM-09/21. This process was facilitated by interactively reviewing parts of the model code (particularly the input data file), attempting to run an example, and asking questions of the model developer.

4.11   The Working Group agreed that models like that developed in WG-SAM-09/21 help to synthesise thinking about complex issues and can be used for at least two purposes:

(i)   to identify priority requirements for information gathering, data collection and synthesis;

(ii)   to evaluate the effectiveness of management measures intended to conserve VMEs.

4.12   With respect to point (i), the Working Group agreed that the model presented in WG-SAM-09/21 would provide a useful framework to guide discussions at the forthcoming meeting of WG-EMM and the VME Workshop. The Working Group therefore recommended that WG-EMM and the VME Workshop discuss ecologically appropriate parameterisations and functional forms for use in the model.

4.13   The Working Group advised that, as far as possible, WG-EMM and the VME Workshop should distinguish between appropriately interpreted empirical observations and subjective expert opinion to inform the parameterisation and selection of functional forms.

4.14   With respect to point (ii), the Working Group noted its discussion under Item 5.3 'Model validation' and agreed that further review (here defined as evaluation and validation) of the model presented in WG-SAM-09/21 will be needed, as a full review of the model could not be completed by WG-SAM this year. However, the Scientific Committee must advise on Conservation Measures 22-06 and 22-07 this year, and potential application of the model to evaluate the effectiveness of current or new management measures to conserve VMEs will depend on information that WG-EMM and the VME Workshop can provide to parameterise the model and identify appropriate functional forms.

4.15   The Working Group advised that it may be possible to use the model at the forthcoming meeting of WG-FSA if advice from WG-SAM, WG-EMM and the VME Workshop are incorporated into model developments prior to WG-FSA. WG-SAM also advised WG-FSA that it should provide advice which is commensurate with the state of the model, its documentation and the need for further review (paragraph 5.17), with the need for further review being stipulated within the advice. It also advised that further evaluation and validation by WG-SAM may be needed next year if required by WG-FSA or if other developments are required.

Future work

4.16   Future development of impact assessments like that presented in WG-SAM-09/P1 should:

(i)   incorporate uncertainty (perhaps by bootstrapping);

(ii)   indicate, for each VME indicator taxon, the proportion of the taxon's distribution that is overlaid by the cumulative footprint of each fishing method (or impact source).

4.17   Further development of the model presented in WG-SAM-09/21 should continue; the model code should be further validated by demonstrating the model does what is intended; and Members should aim to collaborate on further work.

4.18   A user manual and more comprehensive documentation should be developed for the model presented in WG-SAM-09/21. A hierarchical set of simple examples that can help the Scientific Committee and its working groups to develop an increased understanding of the model (e.g. like the set used to increase understanding about the behaviour of FOOSA, WG-EMM-06/20) should also be developed.

4.19   As time allows, work to implement the model using object-oriented programming constructs, such as classes (possibly including S4 classes) and methods, should be pursued because these can increase code readability, portability etc.

Decision rules for target species

Evaluation of methods for examining robustness of current decision rules for *Dissostichus* spp. toward meeting CCAMLR objectives

Background and papers

4.20   Consideration of advancements of these methods arises from the Scientific Committee's encouragement for WG-SAM to continue development of MSE (SC-CAMLR-XXVI, paragraph 2.10), which provides a mechanism for measuring efficacy of methods toward achieving management objectives. The Working Group was requested to further develop operating models to generate simulation data for testing candidate management procedures and develop future advice on catch limits (SC-CAMLR-XXV, Annex 5,

paragraph 12.5), and advance evaluation of the assessment and harvest strategy along with the further development and evaluation of management strategies for toothfish fisheries (SC-CAMLR-XXV, Annex 5, paragraph 12.6).

4.21　Two papers were available to the Working Group, WG-SAM-09/13 and 09/14. The Working Group also noted the existing CCAMLR decision rules for toothfish.

4.22　The Working Group agreed that there were two distinct issues that needed to be dealt with separately:

(i)　the appropriateness of using reduced-complexity models as proxies in simulations for MSEs;

(ii)　the appropriateness of alternative exploitation-rate-based harvest control rules (HCRs).

Discussion

Use of reduced-complexity models as proxies
in simulations for MSEs

4.23　The Working Group noted that the use of the simple biomass dynamic model to explore the robustness of the current *Dissostichus* spp. CCAMLR decision rules to various scenarios permitted substantially less computation time, and more straightforward insight into the system from either a biological or management point of view. The Working Group noted that the assumption of this approach is that a management strategy rule that performs well for a simple system may not perform well for the more complex system, but a strategy that performs poorly for the simple system is less likely to perform well for the complex system.

4.24　The Working Group noted that some of the alternative scenarios explored in the biomass dynamic model included future productivity changes over time by adjusting the intrinsic rate of increase, r. It was agreed that it may be useful in this model to also explore the effect of changes in carrying capacity, K. The Working Group recommended that a slightly more complex cohort model should be employed as the underlying operating and assessment models to explore the robustness of the current *Dissostichus* spp. CCAMLR decision rules, which could change the dynamics, add complexity and potentially allow for more effects to be detected.

4.25　The Working Group recommended further investigation of how simplified systems could be used as proxies, noting their likely value in evaluating assessment and harvest strategies for achieving management objectives.

Alternative exploitation-rate-based HCRs

4.26　The Working Group examined a comparison of the robustness of the CCAMLR HCR with an alternative target-limit reference point HCR that uses exploitation rates, presented in WG-SAM-09/14. The HCRs were explored with respect to biomass depletion, assessment

precision, time-horizon, implementation error and future changes in productivity. The results indicated that the alternative HCR outperformed the CCAMLR HCR in some simulations, although neither did well when stocks were depleted.

4.27   The Working Group noted that the greater robustness of the HCR may be a result of the rate at which the HCR would return the stock to the target level, i.e. the HCR attempts to set a catch to return the stock to the target level over five years rather than over 35 years. The Working Group also noted that there may be differences in performance as a result of projecting with incorrect assumptions over differing time periods. However, the biennial frequency of assessment for *Dissostichus* spp. stocks will help correct these errors. An important consideration in the use of any HCR is the consequences of the strategy over a population generation, which is captured in the current CCAMLR HCR. A shorter projection period in the HCR may have differing long-term consequences for achieving the objectives.

4.28   The Working Group agreed that consideration of the length of the projection period in the yield assessments and the issues discussed in paragraphs 4.26 and 4.27 represent a valuable beginning in a process of exploring alternative HCRs, and recommended that WG-FSA include consideration of these issues in their discussion. The Working Group requested submissions to future WG-SAM meetings for additional development of methodologies and analysis of consequences of modifying current decision rules.

4.29   The Working Group briefly considered the suggestion set out in WG-SAM-09/13 that it may be worthwhile considering a modifier of the projection procedure for the *D. eleginoides* fishery in Subarea 48.3. This issue arose as a result of the apparent very low recruitments to some recent cohorts which are indicated by some survey data. The assumption that future recruitment will return to historical levels in the projections will carry some risk that the catch limits using the existing CCAMLR HCRs would allow the spawning biomass to drop below the target of 0.5 B_0. The Working Group recognised that, once the stock was fished to 50%, there would be fluctuations about the target level. The Working Group noted that this concern might be alleviated by considering using an appropriate subset of the recruitment indices and resampling from these in the Monte Carlo projections. The Working Group recommended exploring the use of a subset of recruitment indices for Subarea 48.3 by WG-FSA.

4.30   The Working Group recommended that WG-FSA consider how to manage scenarios where there are trends or significant changes in the stock dynamics, and the implications of this on the definition of B_0, as well as the objective of the decision rules. The Working Group recommended that there needs to be additional consideration given to stocks that are near or at target levels, and implications of fluctuations around target levels due to, for example, recruitment events/variability.

OTHER ADVICE FOR SC-CAMLR

Observer sampling requirements

Impact of changing sampling priorities for observers
on toothfish assessments

Background and papers

5.1   Changing research priorities, for example, due to sampling efforts for the Year-of-the-Skate, has led to changes in sampling intensity of toothfish by observers in new and exploratory fisheries. WG-FSA requested that WG-SAM consider a statistical analysis of the required sampling level of *Dissostichus* spp. by observers for the collection of biological, age and length data (SC-CAMLR-XXVII, Annex 5, paragraph 11.8(vi)).   No papers were submitted on this topic.

Discussion

5.2   The Working Group noted that simulation frameworks and power analyses would be appropriate methods to evaluate observer sampling intensity versus the benefits from increased assessment precision.

5.3   The Working Group noted that the analysis of the optimum sampling intensity would be different if a season's data was considered in isolation, as opposed to where a time series of data exists.

5.4   The Working Group welcomed New Zealand's proposal to undertake an assessment of how changing sampling intensity for otoliths and length frequencies may impact on the CV of the annual estimates of catch-at-length and catch-at-age in the Subarea 88.1 *Dissostichus* spp. fishery.

Future work

5.5   The Working Group encouraged Members to develop simulation models to assist WG-FSA with prioritising observer tasks and sampling intensities.

Data quality

Background and papers

5.6   The Working Group noted that WG-SAM-09/19 presented further development of a method for selecting a tagging dataset, initially presented in WG-SAM-08/13, and WG-SAM-09/5 provided details of the CCAMLR databases and the data-quality validation conducted by the Secretariat.

Discussion

5.7   The Working Group noted that the development of WG-SAM-09/19 (paragraph 2.20) had illustrated inconsistencies and errors in observer and vessel data that originated at the point of collection, and indicated that some errors were not detected during the Secretariat's existing data validation routines. Further, some data had been inadvertently replicated by the Secretariat following repeated data submissions; this situation was rapidly corrected through correspondence with the Secretariat.

5.8   The Working Group also noted the Secretariat's progress in developing data-quality assessment, and in ensuring that users of CCAMLR data are fully aware of the integrity procedures that have been applied to the data (WG-SAM-09/5). The CCAMLR database documentation (WG-SAM-09/5, Appendix 1) was greatly appreciated and would provide a very useful resource for data users to better understand the CCAMLR database.

5.9   The Working Group also noted the time overhead involved in the iterative process between the Secretariat and Members in the data validation process and that any failure to submit data in an accurate and timely fashion slowed the availability of data for use in assessments.

Future work

5.10   The Working Group recommended:

(i)   the sensitivity of assessments to using a subset of data from the current season should be investigated;

(ii)   a suite of standard data-quality reporting procedures (including appropriate data-quality metrics) should be developed to assist the Secretariat and data analysts to:

(a)   identify anomalous observer and vessel data
(b)   provide feedback to data providers
(c)   create metadata records to assist future data users by clarifying data-quality issues.

Model development and validation

A process for validating models used in providing advice

Background

5.11   In 2008, WG-SAM (SC-CAMLR-XXVII, Annex 7, paragraphs 8.4 and 8.5) and WG-EMM (SC-CAMLR-XXVII, Annex 4, paragraph 8.16) noted the need to establish a process for validating models used in providing advice. This process should be consistent with SC-CAMLR-XXVI, Annex 7, paragraph 8.19, which indicated that scrutiny of methods,

procedures or approaches could be undertaken by other working groups where they considered they could satisfactorily do the task but, where this was not the case, the preferred process would be:

(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).

Discussion

5.12   In considering models, the Working Group noted that the primary aim of validation is to give the users confidence that the model is suitable for the task and that there are two components to validation:

1.   Is the model technically competent to do what it says it can do?

2.   Can the model be used for the purposes for which it was designed, including appropriately representing the systems to be modelled?

5.13   The Working Group recommended that to satisfy the first validation, a model that is to be used for a task should be accompanied by a manual for the time of use and that the manual be sufficient for a user to satisfy themselves that the model is technically competent. A manual would, ideally, provide clear and comprehensive documentation of the maths, procedures and methods of use, along with technical demonstrations and examples of proof that the model and methods work as expected.

5.14   With respect to the second validation, the Working Group noted that users will need to determine if the forms of the functions appropriately represent the processes to be modelled. WG-SAM can provide advice on mathematical and statistical methods to represent different functions and uncertainties where needed.

5.15   The Working Group noted that the validation process will need to take account of the time-scale of delivery of a proposed model being presented.

5.16   For models proposed to replace existing methods, WG-SAM recommended that the procedure in SC-CAMLR-XXVII, Annex 7, paragraph 3.21, be generalised as:

(i)   a full paper detailing the method and its implementation needs to be compiled from existing work and presented to WG-SAM with further consideration of its implementation as discussed in the following points;

(ii)   simulated (theoretical) data need to be developed for a number of scenarios and those data need to be analysed using the existing model and the proposed model in order to compare how the two methods perform using data from known attributes to be estimated or modelled;

(iii)   mathematical and statistical details of how the input data for the new model are generated from the available datasets used in the existing model, including any pooling of the data in space and/or time, need to be provided;

(iv)   comparison of the outputs of the existing and proposed models and the reasons for any differences.

5.17   For models that have been developed to meet a specific request of the Scientific Committee or Commission by a short deadline, WG-SAM noted that there may not be time available for a full evaluation and validation before they need to be used. In such a situation, WG-SAM recommended that:

(i)   advice arising from the model is commensurate with the level of evaluation and validation of the model;

(ii)   users review the model code and documentation available, including how the model performs with respect to the task for which it will be applied, noting that developments and subsequent review could increase the utility and confidence in the model.

5.18   WG-SAM noted that the development and validation of models would be enhanced by maintaining the code on a fileshare that can be accessed by model developers and reviewers to add to, revise and/or review the code and its implementation. It also noted that this would be facilitated by having software to track updates and comments on the code (SC-CAMLR-XXVII, Annex 7, paragraphs 7.1 to 7.4). In this regard, a SubVersion (SVN) client, a mostly compatible successor to the widely used Concurrent Versions System (CVS) discussed last year, was demonstrated to the Working Group. It was considered to be a useful software package to help manage versions of these models. WG-SAM recommended that the Scientific Committee consider how this process could be facilitated.

FUTURE WORK

6.1   The Working Group identified the following future work:

(i)   ALKs (paragraph 2.8);

(ii)   tagging data (paragraphs 2.25 to 2.27);

(iii)   age-based assessments (paragraphs 3.15 to 3.19);

(iv)   length-based assessments (paragraphs 3.24 and 3.29 to 3.32);

(v)   standardising or estimating general abundance counts of seals and penguins (paragraph 3.33);

(vi)   spatially structured population models (paragraph 4.6);

(vii)   conserving VMEs (paragraphs 4.16 to 4.19);

(viii) decision rules for target species (paragraphs 4.24, 4.25, 4.28 and 4.30);

(ix)   observer sampling requirements (paragraph 5.5);

(x)   data quality (paragraph 5.10);

(xi)   model development and validation (paragraph 5.18).

ADVICE TO THE SCIENTIFIC COMMITTEE

WG-EMM

7.1   WG-SAM has provided advice to WG-EMM on the following items:

(i)   standardising or estimating general abundance counts of seals and penguins (paragraphs 3.35 and 3.37);

(ii)   conserving VMEs (paragraphs 4.9 and 4.11 to 4.14).

WG-FSA

7.2   WG-SAM has provided advice to WG-FSA on the following items:

(i)   ALKs (paragraphs 2.10 and 2.15);

(ii)   tagging data (paragraphs 2.19, 2.22 and 2.24);

(iii)   estimation of stock size of *Dissostichus* spp. in new and exploratory fisheries (paragraphs 2.41 and 2.42);

(iv)   review of the Japanese longline research survey proposal (paragraphs 2.54 and 2.55);

(v)   use of research hauls in the exploratory fisheries for *Dissostichus* spp. (paragraphs 2.59 to 2.61);

(vi)   estimating biomass using commercial longline data in Divisions 58.4.1 and 58.4.2 (paragraph 2.65);

(vii)   age-based assessments (paragraphs 3.10 to 3.14);

(viii) length-based assessments (paragraphs 3.23 and 3.29 to 3.31);

(ix)   spatially structured population models (paragraph 4.5);

(x)   conserving VMEs (paragraphs 4.9 and 4.11 to 4.14);

(xi)   decision rules for target species (paragraphs 4.28 to 4.30).

WG-IMAF

7.3   There was no advice specific to WG-IMAF.

General

7.4   WG-SAM has provided general advice on the following items:

(i)   model development and validation (paragraphs 5.11 to 5.17);

(ii)   standardisation of CPUE for different longline fishing methods (paragraph 2.46).

7.5   The Working Group advised the Scientific Committee that submission of only abstracts is insufficient to undertake adequate reviews of papers and their conclusions. It requested that papers be submitted in full to future meetings.

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 Constable thanked the participants for their open and warm approach to their work, the subgroup coordinators for motivating clear and focused discussions, and the rapporteurs for producing a succinct report. He also thanked Mr Iversen and IMR for providing excellent facilities and meeting arrangements, and the Secretariat for its support.

8.3   The Working Group noted that the development of the meeting document archive on the CCAMLR website had greatly enhanced access to past meeting documents and reports.

8.4   Dr Agnew, on behalf of the participants, thanked Dr Constable for his leadership, and for introducing a new format to the meeting and report.

REFERENCES

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(Bergen, Norway, 29 June to 3 July 2009)

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AGENDA

Working Group on Statistics, Assessments and Modelling
(Bergen, Norway, 29 June to 3 July 2009)

1. Introduction
   1.1 Opening of the meeting
   1.2 Adoption of the agenda and organisation of the meeting

2. Use of data in assessments
   2.1 Age–length keys
   2.2 Tagging data
   2.3 Research longline data in estimating stock size

3. Assessments
   3.1 Age-based (toothfish)
   3.2 Length-based (icefish)
   3.3 Abundance of seals and penguins

4. Management strategies and their evaluation
   4.1 Spatially structured population models
   4.2 Conserving VMEs
   4.3 Decision rules for target species

5. Other advice for SC-CAMLR
   5.1 Observer sampling requirements
   5.2 Data quality
   5.3 Model validation

6. Future work
   6.1 Long-term work plan
   6.2 Other issues

7. Advice to the Scientific Committee
   7.1 WG-EMM
   7.2 WG-FSA
   7.3 WG-IMAF
   7.4 General

8. Adoption of report and close of meeting.

LIST OF DOCUMENTS

Working Group on Statistics, Assessments and Modelling
(Bergen, Norway, 29 June to 3 July 2009)

WG-SAM-09/1   Draft Agenda for the 2009 Meeting of WG-SAM

WG-SAM-09/2   List of Participants

WG-SAM-09/3   List of Documents

WG-SAM-09/4   CCAMLR Tagging Program
               Secretariat

WG-SAM-09/5   Data quality assessment in CCAMLR: requirements for minimum
               integrity testing to ensure that data are fit for purpose
               Secretariat

WG-SAM-09/6   Allocation of research hauls in the exploratory fisheries for
               Dissostichus spp. in Subareas 48.6 and 58.4 in 2008/09
               Secretariat

WG-SAM-09/7   Otolith-based ageing of the Patagonian toothfish (*Dissostichus
               eleginoides*) for the Heard and McDonald Islands: modelling fixed
               and random reader error using multiple readings of a reference
               S.G. Candy, G.B. Nowara, D.C. Welsford and J.P. McKinlay
               (Australia)

WG-SAM-09/8   Incorporating sampling variation and random reader error into
               calculation of effective sample size in the application of age length
               keys to estimation of catch-at-age proportions
               S.G. Candy (Australia)

WG-SAM-09/9   Update of the integrated stock assessment for the Patagonian
               toothfish (*Dissostichus eleginoides*) for the Heard and McDonald
               Islands using catch-at-age data and two years of survey abundance
               S.G. Candy (Australia)

WG-SAM-09/10   Abundance and biological information on toothfish in
               Division 58.4.4.a and b by *Shinsei Maru No. 3* in 2007/08 season
               K. Taki, T. Ichii, M. Kiyota and S. Kawahara (Japan)

WG-SAM-09/11   Research plan for toothfish in Division 58.4.4a and b by *Shinsei
               Maru No. 3* in 2009/10
               Delegation of Japan

WG-SAM-09/12	Antarctic toothfish stock assessment in Division 58.4.1 on the basis of CPUE data D. Vasilyev, K. Shust, V. Tatarnikov, I. Istomin and A. Petrov (Russia)
WG-SAM-09/13	Adding catch at age and survey data to the 48.3 toothfish CASAL assessment D.J. Agnew and M. Belchier (United Kingdom)
WG-SAM-09/14	Exploring the robustness of the current toothfish spp. harvest control rules and potential exploitation rate-based alternatives R. Hillary (United Kingdom)
WG-SAM-09/15	Length-based assessment for the mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 R.M. Hillary, D.J. Agnew and R. Mitchell (United Kingdom) (*CCAMLR Science*, submitted)
WG-SAM-09/16	Draft software user guide for: ICESCAPE: Integrated Count Effort by Seasonally Correcting Animal Population Estimates J. McKinlay, C. Southwell and R. Trebilco (Australia)
WG-SAM-09/17	Spatial population model user manual A. Dunn and S. Rasmussen (New Zealand)
WG-SAM-09/18	Development of spatially explicit age-structured population dynamics operating models for Antarctic toothfish in the Ross Sea A. Dunn, S. Rasmussen and S. Hanchet (New Zealand)
WG-SAM-09/19	Identification of data quality metrics for tagging data selection D.A.J. Middleton and A. Dunn (New Zealand)
WG-SAM-09/20	Analysis of icefish (*Champsocephalus gunnari*) spatial distribution for optimisation of the bottom trawl survey sampling S.M. Kasatkina (Russia)
WG-SAM-09/21	A simulation model for evaluating management strategies to conserve benthic habitats (vulnerable marine ecosystems) which are potentially vulnerable to impacts from bottom fisheries A.J. Constable (Australia)

Other Documents

WG-SAM-09/P1	An impact assessment framework for bottom fishing methods in the CCAMLR Convention Area B.R. Sharp, S.J. Parker and N. Smith (New Zealand) (*CCAMLR Science*, Vol. 16 (2009): 195–210)