REPORT OF THE 2013 MEETING OF THE ICCAT WORKING GROUP ON STOCK ASSESSMENT METHODS (WGSAM)

(Madrid, Spain – March 11 to 15, 2013)

1. Opening, adoption of Agenda and meeting arrangements

Dr. Pilar Pallares, ICCAT Assistant Executive Secretary, opened the meeting and welcomed participants. The meeting was chaired by Dr. Paul de Bruyn. Dr. de Bruyn welcomed the Working Group participants, reviewed the objectives of the meeting and proceeded to review the Agenda which was adopted with minor changes (**Appendix 1**).

The List of Participants is attached as **Appendix 2**.

The List of Documents presented at the meeting is attached as **Appendix 3**.

The following participants served as Rapporteurs for various sections of the report:

Section	*Rapporteurs*
1	P. de Bruyn
2	R. Coelho and J. Ortiz de Urbina
3	S. Cass-Calay
4	H. Arrizabalaga, G. Merino, D. Die and C. Brown
5	V. Ortiz de Zarate
6	G. Scott
7	N. Abid and C. Palma
8-9	P. de Bruyn

2. Model diagnostics

Document SCRS/2013/025 summarizes common model diagnostics available for Stock Synthesis and describes their interpretation. Examples of model misspecification are described and the resulting diagnostics are illustrated. The authors also provide a framework to facilitate an efficient and complete evaluation of model diagnostics.

The Group acknowledged the importance and usefulness of such diagnostics and noted that most of the tools and diagnostics presented would be similar and useful for most non-linear models, and not necessarily specific to SS3.

The Group discussed the importance and some issues with the estimated parameters correlation matrix. One point raised was that in the correlations matrix there may be a dependency between parameters. Still, it was noted that the examination of the estimated correlations between the parameters is an important diagnostic and further work is recommended.

A framework for model diagnostics in SS3 is presented in **Appendix 4**.

Document SCRS/2013/027 presents a variety of methods for exploratory data analysis and evaluation of the goodness of fit and inspection of diagnostics for the use in stock assessment. The intention is to list a set of common methods that can be used for a range of stock assessment models (from simple to complex) and for different data requirements, (e.g., biomass, size and age). A range of methods, to show how they can be implemented in R then discuss the consequences for stock assessments and strategies resolving problems identified was listed.

A general recommendation from the Group was that all stock assessment papers and documents presented to the ICCAT SCRS should provide appropriate diagnostics for the models being used, recognizing that even though different models and methods may have slightly different diagnostics, in general many diagnostics will be common to all methods.

The Group noted the need to move towards having diagnostics in all models, but keeping in mind that the diagnostic tools may be very large and take much time to work on, there was a general recommendation that those tools should be general and flexible. It was suggested that those diagnostics could be developed and used experimentally during 2013 for the albacore and swordfish stock assessments. After receiving feedback from those working groups, the diagnostic tools and recommendations could, as necessary, be revised for next year.

The Group noted the importance of having all these methods and tools well documented and freely available in open-source software. It was mentioned that these tools are currently being developed and implemented in R and made available through CRAN or other repositories (e.g., the package CPUE, R4SS, FLR, R4MFCL, etc). The "CPUE" package can read model outputs from any assessment method (e.g., ASPIC, VPA, MFCL, SS3) and then run a standard set of model diagnostic tools. Examples on the use of those tools were provided to the Group, and some graphical examples are provided in the paper.

Document SCRS/2013/030 documents available model diagnostics for the virtual population analysis routine VPA-2BOX. The particular example used for this document is the 2012 assessment of western Atlantic bluefin tuna. Model diagnostics included model convergence statistics, bias and standard error of model results, correlation and co-variance matrices for model parameters, sensitivity analyses of abundance indices and life history assumptions, and bootstrap analysis to evaluate model robustness and estimate central tendency and variance of parameter estimates. The usefulness of these diagnostics in evaluating model performance during the stock assessment is discussed, and recommendations for future improvement are provided.

The Group noted the importance of such tools and discussed, in general, the bootstrapping procedure, and its potential for diagnosing problems with violations of model assumptions. The Group also noted that preliminary data analysis and data cleaning procedures remain important procedures.

3. Review of current ICCAT methods for estimating EFFDIS.

Document SCRS/2013/021 presents a review of the previous methods of estimation of the total longline effort. The most recent estimation adopted by the SCRS was made in 2009 used the nine major ICCAT tuna and tuna like species to obtain Task I global nominal catches (in weight) and CPUEs from partial catch and effort (Task II) statistics. In 2011, the Secretariat presented a proposal based on a similar methodology but splitting the base effort calculations in two main areas (ATL/MED) in order to reduce the side effects of poor catch and effort statistics available for the Mediterranean Sea. The overall longline (LL) effort estimations increased considerably (>10%) in most recent years. The SCRS considered this new approach an important improvement, but at the same time noted that, LL Task II catch and effort statistics of important Mediterranean Countries need to be revised.

The current model basic assumption considers that catch rates are equivalent at partial and global level. Comparing the results with previous estimates (obtained during the inter-sessional meetings on ecosystems in 2007 and 2008) the global results do not show major differences. However, at more disaggregated levels the differences are larger for certain flags. In the majority of the cases, large relative variations are usually associated with various improvements and corrections made to some specific datasets. Global geographical distribution shows a small increase near the Venezuela waters due to various corrections made to spatial distributions of catch and effort statistics from Venezuela in several years. Potential areas for improvement of EffDIS estimation for the future are presented in order to stimulate discussion at the 2013 ICCAT WGSAM on ways to improve EffDIS information.

The Group recognized that EffDIS is a valuable tool that allows visualization and quantification of the spatial and temporal distribution of longline effort. It is often used by Sub-Committee on Ecosystems, particularly for assessments of the impact of ICCAT fisheries on bycatch species, including seabirds. In the past there has been concern regarding the method used to calculate these estimations and improvements in the methodology are required. Recent improvements to the dataset were described including stratification by month and the addition of fleets which reduced the total effort of unclassified fleets ("Other") from 17% to 13%.

The Group also discussed recommendations for improving the EffDIS dataset, including where possible:

- That data series reported by quarter or year be resubmitted by month.
- That data series reported without spatial information, or by stratification larger than 5° by 5° be resubmitted using at least a 5° by 5° stratification.

- That data series reported without longline effort be revised to include the corresponding effort.
- Recover historical datasets, particularly prior to 1991.
- Expand the number of species used in the raising of effort using the ratio of T2CE to T1NC to include major shark species (blue, porbeagle, and mako). This action would improve estimation of total effort. Note: EffDIS estimates are sensitive to species composition. A more complete characterization of species composition could be helpful.
- Differentiating Atlantic and Mediterranean fishing effort.
- Revise/improve the most important Mediterranean Sea Task II catch and effort series.
- To investigate the possibility of integrating into the analysis metadata regarding fleet behaviour targeting, (aiming to identify fleet profiles) in order to achieve more accurate projections of relative effort of fishing fleets.
- Examine suitability of assumptions for raising fleets (e.g., U.S. and Japan assumed to report full information and are not currently raised).

The Secretariat noted that improvements to EffDIS began in 2007 and are ongoing. Some improvements are largely complete (i.e., most catch-effort data is now by month and by 5 by 5 degree square) while others are pending.

The Group agreed that the recommendations listed above are appropriate and important. In addition, the Group suggested the following:

- An effort should be made to develop similar EffDIS estimates for the BB and PS gears. This would be particularly useful for evaluations of time-area closures.
- The Working Group recognizes the importance of accounting for changes in fishing operations and characteristics of the main fleets from each CPC operating within the ICCAT Convention area as these affect the efficiencies of the fleets for catching target and by-catch species. Documentation of these technological and behavioral changes is particularly important to understand the national reports of catch and effort annually submitted (Task II-CE). Taking into consideration also that CPCs are required to report fleet composition data (Task I-FC), it is recommended that CPCs present an SCRS document with the details of the fleet composition, sampling, coverage, and statistical methodology to estimate total catch, catch and effort, catch-at-size for each of the main fleet components. This report should also communicate the potential limitations and or restrictions of the data and information provided to be taking into account within any further analysis by the SCRS or the Secretariat.
- The uncertainty of EffDIS estimates should be characterized. Substitutions, raising ratios and proportion of unclassified fleets (“other”) should be clearly described in documentation.
- Additional methods of raising data should be explored (e.g., Rubin 1976) to evaluate their statistical rigor.
- Methods to cross-validate EffDIS estimates should be explored (e.g., VMS data).

4. Limit reference points and management strategy evaluation

At the beginning of the session, draft conclusions of a recently held ISSF Workshop (Harvest Control Rules and Reference Points for Tuna RFMOs, San Diego, California, USA, March 6-8, 2013) were presented to the Methods Group as the meeting pertained to Management Strategy Evaluations and Limit Reference Points agenda item. It was noted that the conclusions presented were considered draft since a final review of the Workshop report was still in progress. The ISSF Workshop participants indicated that management strategies include monitoring, stock assessment, harvest control rules, reference points and management actions. The workshop was convened to review the current status of the adoption of these elements into the decision-making process of five Tuna RFMOs and to make recommendations for harmonizing and facilitating the process among RFMOs. Of the five RFMOs, CCSBT has formally adopted a management strategy (management procedure) for decision-making. The other four RFMOs are making substantial progress to identify and test key elements of management strategies, such as reference points (limit and target) and harvest control rules. Some of this work is being done primarily by the RFMO science bodies, sometimes without formal Commission mandates. The workshop focused on key issues that should be kept in mind when developing and testing management strategies: data and models, the treatment of F_{MSY} as a target or a limit, testing of the strategy, and implementation. The workshop noted that these management strategies have worked quite well elsewhere in fisheries, and that there is no technical constraint to advance them in the tuna RFMOs. This could be done in many cases with relatively simple, existing tools. The report contains specific recommendations on limit and

target reference points, harvest control rules, and other considerations for management strategy evaluations. The finalized report of the workshop shall be posted on the ISSF web site (http://iss-foundation.org) in the near future.

A summary of the history of development of reference points, harvest control rules and the implementation of Management Strategy Evaluations in ICCAT was presented. In the ICCAT Convention text MSY is the only reference point mentioned. The precautionary approach was developed after the creation of ICCAT and the SCRS has discussed the benefits of having precautionary target reference points. However the Convention text has not still incorporated other reference points and MSY has therefore functioned as the target reference point for ICCAT since the creation of the Commission. But recently the Commission adopted a Decision Framework (Rec. 11-13) which effectively treats F_{MSY} as a limit and not a target reference point.

The presentation was divided in two parts summarizing ICCAT and tRFMO's activities:

The first part summarised the implementation of the Kobe process in ICCAT. A range of stock assessment methods are used by the Standing Committee of Research Statistics (SCRS), e.g., ASPIC, Bayesian Surplus Production Models, Adapt, Multifan-CL, Stock Synthesis. The main management objective of ICCAT is to maintain the populations of tuna and tuna-like fishes at levels which will permit the maximum sustainable catch. Thus MSY was originally interpreted as a target. ICCAT was formed before the Precautionary Approach (PA) and the Ecosystem Approach to Fishery Management (EAFM), so neither are mentioned in the convention, in spite of this, the Commission has embarked on including both the PA and EAFM in its decisions. Stock assessments routinely consider a range of uncertainties and assessment are conducted for bycatch species (e.g., seabirds, turtles) and sharks.

Recovery plans are in place for both the eastern and western bluefin (as well as for other stocks like North Atlantic swordfish), and work on developing an Operating Model under the GBYP is commencing this year. Harvest Control Rules (HCR) including Limit Reference Points (LRPs) are being developed for North Atlantic swordfish and North Atlantic albacore this year, by conducting a Management Strategy Evaluation (MSE) to evaluate the performance of reference points as part of HCR.

The second part summarized the Third Joint Tuna RFMOs meeting (Kobe III; www.tuna-org.org/Kobe3.htm). It was recognised that an MSE process needs to be widely implemented in the tRFMOs in order to implement a PA for tuna fisheries management. Kobe III recommended that a Joint MSE Technical Working Group be created and that this joint working group work electronically, in the first instance, in order to minimize the cost of its work. Three activities are currently being conducted i.e., a review of the Kobe Advice framework, MSE tools and the use of parallel and cloud computing.

ICCAT is developing HCRs which include limit reference points (LRP) for North Atlantic swordfish (see Rec. 10-02) and North Atlantic albacore. The SCRS plans to develop these HCRs by evaluating the performance of alternative limit reference points when they are incorporated in an HCR. This evaluation can be done through simulations conducted with an MSE framework which incorporates a range of quantifiable uncertainties. The Group discussed that incorporation of such range of uncertainties can be complicated when there are multiple assessment scenarios or assessment models used. In such cases it is advantageous to select HCRs and LRPs which are robust across models and/or scenario results. The Group also discussed the fact that reference points may not remain constant in time.

The ICCAT WGSAM has discussed in the past how to develop an HCR (Anon. 2011). The Commission has recommended that stocks be managed with a "high probability" (Rec. 11-13) of being in the green quadrant of the Kobe phase plot, although the Commission did not specify that probability level. The Group discussed that the probability of various management strategies, including alternative HCRs, to comply with this Recommendation can be evaluated with MSEs. The Group noted the importance of clarifying and harmonizing terminology. When revising the "generic" HCR described in WGSAM (Anon. 2011), the Group noted that, although the WGSAM focused on B_{LIM} (the biomass level below which the HCR line is set at F=0; i.e., the point where the fisheries should be closed), whereas managers may be more interested in B_{thres} (the hinge-point of the HCR occurring at a level of biomass reduction below which some reductions in F should start).

This generic HCR can be parameterized for each stock (i.e., setting up concrete values for the so called B_{LIM}, B_{thres} and the target value of F). An example of a harvest control rule and limit reference points to be considered by the Swordfish assessment Group in its June meeting is shown in **Figure 1**. The Group agreed that the data availability will drive the decision of whether designing "generic" or "species specific" harvest control rules. For

some data poor stocks, it may be necessary to develop an HCR based only on F because there is little data available for estimating biomass. The Group discussed the need to define a threshold level of relative biomass below which, the HCR indicates additional management is triggered. MSEs may be useful in defining the appropriate threshold level that minimizes unnecessary management action as the stock fluctuates naturally around MSY levels, but still provides adequate protection for maintaining stock levels. Another possibility raised was to define nonlinear HCRs that would be triggered once biomass fell below that which would support MSY (e.g., the threshold level would be equal to BMSY), but which would require negligible reductions when biomass was close to B_{MSY} (e.g., exponential decline); this alternative would not require a separately define threshold level. A wide variety of HCRs, including the shapes of the reduction functions, can be evaluated through simulation.

Rec. 11-04 for North Atlantic albacore requests a limit reference point that would trigger a rebuilding plan when biomass falls below it ($B_{THRESHOLD}$). The Group discussed plans to develop this for albacore (SCRS/2013/033, SCRS/2013/034 and SCRS/2013/035), using MSE, and then to draw upon this experience in order to prepare LRPs for the North Atlantic swordfish assessment. It was noted that, in past assessments, swordfish management advice was based on ASPIC results, whereas the initial work for albacore would be based on Multifan. In addition to considerations of the time involved to develop swordfish-specific MSEs in time for this year's assessment, the Group considered that the applicability may depend on the type of model(s) used for the management advice. In other words, that the Assessment Model to use in the MSE should not be more complex than the Operating Model used (Multifan for albacore and ASPIC for swordfish). If the full range of uncertainties is going to be incorporated alternative fleet/fishery mixes (e.g., relative effort of longline vs. purse seine vs. baitboat, or otherwise between fleets with different age selectivites, which is highly involved for Multifan) may have to be considered. This has a high price in terms of time for multiple runs. As alternative mixes of fisheries would likely results in changes in selectivity and thereby changes to benchmarks, careful consideration must be given to how to interpret results across multiple scenarios.

The WGSAM recognized that this is an ongoing process, and that short-term and long-term objectives should be clarified. The Group recognized the importance of a firm commitment to this process, including clear objectives and commensurate funding, in order to meet management needs.

For further developments in this task, tWGSAM indicated a need of new projects and international collaborations to move towards a common MSE framework. The progress on the Albacore case study was presented as an example of MSE framework that could be extended to other stocks. In addition, WGSAM recognized the benefit of the work presented as a result of collaborations between ICCAT's Secretariat and national organisations and encourages further interactive cooperation.

5. Identification of key research needs and components of the SCRS Science Strategic Plan as well as identification of capacity limitations and gaps and how these can be addressed

Strategic Planning is recommended as a structured approach to guide the future workings of the SCRS (2011 SCRS Report and responsive to Res. 11-17 on Best Available Science). Document SCRS/2013/024 outlined an approach for identifying key research needs and components of and a roadmap for developing the 2015-2020 SCRS Strategic Plan. SCRS/2013/024 points out that Strategic Planning deals with three basic constructs: "What do we do?", "For whom do we do it?" and "How do we excel?" Furthermore, the key components of strategic planning include an understanding of the SCRS mission (our purpose), our vision for the future, values we shall apply in conduct of our work, our goals and strategies to achieve them. It was pointed out that Strategic Planning also provides a methodology to identify critical capacity and data gaps and prioritize research activities to address them. A roadmap and time-frame for developing the SCRS 2015-2020 Strategic Plan was proposed in SCRS/2013/024 which includes contracting a consultant to provide a framework for the specific methodology to be applied in developing the Strategic Plan and regular consultation and review by SCRS officers and SCRS Plenary prior to review and acceptance by the Commission.

The Methods Working Group endorsed the plan and recommended plan development be initiated as outlined in SCRS/2013/024.

6. A discussion and amendment of the current ICCAT peer review TORs, as well as the agreement of a protocol for invited expert/reviewer selection

In its Resolution on Best Available Science (Res. 11-17), the Commission called for strengthening the peer review mechanisms within the SCRS, including the participation of outside experts. This section provides some background on the evolution the peer review process within the SCRS, as well as discussions by the Group on how to strengthen the peer review process and enhance the participation of external experts, including the development of terms of reference. When considering these recommendations, it is important to note that the Commission also called on its members (within the same Resolution, Res. 11-17) to consider broadening financial support and mechanisms for the purpose of the implementation of this peer review/external expert participation strengthening, as well as for the support of the other objectives identified therein. In order to successfully implement the steps described within this report, and achieve the objectives called for in Res. 11-17, it is critical that this effort be fully funded.

External peer reviews of the work of ICCAT SCRS working groups have been conducted (Santiago *et. al*. 2013). At the 2010 Kobe II meeting it was concluded that peer review should be included in all tRFMO scientific assessments. The Report of the Independent Performance Review of ICCAT (Hurry *et.al*., 2008) indicated "the analyses used by the SCRS to formulate its advice are peer reviewed through a rigorous three stage process working/assessment groups to species groups to SCRS plenary). The structure of the process, the diversity of the participants/analysts and the large number of people involved does not guarantee that errors will not be made, but it provides a reasonable assurance that if errors are made, they will be discovered, admitted, discussed and corrected."

Peer reviews of assessments in ICCAT currently in place follow the process adopted by the SCRS in 2002. Recently, the SCRS recommended conducting at least 2 *in situ* reviews per year. The purpose of the reviews is to provide additional peer review to SCRS and its species groups to guide improvements in stock assessments.

During the 2012 meeting of WGSAM, the issue of peer review in ICCAT was again discussed and Terms of Reference (TOR) for external experts as peer reviewers in the SCRS stock assessment meetings were drafted (Anon. 2013). Terminology regarding both invited experts and external reviewers attending the WGs have been used somewhat interchangeably in ICCAT. Therefore, the Group reviewed documents presented at the meeting that dealt with these topics.

The WGSAM discussed document SCRS/2013/23 which presented potential TORs to distinguish between invited experts and external reviewers. SCRS/2013/23 identified three different levels of peer review functioning. First, there is internal peer review, which is usually facilitated by working groups of diverse national scientists who in "real time" review and provide critical input/advice to the scientific process; on occasion this is supplemented by the participation of an external expert. Second, external peer review is facilitated by sending the assessment outcomes to contracted external experts for review and "quality control" or having the experts attend working group meetings as observers who then report on the meeting outcomes. External peer review may also be conducted through a joint meeting with an advisory expert panel. Lastly, scientific peer review may be facilitated by publishing scientific outputs in peer reviewed journals or presenting them at international conferences. Invited experts take part in the assessment process, providing information and advice on how the stock assessment can be conducted/improved/streamlined within the assessment process. An external reviewer should in theory play no active part in the assessment. In this context, the Secretariat provides a potential transparent process for selection of experts from a list of experts kept by ICCAT.

Another document (SCRS/2013/028) was presented to WGSAM. It described aspects of the Center for Independent Experts (CIE), a NOAA-funded process that provides peer reviews for the U.S. National Marine Fisheries Service (NMFS), in the United States. The process of selecting reviewers consists of matching the skills required for the review, with the ability of suitable experts subject to constraints set up to avoid picking candidates with potential conflicts of interest. This process is conducted by the CIE independently of the client, NMFS. This paper presented some of the lessons learned by the CIE to inform the discussions on the TOR for the 2013 peer review of the upcoming albacore assessment in 2013 and future peer reviews. Furthermore, the paper explicitly highlights some problems that are pending in the ICCAT review process (**Table 1**).

After reviewing all the information provided, discussion took place to clarify the separation of invited expert versus reviewer roles within SCRS performance. Consequently a text with TORs was accomplished for both invited expert and reviewer assistance to the peer review SCRS process. Revised TORs for an invited expert are included in **Appendix 5** and revised TORs for an external reviewer in **Appendix 6**. Likewise, it was

recommended that the expert participation in a given species stock assessment will be proposed by the Working Group Chair and the SCRS Chair. In addition, a list of CIE and other RFMO reviewers shall be kept available at ICCAT. Alternatively, ICCAT could consider a common list of reviewers developed with other RFMOs as suggested in SCRS/2013/028.

The Group discussed the possibility of using the salary rates and time frames for CIE reviews as guidelines for ICCAT to contract peer reviews. Currently CIE reviewer is paid a consulting fee of US $800.00 per day and an average of 14 days for stock assessment review (2 days of travel, 5 days of meeting, 4 days of preparation and 3 days of report writing) (SCRS/2013/028).

7. Other matters

7.1 ICCAT cloud computing

The "cloud" is an emerging paradigm in the way we use and share computing resources (hardware, software,) and information (documents and data). Virtually unlimited (budget dependent) and elastic (use what you need) computing resources, can be deployed in minutes instead of weeks. Computing power, security, concurrency and shared work are fully optimized on the cloud.

Provision of advice for the Commission is increasingly dependent upon the use of computer intensive methods such as, Monte Carlo simulations, bootstrapping used when building Kobe II strategy matrices, MCMC runs, stochastic projections used on stock assessments and for example the evaluation of limit reference points using MSE. Often in the last few years it has not always been possible to conduct such analyses during working groups, making it difficult for working groups to finalise reports. Therefore the SCRS (guided by the Methods Working Group and the tRFMO MSE WG) recommended the ICCAT Secretariat to study the use of the Cloud Infrastructure (virtual servers, distributed and parallel computing, concurrent services, etc.).

The ICCAT Secretariat presented a work plan to the Group with the guidelines for the development of ICCAT Cloud Computing infrastructure (document to be added to http://tunalab.iccat.int). This work plan describes the preliminary studies made, the cloud topology/model proposed, and the requirements (hardware, and cloud services) necessary to a first year development phase (Phase 1). An estimation of the expected costs was also presented.

In addition, the Secretariat also presented to the Group the 2013 deployment plan (Phase 1) and, finally, the current development status. In summary, it was described how the cloud servers are administered and used, how services are deployed and configured (Apache web server, R-CRAN, RStudio server, etc.) and the documentation (short tutorials: cloud administration, Studio administration, remote access User's guide) already available. All these documents should be published on the "under-development" ICCAT cloud website (http://tunalab.iccat.int).

The Secretariat has planned to start some important tests of the cloud infrastructure already deployed, starting with the 2013 Albacore Data Preparatory Meeting (Madrid, Spain 22-26 April).

7.2 Future work plan

The Working Group discussed the future work plan and retained mainly the following actions:

- WGSAM recommends reviewing the protocols and algorithms for estimating Effort distribution (5x5) for longline (EFFDIS), and extended to purse-seine, and bait boat gears, currently prepared by the Secretariat. The WG should also include estimates of uncertainty on these products. It is suggested that published estimates in the ICCAT Web page, include also detailed description of the estimate assumptions and uncertainty related to these products to make aware the potential users of their limitations.

- The Commission expects risk-based advice on management measures as prescribed in the Kobe II Strategy Matrix and as embedded in its Decision Framework (Rec. 11-13). An important aspect of providing such scientific advice is adequate quantification of uncertainty in stock condition and future prospects under future management option scenarios. With the advent of more commonly applied, highly parameterized stock assessment models, the computational investment in quantifying uncertainty in stock status and future prospects is quite heavy. This is also the experience at other tRFMOs and a number of

approximations for quantifying both process and observational uncertainty are being applied to develop risk-based management advice. Guidance on the evolution of and possibility of harmonizing methods to apply for uncertainty characterization across species groups should be provided by WGSAM.

- Including during the agenda items of 2014 some of the Horizontal Themes identified during the process of elaborating the SCRS Strategic Plan in 2013, particularly those related to participation and capacity building and quality control of the stock assessments and management advice.

- WGSAM recognized that there is a trend in recent assessments conducted by the SCRS to use multiple modeling methods to estimate the status of the stock relative to ICCAT conservation benchmarks. While WGSAM agrees the use of multiple approaches is a good practice, situations have arisen where the different methods give results that are not consistent yet equally plausible. Having guidance from the WGSAM on best practices to reconcile or combine such results would be very helpful (see, for example, ICES 2007).

7.3 Collaboration

- The World Conference on Stock Assessment Methods for Sustainable Fisheries (WCSAM) will take place in Boston, USA, 15-19 July 2013. The conference will provide a forum for presentations on the application and future of stock assessment methods. It will consider single stock approaches for data rich and poor stocks, and also multispecies and ecosystem based approaches. It is being organised by researchers from a range of scientific institutions and RFMOs across the world. The conference will be preceded by a two-day workshop (15-16 July 2013) where studies on the application of stock assessment methods to predefined data sets will be reviewed. ICCAT is actively participating in WCSAM.

- Continued collaboration through participation in other Regional Fisheries Bodies (RFBs) meetings regarding implementation of MSE is needed to enhance utilization of this important tool for addressing uncertainties and risks associated with stock assessment models and providing better scientific advice.

- Continued collaboration with ICES working groups and, in particular for assessment of sharks species is viewed as an important work area.

- WGSAM recognized the benefits of the work presented as a result of collaborations between ICCAT's Secretariat and national organisations and encourages further interactive cooperation.

8. Recommendations

1) WGSAM recommends SCRS and the Secretariat work with other tRFMOs to develop common protocols for peer reviews when applicable, particularly with regard to identification of suitable experts.
2) Diagnostics should be evaluated for assessment models. Suitable diagnostics may vary between assessment models, but model appropriate diagnostics should be presented to help evaluate the quality of management advice arising from the assessments.
3) Peer review reports on stock assessment working groups should be in the form of an SCRS document, with a summary of the peer review included as part of the detailed report of the assessment meeting. The recommendations in the peer review summary are to be included and taken into consideration in future assessment sessions and may not necessarily be addressed in the same year as the assessment.
4) Long term work plans should be drafted for the joint tRFMO MSE Working Group in order to ensure the Group functions effectively and made available on the Group's website. (http://code.google.com/p/trfmo-mse/)
5) WGSAM endorsed and recommended the plan outlined in SCRS/2013/024. As the SCRS Strategic Plan is currently being developed, Species Groups should include an item in the agendas of their meeting in 2013 to assess data gaps and needs and identify goals and strategies in advance of SCRS Plenary to permit the 2013 SCRS to validate goals and strategies and agree on mission, vision, and values components for the 2015-2020 Strategic Plan.
6) Reimbursement for invited experts and external reviewers could be based on the standard time frames and rates developed by the CIE. Invited external experts and peer reviewers should follow the TORS prescribed by the WGSAM in 2013.

7) WGSAM has described specific recommendations to improve estimation of the temporal and spatial distribution of longline effort (EffDIS), and recommends that these efforts continue. In addition, WGSAM recommends that efforts be made to develop similar EffDIS estimates for the BB and PS gears.

8) For years in which stock assessments are to be conducted, in order to enhance quality assurance of scientific advice, working groups are required to prepare detailed work plans in order to provide guidance for the meeting preparations and to ensure complete and timely availability of required data and model inputs, as well as to facilitate the coordination of responsibilities within the working group as and/or with the Secretariat.

9) WGSAM recognizes the importance of accounting for changes in fishing operations and characteristics of the main fleets from each CPC operating within the ICCAT area of competence, as these affect the efficiencies of the fleets for catching target and by-catch species. Documentation of these technological and behavioral changes is particularly important to understand the national reports of catch and effort annually submitted (Task II-CE). Taking into consideration also that CPCs are required to report fleet composition data (Task I-FC), it is recommended that CPCs present an SCRS document with the details of the fleet composition, sampling, coverage, and statistical methodology to estimate total catch, catch and effort, catch-at-size for each of the main fleet components. This report should also communicate the potential limitations and or restrictions of the data and information provided to be taking into account within any further analysis by the SCRS or the Secretariat.

9. Adoption of the report and closure

The report was adopted during the meeting. The Chairman thanked the participants and the Convener of WGSAM for their efficiency and hard work. The meeting was adjourned

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Table 1. Unresolved issues about ICCAT peer review system identified by the SCRS (ICCAT 2013).

Issue	*Quotation from ICCAT 2013*
Need for consistency in quality of the review	**"…**inconsistence in advice: where you get different peer reviewers from one assessment to another."
Dual role of experts as reviewers and analysts	**"…**A potential problem was that when a reviewer actively participates in a meeting, he/she will also have part ownership of the results from the meeting… For example by participating in a data prep meeting they will have had responsibility for inputs into the assessment."
Reviewers becoming part authors of the outputs in a multistage assessment process	"It was agreed that if there is a capacity problem then we there is a need to strengthen the stock assessment teams and not rely upon a peer reviewer to provide missing expertise."

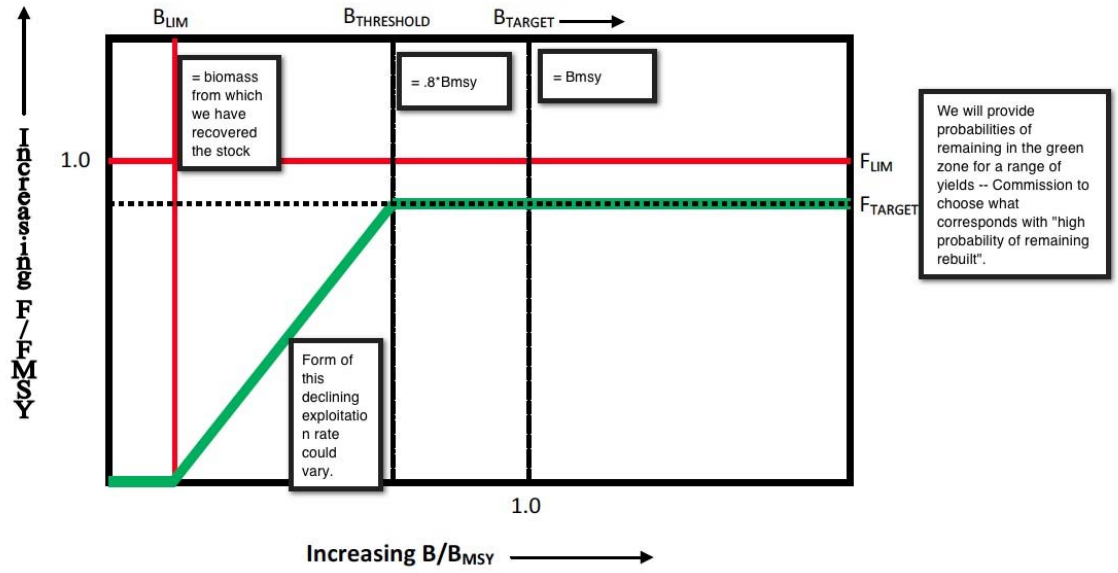

Figure 1. A possible approach for a Harvest Control Rule and Limit Reference Points for North Atlantic swordfish that uses the template developed by the Stock Assessment Methods Working Group (Anon. 2011). Building upon the method currently used to provide management advice, the Assessment Group could use biomass dynamics approaches and available input data, to identify a biomass limit reference point associated with the lowest biomass observed in the series, and a threshold associated with $0.8*B_{MSY}$). In this example, the $B_{THRESHOLD}$ was based on the work of Neilson *et al.* (2013) who worked with VPA results presented in the 2009 stock assessment to determine the impact of observed recruitment variation on reference points. These are provided as examples only, and such reference points could be refined further during the June 2013 Methods/Data meeting. Following the June meeting and prior to the September assessment meeting, the Working Group will conduct an MSE to evaluate the suitability of these proposed limit reference points.

Appendix 1

AGENDA

1. Opening, adoption of agenda and meeting arrangements
2. Model diagnostic discussion
   - Basic review of assessment models used by ICCAT
   - Common assessment model diagnostics
   - Development of protocols for presenting model diagnostics
3. Review of current ICCAT method for estimating EFFDIS
   - Discussions and development of improved methods for calculating EFFDIS
4. Limit Reference points and Management Strategy Evaluation
   - Discussion on generic LRPs and use in HCRs
   - How LRPs are used in other fora
   - LRP developments for ICCAT
5. Examples of simulation testing of LRPs using MSE and including biological information
6. Identification of key research needs and components for the SCRS Science Strategic Plan as well as identification of capacity limitations and gaps and how these can be addressed.
7. A discussion and amendment of the current ICCAT peer review TORs, as well as the agreement of a protocol for invited expert/reviewer selection.
8. Other matters
9. Recommendations
10. Adoption of the report and closure

Appendix 2

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Appendix 3

LIST OF DOCUMENTS

SCRS/2013/023 Suggested revisions and clarifications to the Peer review process in ICCAT. de Bruyn, P.A., Santiago, J. and Kell, L.

SCRS/2013/024 A Plan for The Plan. Santiago, J., de Bruyn, P., Arrizabalaga, H., Murua, H. and Scott, G.

SCRS/2013/025 Model diagnostics for Stock Synthesis 3: Examples from the 2012 assessment of Spanish mackerel and cobia in the U.S. Gulf of Mexico. Cass-Calay, S.L., Tetzloff, J.C., Cummings, N.J. and Jeffery Isely, J.

SCRS/2013/027 Examples of Stock Assessment diagnostic. Kell, L.

SCRS/2013/028 Some key issues to get right in peer reviews of stock assessments: Lessons from the U.S. Center of Independent Experts. Die. D.J. and Shivlani, M.

SCRS/2013/030 VPA-2Box model diagnostics used in the 2012 assessment of western Atlantic bluefin tuna (*Thunnus thynnus*). Cass-Calay, S.L. and Lauretta, M.

SCRS/2013/033 An example of a management procedure based on a biomass dynamic stock assessment model. Kell, L., Merino, M., de Bruyn, P., Arrizabalaga, H., Muara, H. and Santiago, J.

SCRS/2013/034 An example of conditioning an operating model using Multifan-CL. Kell, L., Merino, M., de Bruyn, P., Arrizabalaga, H., Muara, H. and Santiago, J.

SCRS/2013/035 An example of a management strategy valuation of a management procedure based on a biomass dynamic stock assessment model. Kell, L., Merino, M., de Bruyn, P., Arrizabalaga, H., Muara, H. and Santiago, J.

Appendix 4

A FRAMEWORK TO FACILITATE AN EFFICIENT AND COMPREHENSIVE EVALUATION OF STOCK SYNTHESIS MODEL PERFORMANCE

1. Does the model run?
    a. No → use echo input to debug
    b. Yes → continue

2. Are there any parameters on bounds?
    a. No → continue
    b. Yes → change starting values/change bounds/add priors → rerun

3. Plot model output. Anything obviously wrong? Examples: productivity way too low, selectivity patterns that don't make sense, drastic decrease/increase in biomass in a single year, abnormal recruitment patterns (boom/bust).
    a. No → continue
    b. Yes → go through report file to diagnose (depends on problem)

4. Does the hessian converge?
    a. No → check warning file, check estimated parameters in report file
    b. Yes → continue

5. Examine parameter estimates. Plot parameter distributions along with starting values, bounds, and priors. Do parameters appear well estimated?
    a. No → check bounds, check priors, check phase of estimation
    b. Yes → continue

6. Look at trace plots of parameter estimates relative to phase of estimation? Do model parameters change much in the final phase?
    a. No → continue
    b. Yes → try alternative phases: for example, important scaling parameters like mean recruitment and catchability might be estimated in the first phase, recruitment deviates estimated added in the second phase, and selectivity added in the final phase.

7. Look at mean and standard deviation of estimated parameters. Is CV of estimated parameters less than 1?
    a. No → is there data to inform parameter?
        i. No → change bounds/add informative prior/fix parameter
        ii. Yes → check correlation matrix
    b. Yes → continue

8. Are any of the parameters highly correlated?
    a. No → continue
    b. Yes → why? Does one of the parameters require an informative prior?

9. Plot model fits to data and diagnostics. Is model fitting data reasonably?
    a. No → diagnose the problem.
    b. Yes → continue

10. As appropriate, tune input variance levels, sigmaR, bias adjustment. Is model performance improved?
    a. No→ diagnose the problem, retune as needed.
    b. Yes → continue

11. Check for model stability to initial starting parameters using Jitter analysis. Does model converge to a "global" solution?
    a. No → identify why.
        i. look at which likelihood components are changing
        ii. Evaluate the phases of estimation
        iii. Plot distribution of estimated parameters over all model runs
    b. Yes → continue (try again with larger deviation from starting values)

12. Profile leading model parameters such as stock-recruitment parameters (steepness/R0) or natural mortality. Was the profile smooth?
    a. No → Plot estimated parameters as a function of profiled leading parameter
        1. Do any of the parameters hit bounds across the runs? Do any of the parameters bounce between alternative solutions? Do some parameters show similar patterns?
            a. Yes → may not have enough data to inform all estimated parameters: add informative priors/reduce the number of estimated parameters.
    b. Yes → Does profile show leading parameter is well estimated? Do the different data components show similar signals?
        i. No → parameter may require informative prior or need to be fixed
        ii. Yes → profile at finer scale
            1. Does profile remain smooth?
                a. Yes → continue

13. Evaluate model sensitivity to key model assumptions, data weighting choices, and alternative data inputs. Was model highly sensitive to any key model assumptions or certain data sources?
    a. No → continue
    b. Yes → Is model specified correctly? Are assumptions appropriate? Is model over-parameterized? Should data be re-weighted?
    c.
14. Evaluate model sensitivity to the most recent years of data using a retrospective analysis. Did the retrospective analysis reveal any inconsistencies in the data?
    a. No → continue
    b. Yes → identify source of the retrospective pattern

15. Evaluate model uncertainty using bootstrap approach. Plot distribution of parameter estimates and derived quantities from bootstrapped runs. Compare MLE of parameter estimates to mean of bootstrap results. Are parameters or derived quantities well estimated when data is resampled?
    a. No → do distributions show multi-modality or high proportion of bounding?
        i. Yes → may not have enough data to inform all estimated parameters: add informative priors/reduce the number of estimated parameters.
    b. Yes → continue

16. Optional: Evaluate model convergence using MCMC approach. Use standard approaches to evaluating MCMC results: look at trace plots/plot posterior distributions/compare MLE to mean of posterior distribution. Does MCMC converge on a single solution? Are MLEs of parameters/derived quantities similar to mean of posterior distributions? Poor performance has been noted in some SS models that otherwise appear well parameterized. However, poorly performing MCMC simulations may indicate a need to further explore model parameterizations.

Appendix 5

REVISED TORS FOR AN INVITED EXPERT

Introduction

These Terms of Reference (TORs) have been developed as a guide to assist working groups in defining the work to be conducted by invited experts. It is acknowledged that the requirements may differ for each individual assessment session and these differences can be reflected in modifications to these TORs. The chair and the working group should clearly define in the work plan for the group the final TORs as well as tasks required from the invited expert which should then be approved by the SCRS. In this way, the invited experts should have a

clear definition of what is required of them. In order to provide quality control feedback on this process, it would be beneficial if the working group could provide feedback on the work conducted by the invited expert.

The proposed TORs for an invited expert are slight modifications of the TORs proposed by the WGSAM in 2012. These therefore are:

1) Prior to the meeting, the invited external expert(s) will be given access to previous reports of the working group. To the extent possible, the expert should attend both the data preparatory and stock assessment sessions.

2) The external expert (s) will be provided with the official data to be used in the stock assessment, and will be bound by any applicable confidentiality agreements that apply to participating members of the assessment working group. These data will be made available to the expert(s) at the same time they are available to the working group in general.

3) Fully participate in the discussions of the appropriate analyses to be conducted at the meeting including, but not limited to:
   - The data and software available for analysis and based on this information the selection of the assessment model(s) to be used which is appropriate for the data available, model assumptions, biological parameters, selection of model run(s).
   - As necessary conduct specific tasks or analyses as requested by the assessment group.
   - When appropriate, suggest alternative assessment methods that could better characterize the dynamics of the stock.
   - As appropriate participate in the development of the main conclusions of the stock assessment and management recommendations from the meeting.
   - Participate in the identification of specific research needs for the future.

4) The comments and suggestions of the external expert will be taken into consideration by the working group during the stock assessment process and in the preparation of the meeting report. If a specific body of work has been conducted by the expert, they should fully document this work in an SCRS document, and provide at least a summary document as to their contribution to the meeting as described in the work plan.

Appendix 6

REVISED TORS FOR AN EXTERNAL REVIEWER

Introduction

These Terms of Reference (TORs) are intended to provide a guideline for working groups to define the role of external reviewers contracted to review the outputs of the assessment working group. These TORs can and should be modified as appropriate to cover the diverse requirements of the individual assessment sessions. It is intended that advice provided by external reviewers will be taken into account in future stock assessment sessions in order to improve the assessment process. It is envisioned that the reviewer will provide a detailed peer review report that should be submitted as an SCRS document, as well as a summary of the peer review report to be included in the detailed report of the stock assessment.

The role of the external reviewer is to:

1) Evaluate the adequacy, appropriateness, and application of data used in the assessment.
2) Evaluate the adequacy, appropriateness, and application of methods used to assess the stock and if appropriate recommend alternative approaches to be accomplished in the future.
3) Evaluate the methods used to estimate population benchmarks and stock status (e.g., MSY, F_{MSY}, B_{MSY}, or their proxies).
4) Evaluate the adequacy, appropriateness, and application of the methods used to evaluate future population status, given the commissions objectives.

5) Evaluate the adequacy, appropriateness, and application of methods used to characterize the uncertainty in estimated parameters. Comment on whether the implications of uncertainty in technical conclusions are clearly stated.
6) Comment on whether the stock assessment results are clearly and accurately presented in the detailed report of the stock assessment.
7) Comment on potential improvements on the stock assessment SCRS process (CPC participation, transparency, objectivity, documentation, uncertainty characterization, etc.) as applied to the reviewed assessments.
8) Comment on the adequacy of the workplan for the assessment and whether it was adequately addressed by the data or assessment working groups.
9) Consider the research recommendations provided by the working group and suggest any additional recommendations or prioritizations warranted. Clearly denote research and monitoring needs that could improve the reliability of future assessments. Recommend an appropriate interval for the next assessment considering control rules or management strategy in effect.
10) Prepare a Peer Review Report which should specifically address each TOR. Complete and submit this Peer Review Report along with a summary no later than the two weeks after completion of the assessment meeting.