SECOND MEETING OF THE STANDING WORKING GROUP TO ENHANCE DIALOGUE BETWEEN FISHERIES SCIENTISTS AND MANAGERS (SWGSM)

(Bilbao, Spain, 22-24 June 2015)

1. Opening of the meeting

The Chair of the Standing Working Group (SWGSM), Dr. Martin Tsamenyi (Ghana), opened the meeting, welcomed all participants, and introduced the Commission Chairman, Mr. Stefaan Depypere (EU). The Commission Chairman encouraged the Standing Working Group to make concrete progress that will facilitate the work of the Commission. It is critical to maintain an open atmosphere, so as to encourage debate and discussion. He noted that a greater degree of participation from the CPCs would enrich the discussions of the Standing Working Group and suggested that this should be a goal for the future.

The Executive Secretary introduced the following CPCs to the meeting: 15 CPCs, Canada, Côte d'Ivoire, European Union, Ghana, Guinea, Japan, Mexico, Nigeria, Norway, Senegal, South Africa, Tunisia, United States, Uruguay and Vanuatu.

The following intergovernmental and non-governmental organizations also attended the meeting: FAO, Ecology Action Center (EAC), International Seafood Sustainability Foundation (ISSF), Pew Charitable Trusts and the Ocean Foundation.

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

2. Adoption of Agenda and meeting arrangements

The Chair explained that an initial draft of the agenda was circulated to all CPCs in January 2015 with a request for input. Several CPCs had offered comments that are reflected in the revised draft agenda. The Chair explained further that he had developed the draft annotated agenda to guide discussions based on the revised terms of reference for the Standing Working Group, which were established in Rec. 14-13. He noted some concern that, as was the case last year, the slate of presenters and facilitators is lacking individual experts from developing States. Although the Chair had initiated a transparent process through a circular requesting that all CPCs provide input on possible presenters or facilitators, only four CPCs responded to this request. The Chair had then reached out to many different CPCs to seek a diverse range of experts but many individuals were unable to accept, as they had other obligations and commitments. It was noted that this meeting afforded an opportunity for every CPCs to participate actively in the discussions and offer their expertise in this way, and that indeed, active participation in the dialogue by all CPCs is very important to the process.

Balanced participation by scientists and managers is critical to the success of this Working Group. Everyone recognized the advantages of the dialogue taking the form of an informal exchange as a means of achieving broader engagement from individual experts. Participants noted the potential value of this approach for future meetings consistent with Rec. 14-13, which provides for discussions to take place in an open forum.

The Agenda was adopted without change and is appended as **Appendix 1**.

3. Nomination of the rapporteur

Ms. Rachel O'Malley (United States) served as rapporteur for the meeting.

4. Review of the objectives of SWGSM [Rec. 14-13] and expected meeting outcomes

The Chair emphasized that the Working Group's overall objective is to enhance communication and foster mutual understanding between fisheries managers and scientists. These efforts will support the further development and implementation of science-based management strategies. Participants agreed that tangible outcomes from this meeting would be an important way to advance the Working Group's discussions. These could include a work plan for implementing Rec. 11-13 through case studies or "pilot stocks". Without prejudging the discussions to

take place under subsequent items of the Agenda, the Chair suggested that any agreed outcomes could be captured in the form of a recommendation to be referred back to the Commission. The Chair emphasized that the Working Group has a mandate in Rec. 14-13 that lays out expectations; we must determine how best to accomplish this charge. Whatever conclusions are reached, it will be critical to define the next steps.

5. Recap of the basic components of precautionary management (from SWGSM 1), including necessary trade-offs between short-term and long-term management objectives

Dr. Santiago recalled that discussions on this topic have deep roots, stretching back to the first SCRS Methods Working Group meeting in 1999. He suggested that reaching agreement on formal definitions of key terms could help to provide clarity (e.g., target vs limit vs threshold). He highlighted several issues from the first Standing Working Group meeting, including the importance of establishing management objectives for individual stocks and clarifying the roles and relationship between the SCRS and the Commission. Building on the principles of decision making that were agreed in Rec. 11-13, managers need to provide more specific guidance to the SCRS on their expectations in terms of probabilities and timelines. Several existing recommendations provide examples of timelines and probabilities (both implicit and explicit) that have been adopted by ICCAT in the past. He noted that even without the establishment of formal reference points, the implicit target area is the green zone of the Kobe plot ($F<F_{MSY}$ and $B>B_{MSY}$).

Dr. Josu Santiago reminded participants that uncertainty is inherent to the fisheries management process. One job of the SCRS is to quantify and characterize uncertainty. It was suggested that further discussion is needed concerning how to incorporate uncertainties when making management decisions. Dr. Santiago explained that MSE is a tool that can be used to evaluate the main sources of uncertainty surrounding a management goal. MSE can also be useful for considering socioeconomics in our decision making. Greater uncertainty indicates a need for greater precaution. One CPC suggested that when determining specific management objectives to be balanced through the MSE process, other factors to consider could include monitoring, control and surveillance measures and the nature of the fisheries for that particular stock.

6. Consideration of how Harvest Control Rules for ICCAT fisheries might be designed, in the light of specific biological, environmental and socio-economic considerations

6.1 Basic elements of Harvest Control Rules

Dr. Gerald Scott gave a presentation highlighting the basic elements of Harvest Control Rules (HCRs) (**Appendix 3**). HCRs are a set of pre-agreed rules that will be applied to ensure that management seeks to achieve identified targets and avoid limits. Dr. Scott explained that HCRs are one of many elements in a harvest strategy, including data collection, setting targets and limits and associated probabilities, and estimating stock status relative to the reference points. He pointed out that similar discussions have been occurring in other tuna RFMOs, and their work may provide some useful examples.

Dr. Scott noted that Recommendation 11-13 provides a framework for establishing harvest control rules, but that more work is needed to operationalize this recommendation. What is needed from the management side - building on Rec. [11-13] - is specific input on desired probabilities of being in the 'green' zone and of avoiding limits, as well as input on how long should it take to accomplish these outcomes. Scientists will continue work toward full characterization of uncertainty in stock status evaluations to improve advice concerning the odds of achieving the specified management objectives. While there are a number of methods employed to characterize and quantify uncertainties, a range of unquantified uncertainties can be reasonably captured in the Management Strategy Evaluation process.

To facilitate a more interactive engagement on these issues, Dr. Scott circulated a spreadsheet developed at IOTC that enables participants to select control parameters for a fishery loosely based on north Atlantic albacore and see the resulting simulation of management outcomes. In addition, he circulated a questionnaire to be answered anonymously to evaluate the views of the meeting participants on the basic elements of harvest control rules, control mechanisms, management objectives, risks and probabilities.

6.2 Conservation considerations: How F_{MSY} and B_{MSY} should be considered (e.g. are they target or limit reference points? Which probability and timeframe should be associated to these reference points in each case? Should we define reference points based on the precautionary approach?)

Dr. Victor Restrepo opened his presentation (**Appendix 3)** by explaining the apparent contradiction between the UNFSA Annex II Guidelines and the objectives contained in RFMO Conventions such as ICCAT's, which has caused some confusion as to whether F_{MSY} should be a limit or a target. At the time UNFSA was negotiated, it was common for stock assessment methods to assume perfect knowledge in many parameters and to ignore important sources of uncertainty. In situations like these, it is reasonable to view the estimate of F_{MSY} with caution and to consider a target F that is less than F_{MSY} so as to provide the precautionary buffer envisioned in the UNFSA Guidelines. In common practice today, F_{MSY} is estimated taking a more realistic account of data and biological uncertainties, variability in productivity, stock status and fishery selectivity. Whether or not such an estimate of F_{MSY} is a reasonable target in a particular situation is a question that could be studied through Management Strategy Evaluation.

Dr. Restrepo noted that a safe option is to view MSY as a threshold that triggers management action. This is consistent with Recommendation 11-13. He described the $B_{threshold}$ as a "soft limit" that triggers some management action before the biomass declines to a level below B_{lim}; if a harvest control rule establishes only a B_{lim}, more drastic management action will be needed to reduce fishing mortality when that limit is breached.

It should be noted that, if F_{MSY} is set as a target and F is maintained at that level, stock biomass will fluctuate above and below B_{MSY} due to recruitment variation and other factors. These fluctuations can be considerable for some stocks. Dr. Restrepo suggested that for most ICCAT stocks there are proxies for MSY that could be used instead (e.g., $F_{0.1}$, which requires less data and performs well under many circumstances).

It was noted that if B_{MSY} or F_{MSY} is selected as the target, then on average the stock will be in the green zone of the Kobe plot (no overfishing occurring; stock not overfished) but sometimes it will be outside of the green zone. To be consistent with the principles established in Rec. 11-13, the aim should be to fluctuate within the green quadrant.

As a first step, the managers need to define objectives. For example, it may be possible to get a higher long term average yield with a lower F level. Several participants expressed a desire to seek stability in yield. There was openness to considering various kinds of reference points, including targets, limits and thresholds (or intermediate limits), and a range of probabilities associated with crossing these points. This should be done for individual stocks, taking into account stock status, uncertainty, life history and other factors. It was suggested that a range of target biomass could be considered. The identification of pilot stocks may be helpful to demonstrate how these concepts work. The SCRS Chair suggested that the easiest way forward is to build on related efforts that are already underway at the SCRS (e.g., determination of interim reference points for several stocks).

The Chair confirmed that he would return to a discussion of objectives later in the Agenda. It was also generally agreed that the quality of the data is of critical importance, and ICCAT must continue its efforts to improve data quality and data reporting.

6.3 Ecosystem considerations (e.g., by-catch, impact on other stocks) What are the most appropriate ecosystem indicators that have impact on tuna fisheries?

The Chair informed Working Group participants that relevant discussions on this topic by the SCRS took place two weeks prior at the meeting of the SCRS Sub-committee on Ecosystems. He asked the Chairman of the SCRS to provide a brief presentation on some of the SCRS discussions at that meeting (**Appendix 3**). Dr. Die (SCRS Chair) explained that related work has been ongoing at the SCRS over the last several years. The development of an Ecosystem Based Fisheries Management (EBFM) framework requires input from all ICCAT stakeholders; he suggested that the SWGSM is the ideal forum for these discussions.

Dr. Die introduced the basic components of an EBFM framework: ecological (biodiversity, productivity of target stocks), economic (resilience and value of the fisheries), social/cultural (community structure and behavior) and institutional. He explained that a conceptual management objective must be developed for each element that is part of the components of the framework. These objectives should relate to sustainability and very generally describe the desired state (e.g., conserve biodiversity and habitat within the Convention Area). The conceptual objectives are then linked to specific operational objectives; this helps to identify gaps and establish clear priorities. After objectives are agreed, then the SCRS will select a series of indicators that are measureable and tied to specific reference points. At this stage, the SCRS proposes to focus on the four elements of the ecological dimension of the framework: habitats, bycatch, trophic relationships and target species.

Dr. Patrick Daniel (EU) gave a presentation on ecosystem consideration: "*The Ecosystem Approach to Fisheries Management: What Indicators for What Objectives? The Case of the European Union"* (**Appendix 3)**. Dr. Daniel explained that the EU marine environment strategy has a general objective covering the ecological focus of the ecosystem approach. Eleven criteria and descriptors cover the fields relating to the different components of the marine ecosystems, biotic and abiotic, including their productive capacity, sustainability and the impact of human activities on these ecosystems. For each criterion and descriptor, a series of indicators has been fixed. The way of taking account of these indicators and any associated reference points, is linked not only to the dynamics of the different fishery populations but also their interactions within food webs and the broader marine ecosystems. Dr. Daniel concluded that all objectives and indicators should be assessed in light of their sensitivity to changes in the marine environment, so as to eventually be able to measure and anticipate the impact of changes in marine ecosystems on the evolution of fishing activities.

The facilitator, Dr. Guillermo Diaz (USA), opened discussion of both presentations. The importance of certain environmental factors was emphasized by some Working Group participants, including climate change and ocean acidification, as well as human activities such as aquaculture. Dr. Die confirmed that the SCRS is looking not just at how fishing activities affect the environment, but also working to understand how other components of the ecosystem (e.g., climate change) impact the target species. One of the benefits of taking a broader range of ecological data into account is that it can improve the quality of the scientific advice the SCRS provides for the target species. The SCRS Working Group on Stock Assessment Methods is developing simulations to evaluate which environmental indicators are most important to the stock assessment process.

One participant suggested that a risk analysis could help to identify which ecosystem effects are important for specific fisheries, as this will vary. The SCRS Chair responded that the SCRS has not yet undertaken a risk analysis of this sort. Another suggested that implementing an ecosystem based approach to fisheries management will be especially challenging because of different national legislation; in particular there are sometimes data confidentiality concerns that prevent progress. There was concern expressed by one participant that incorporating ecosystem considerations into the stock assessment process will require a significant increase in the amount of data needed, and the SCRS will need to look at mechanisms or develop data collecting programmes for filling those gaps, as needed.

In response to a question about related initiatives in other tuna RFMOs, the observer from FAO replied that EBFM has not yet been operationalized in other tRFMOs. The ABNJ Tuna Project is prepared to support ICCAT's work in this area by inviting representatives of the other tRFMOs and technical experts to meet in a global forum to discuss their ideas. The same observer indicated that ICCAT seems to be ahead of other tRFMOs in the development of an EBFM framework. One participant pointed out that non-tuna RFMOs are also working in the development and implementation of EBFM. For instance, NAFO has established a Committee to look at the impact of other maritime activities, multispecies interactions and minimizing by-catch, and this may provide some inspiration to the work of the tRFMOs.

Dr. Santiago reminded participants that EBFM is addressed in the SCRS Science Strategic Plan for 2015-20, including through specific goals, objectives and measureable targets. There was general agreement within the Working Group that ICCAT should maintain its momentum in the area of EBFM. Given the complexity of the issue, a stepwise approach will be required. Dr. Guillermo Diaz asked participants to focus their discussion on potential objectives for the four ecological elements: habitats, by-catch, trophic relationships and target species. He clarified that the Commission does not need to tackle all four elements at once; initially, the Commission can focus on identifying objectives for certain elements only. The work of the SCRS is most advanced in the areas of target species and by-catch, so these elements may be a logical place to begin defining objectives. Participants concluded that with a better understanding of the SCRS's work in this area, the Commission is now well-positioned to develop clear objectives that will allow the SCRS to move forward in their work.

6.4 Socio-economic considerations: What socio-economic indicators should be associated to the different fisheries affective a same stock?

Mr. Antonio Cervantes (EU) gave a presentation on *Current EU Provisions for the Collection of Socio-Economic Data and Their Use in the Context of the EU Fisheries Management Framework and Management Strategy Evaluations* (**Appendix 3**). Ms. Faith Scattolon (Canada), facilitated this Agenda item, and she invited participants to engage in discussions. Several noted that social and economic factors are very important considerations for managers, but that they are often difficult to quantify. Relevant data are not readily available for many ICCAT fisheries. It was also recognized that CPCs generally do not send economists to SCRS or Commission meetings, and this lack of expertise would need to be addressed if the Commission were interested in advancing work in this area. Dr. Die concurred that the SCRS, as currently constituted, has limited capacity to advise the Commission on this issue or even engage in a productive dialogue on the topic.

Regarding the question of which economic indicators should be considered, it was noted that many indicators *could* be considered, but economic expertise would be needed to determine which indicators *should* be considered. The Working Group was not ready to make this determination and agreed that the identification of specific objectives would help determine what socio-economic data might need to be collected. Initially, this question might be informed by looking at a case study. It was suggested that one use of social and economic information can be to evaluate the relative economic impacts as well as net benefits associated with alternative management options in order to assist managers in selecting a management approach.

One participant suggested that the central issue related to the question of socio-economics is one of profitability (i.e., revenue minus variable costs and labor). Others agreed that profitability is an important, but perhaps not the only relevant socio-economic concept, and also questioned whether the SCRS could or should play a central role in trying to evaluate profitability. The issue of profitability is complex: lower catches may yield higher prices (due to increased demand in the marketplace), but lower catches may coincide with increased costs (increased variable costs if catches are low), thus lowering overall profitability. Different management strategies that affect catchability will also impact harvesting costs.

Several participants noted the potential difficulty in reaching consensus on economic objectives at the Commission level given the diversity of the various ICCAT fisheries and the varying needs of CPCs. It may be more appropriate for CPCs to determine their economic objectives on a national basis and take these objectives into consideration when implementing ICCAT recommendations through the management of their own domestic fisheries.

The Working Group recognized that, while not ideal, there are ways to consider economic objectives through the MSE process with existing information through the use of proxies (e.g., long-term average catch, stability in total allowable catch levels). The performance of various harvest control rules could be evaluated in terms of their success in meeting various objectives, including any economic objectives identified by the Commission. One participant suggested that the Maximum Economic Yield (MEY) should be considered as a management goal.

The Working Group participants all agreed that this is a complex issue that would require the engagement of specialized expertise from the CPCs in order to make progress. There was general agreement on the need to explore ways to more formally consider economic data as a means of informing management decisions. A crucial step initially will be to reach agreement on basic terminology. It was noted that economic information can be helpful in evaluating the impacts of various harvest strategies and can also be used to inform decisions about how quickly to end overfishing and how to determine time horizons for rebuilding.

6.5 Possible needs for social and economic data and research projects

Dr. Craig Brown (USA), facilitator of this Agenda item, opened the discussion by remarking that it is difficult to plan for possible research needs at this stage given that the SCRS is lacking expertise in this field. The working group took note of this and also that such data collection and analysis would significantly increase the SCRS workload, which is already very substantial. One participant noted that a better picture of fishing effort is needed to conduct any analyses, as the price of fuel, labor costs, subsidies, etc., varies substantially by fleet. Another participant noted that market information is very important and the impact of illegal, unregulated and unreported fishing activities would also be an important factor to consider.

Several participants noted, from a practical perspective, the need to consider the kinds of economic information that are already collected by CPCs or available through secondary sources. Price data are available in some areas, for example, but accessing this information will pose a challenge in other areas. Augmenting these data sources through new data collection programmes would be an expensive endeavor in many cases. Several CPCs expressed interest in working together intersessionally to develop a basic questionnaire to determine what types of economic data are currently collected by individual CPCs. These results of this questionnaire could be used to identify data gaps.

One participant noted that developing coastal States have some unique challenges associated with the collection of data to support the evaluation of social and economic considerations. For example, there is a need to develop indicators that could assess the economic activity associated with artisanal fisheries. Several other participants suggested that an initial step is to improve our understanding of these fisheries.

7. Management Strategy Evaluation (MSE) and examples in managed fisheries

Dr. Per Sandberg (Norway) gave a presentation that described how MSE was used to establish a harvest control rule for Norwegian spring spawning herring (**Appendix 3**). This Northeast Atlantic fish stock is utilized by 5 states/parties. The fishery collapsed in the late 1960s, and it took nearly 20 years for the stock to recover. In the late 1990s, managers saw the need to establish a harvest rule for this stock that could determine the annual level of Total Allowable Catch (TAC). This was done by first identifying possible management strategies and thereafter asking their scientific advisor (ICES) to calculate the consequences of the various management strategies. A small Working Group of scientists and managers evaluated the consequences of various management strategies, and advised the managers from the five parties which to choose. With this as a background, the managers chose a harvest rule for the stock, which has now been in operation for 16 years. Dr. Sandberg's presentation explained how the work was organised, and which elements were seen as important, to establish the harvest control rule.

Dr. Sandberg was asked how the initial Group was selected. He explained that as this was a straddling stock, five parties needed to agree to the harvest control rule. It was important to have a good balance of managers and scientists as part of the group. One lesson learned was to involve stakeholders in the process at an early stage. This may be accomplished at the national level through the CPCs or there must be an organizational change to involve stakeholders directly (e.g., through a workshop). Either or both may be appropriate, and this may be considered on a case by case basis.

Ms. Faith Scattolon (Canada) presented a case study on the application of MSE in the Canadian pollock fishery. She described the ways in which MSE can offer particular advantages over the traditional approach to fisheries management. For example, the application of pre-determined inputs enables a focus on long-term research to address uncertainties. In the case of Canadian pollock, the process began with a workshop involving external and internal MSE experts, scientists, fisheries managers and industry stakeholders to scope out key issues and to ensure these participants had a common understanding of the process and expected outcomes. Three management objectives were established, and the management procedure (i.e., formula used to set the TAC) was tested for robustness through a series of simulations including several plausible scenarios for areas of uncertainty. Ms. Scattolon concluded that the choice of management objectives inevitably requires trade-offs, and the MSE approach provides a disciplined approach to their consideration.

Discussion was facilitated by Dr. Joseph Powers. Dr. Powers noted that individual CPCs have very different objectives for their fisheries and asked participants to consider how the SCRS can provide information that will be helpful in determining management strategies.

One participant observed that MSE is a tool that could be used to assess different reference points and determine which ones would best help to achieve management objectives. Alternative harvest control rules can then be tested to examine trade-offs and determine which ones maximize the ability to achieve the identified objectives. The MSE process relies on an active dialogue among managers, scientists and stakeholders. Participants considered which indicators might be appropriate in the ICCAT context. Dr. Powers suggested that three of the main indicators typically relate to sustainability, maximizing catch, and keeping interannual variability of catches low. It was noted that the indicators developed by IOTC may provide a useful example for consideration.

One participant noted the importance of defining stock collapse as related to the HCR framework. As part of the EBFT management recommendation adopted by the Commission, the fishery shall be suspended if signs of recruitment failure are identified by SCRS. This could be interpreted as an implicit reference point (i.e., B_{lim}).

8. Detailed examination of case studies already proposed in 2014

Dr. Die referred the participants to the presentation given by Dr. Santiago at the 2014 Annual meeting and provided an update on the most recent HCR/MSE work underway within the SCRS (**Appendix 3**). He noted that among the case studies, there were some common steps but also some substantial differences in the approaches used.

8.1 N-ALB

Dr. Die explained that the work of the SCRS was most advanced for northern albacore and this would be the topic of a separate presentation. Dr. Gorka Merino presented a preliminary assessment of HCR for North Atlantic albacore (**Appendix 3**). Dr. Merino explained how an MSE framework based on the last albacore stock assessment was used to evaluate how three candidate HCRs perform in achieving the management objectives of maintaining the highest long-term average catch and a high probability of staying in the green quadrant of the Kobe plot.

8.2 N-SWO

On North Atlantic swordfish, Dr. Die reminded the participants that, relative to other stocks, this is a data rich stock and the last assessment showed a greater than 90% probability that the stock is in the green zone of the Kobe plot (i.e., the stock is not overfished and not subject to overfishing). North Atlantic swordfish is the only stock for which the Commission has adopted an interim reference point; a B_{lim} of $0.4B_{msy}$ is specified in Rec [13-02]. Development of MSE for North Atlantic swordfish is at a preliminary stage and not ready for providing management advice. Involved scientists must determine which sources of uncertainty are to be considered and which will not be incorporated. Dr. Die suggested that this could be a future topic for discussion at the SWGSM. He noted that it is essential for managers weigh in on the selection of performance measures. The SCRS has developed a number of different alternative estimation models and reference points. Sample HCR and interim reference points were selected for the initial analysis; consideration of all hypotheses allows the evaluation of the performance of the harvest strategies (combination of data, assessment method, HCR and management action). Overall achievement of the different management goals by each harvest strategy can be visualized using a 'spider-web' graph. Using this type of graph, the quantitative objectives associated with the performance indicators can be examined relative to one another.

8.3 Skipjack

Dr. Die explained that there is a high degree of uncertainty surrounding the biological parameters needed to conduct accurate stock assessments for eastern Atlantic and western Atlantic skipjack. Fully quantitative stock assessments for skipjack tuna are difficult to conduct and therefore, alternative methods of investigating current stock status are required. Following discussion at the first SWGSM meeting in 2014, the SCRS explored the use of catch-at-size information (e.g., proportion of skipjack caught: 1) above their maturity size; 2) above the size that produces the highest yields, and 3) above the size that contributes the most to the reproductive output of the stock) as a possible way to develop applicable quantitative length-based HCR. Due to the nature of the tropical tuna fishery, the SCRS has recommended that any further work to develop a skipjack HCR should take into account yellowfin and bigeye tunas through a multispecies approach.

8.4 Bluefin tuna

Regarding bluefin tuna, Dr. Die explained that MSE work has been coordinated by the GBYP modeling group. The SCRS conducted some related work at the 2015 bluefin tuna data preparatory meeting, but this work has not yet been presented to the full SCRS yet. The objectives of this work are: 1) to test and improve stock assessment methods; 2) to identify important sources of uncertainties in status and productivity of the two bluefin tuna stocks; 3) to evaluate quantitative objectives for the eastern and western Atlantic stocks rebuilding plans; 4) to determine what constitutes a threat of stock collapse; and 5) to consider potential utility of time-area closures. The SCRS has developed a modular approach that can be easily adapted for other stocks.

Dr. Die called the Working Group's attention to the use of 'spider-web' graphs and Pareto plots, noting that it is challenging to display and communicate the full range of MSE results; the SCRS is still exploring the best way to accomplish this. He invited the SWGSM participants to consider useful ways of representing results and to share their views on this matter.

Dr. Die concluded by emphasizing that communication between scientists and managers is essential, that effective dialogue requires consistent use of terminology, and that progress on MSE will depend on the development of clear statements of management objectives. He advised that the SWGSM must be realistic and proceed in small steps; many decisions need to be made, but these efforts are most likely to be successful if we do not try to make progress on all fronts at once. The SCRS Chair was asked to advise the SWGSM about the schedule of the SCRS and opportunities to advance this work.

Dr. Santiago, facilitator of this Agenda item, invited participants to discuss. The Working Group members recognized that work related to the northern albacore stock was more advanced than for other stocks and that this could serve as a useful test case. However, there was general agreement that this should not prevent the SCRS from continuing with related work for other stocks. One participant expressed reluctance to proceed with work on North Atlantic swordfish until any IUU fishing is better quantified. Dr. Santiago explained that MSE could help to cope with this situation, as it provides a framework that can incorporate the impact of deficiencies in implementing the management process. Another participant suggested that IUU fishing and related uncertainties should be built into the MSE exercise for swordfish.

Several participants felt that the application of MSE for bluefin tuna is an attractive idea, but there was also concern about this due to data deficiencies for some of the bluefin fisheries. It was suggested that initial work should focus on a stock that is more data-rich. There were also some questions about how related work on bluefin tuna could proceed given the timing of the next assessment in 2016 and the advance work needed to prepare for that assessment. Dr. Santiago agreed that this is an important consideration and noted that SCRS has mapped out a schedule of related activities through 2018. Dr. Powers added that the meetings of the SWGSM are important opportunities to inform this planning process. While acknowledging the complexity of this endeavor, there was general support among Working Group participants for the SCRS to continue its work on this front.

Dr. Die was asked how CPCs can effectively participate in the MSE process. He responded that the newly formed FADs Working Group could serve as a model; a similar format could be used for engaging scientists, managers, and stakeholders in the MSE process. Dr. Powers noted that in the case of bluefin tuna, work has not yet progressed to that stage. The SCRS is still working to develop a better understanding of the Commission's expectations. Another participant suggested that the SWGSM could be used as a general forum, or umbrella, with subgroups established as needed.

Regarding skipjack, participants noted that while possible to develop a single MSE for tropical tunas, this would add another layer of complexity, as the SCRS would need to define the interactions that exist between the fisheries and the productivity of the various stocks involved. Newly developing data streams may offer support to this effort (e.g., acoustic data from FAD buoys, which could be used as an indicator of productivity, and the sizable investment in a tropical tunas tagging programme). MSE would allow the SCRS and the Commission to make use of all this new information. While it was clear that these initiatives offer some promise for the future, the Working Group participants did not identify MSE for tropical tunas as an immediate priority.

Several participants voiced the importance of establishing a roadmap to guide the development of further MSE work on specific stocks, with associated timeframes. Dr. Die agreed that the development of such a roadmap through the SWGSM process would be a useful outcome from the perspective of the SCRS.

One participant suggested that the Commission's panels could provide a forum for discussing specific management objectives and providing necessary input to the SCRS, while a more general discussion of objectives should continue within the SWGSM. This idea was welcomed and it was agreed that the SWGSM should develop a recommendation to outline future steps. It was also noted that ample time would be needed on the agenda of the Annual meeting to allow the SWGSM to report back to the Commission on its discussions and conclusions.

9. Possible proposals on how to further develop the current provisions of Rec. [11-13]

9.1 Lessons learnt from fisheries other than ICCAT

Ms. Deirdre Warner-Kramer (USA) gave a presentation on *Lessons Learnt for Fisheries Other than ICCAT*. Ms. Warner-Kramer outlined the progress to date in developing harvest control rules and MSE in the other tuna RFMOs, and noted in particular the recent work in the Indian Ocean Tuna Commission to identify management objectives and associated performance indicators. The presentation highlighted the lessons learnt in the experiences of the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) in establishing a management procedure and MSE, and the Northwest Atlantic Fisheries Organization (NAFO) in developing its precautionary approach framework. In NAFO, the long, gradual development of reference points and harvest control rules benefitted from early work to clearly define the respective roles and tasks of scientists and managers in the process. NAFO also worked early on to identify a few candidate stocks that were representative of the range of NAFO stocks and fisheries, which formed the models for later work. In CCSBT, the relatively rapid process of establishing a robust management procedure and MSE was possible because of work at the beginning to agree to a schedule and methods, as well as extensive and transparent communication between scientists, managers, and stakeholders as measures were being refined.

Dr. Scott was invited to present the results of his questionnaire. He noted that responses were provided by individual participants and these responses were not necessarily reflective of the CPCs' official views. A high proportion of attendees had completed the questionnaire. When asked to describe their understanding of HCR, the dominant view expressed by participants was "a vision for where the fishery should be and how to get there considering uncertainty". A majority considered 75% to be a "high probability" of achieving a target, and the most popular response to the question of how long they considered to be "as soon as possible" was 3-5 years, although a high proportion indicated that it depended on the life history characteristics and status of the stock in question. It was also noted that time frames for managing fishing mortality can be much shorter than that required to rebuild biomass to the 'green' zone. The survey results are provided in **Appendix 4**. Dr. Scott suggested that the results could be used to inform the dialogue regarding management issues and potential policy choices.

The SWGSM discussed ways in which Rec. [11-13] can be made operational for individual ICCAT stocks, taking into account lessons learned from other fisheries, with a view to making relevant recommendations to the Commission. Part of the charge of the SWGSM is to translate general principles into overarching management objectives.

Ms. Warner-Kramer reviewed the basic provisions of Rec. [11-13] and noted that while this recommendation outlines the basic principles of decision making within ICCAT, the SCRS has posed specific questions to the Commission to assist with operationalizing this recommendation. One participant noted that there are two basic approaches: either to discuss questions of appropriate probabilities and timeframes generally (i.e., to be applied across species) or examine these questions for individual stocks. It was clarified that the question of timeframes can address two factors, depending on the circumstances: one is the time horizon for rebuilding and the other is the time within which overfishing is ended.

Recalling in particular the lessons learned from NAFO, one participant suggested that a stock-by-stock approach makes more sense. Others agreed that the determination of appropriate values should be stock-specific. One participant explained that we have the ability to define the concept of "high probability" across stocks. Where there are differences (e.g., uncertainty, life history), these differences can be accommodated by shifting reference points.

There was a suggestion that even with a stock-by-stock approach, managers could establish maximum levels of risk or maximum timeframes. Several others supported further exploration of this approach. The SCRS chair proposed a related approach: that the SWGSM select default values (for time frames for stopping overfishing, minimum levels of probabilities and maximum rebuilding times) that could be adjusted as needed for individual stocks. These could be adapted in the panels.

Concerning the role of the panels, there was general agreement that the SWGSM is the appropriate forum for addressing the general question of priorities, work plans, and where to set any generic "floors or ceilings" (i.e., maximum levels of risk or maximum time frames) or default values. The development of specific feedback to be provided to SCRS for individual stocks (e.g., management objectives) is more appropriately addressed through the panels.

Ms. Warner-Kramer encouraged the participants to discuss general management objectives, noting that she had already seen convergence around the objectives of catch levels and stability.

Dr. Scott referred to the management objectives developed by IOTC:

- Status (maximize probability of maintaining stock in the Kobe green zone)
- Safety (maximize probability of the stock remaining above the biomass limit)
- Yield (maximize catch across regions and gears)
- Abundance (maximize catch rates to enhance fishery profitability)
- Stability maximize stability in catches to reduce commercial uncertainty

One participant mentioned that the concept of EBFM is missing from the list of objectives developed by IOTC. Dr. Die remarked that the SCRS is in a good position to provide information on most of the management objectives mentioned at the meeting, perhaps with the exception of ecosystem considerations, where the SCRS has only recently started providing some information. Achievability was also mentioned by one participant as an important factor to consider when establishing management objectives, both on the management side and also for the SCRS.

The EU introduced a "Draft recommendation by ICCAT on the development of Harvest Control Rules and of Management Strategy Evaluation on species under the purview of ICCAT". This proposal is intended to build upon Rec. [11-13] with respect to the definition of reference points. Specific elements were drawn from the 2010 meeting of SCRS Working Group on Stock Assessment Methods. The EU explained that their proposal is designed to provide a road map to facilitate the planning of further work in coordination with the SCRS.

While agreeing with the general intentions behind this proposal, some participants felt that it needed substantial revision in order to reflect the discussions of the SWGSM over the past several days. In particular, it would be good to reflect specific next steps to be taken by the Commission, as well as the SCRS. There was general support for defining key terms. Several participants suggested that they would like to see the Panels' role elaborated, including the need for further dialogue concerning specific management objectives.

Further discussion of the draft recommendation was deferred to Agenda item 11. The Chair noted that a related proposal from the United States "Draft Workplan by ICCAT for Establishing Harvest Strategies" would be reviewed and discussed under 11.

10. Management input/feedback to the SCRS on the programme of work

Participants were reminded that the SWGSM had reviewed the SCRS Strategic Plan for 2015-2020 (Appendix 10, *Report for biennial period, 2014-15 Part I (2014), Vol. 2*) at its intersessional meeting last year and that the Strategic Plan was adopted at the 2014 Annual meeting. Providing feedback to the SCRS on its programme of work is part of the mandate of the SWGSM, as specified in Rec. [14-13]. Similarly, dialogue and communication is identified as a priority goal in the SCRS Strategic Plan.

Dr. Die highlighted several elements of the Strategic Plan, in particular, that relate to the SCRS's ongoing work on HCR/MSE. Regarding stock assessments and advice, he reiterated the request of the SCRS that the Commission reach agreement on stock-specific or general management objectives. Probabilities and timeframes must also be selected by the Commission in order to make further progress in developing HCRs (either by establishing default values or setting these values on a stock-specific basis).

Regarding data collection, Dr. Die explained that the identification of additional data collection needs in this area is dependent on the Commission defining conceptual and operational objectives for EBFM. Following up on earlier discussions under item 6.3, Dr. Die asked the Chair and the Working Group participants to consider what process should be used to develop objectives for EBFM with input from the Commission.

One participant suggested that trade data may enable the SCRS to better estimate production and catch, and proposed that interested CPCs should work together to analyze these data in preparation for the bluefin tuna stock assessment.

In general, the workload of the SCRS has increased substantially in recent years, and many of these activities come at a cost in terms of associated time commitments by the CPCs' national scientists. Dr. Die suggested that the SCRS and the Commission should consider external sources to support the expanded workload, where appropriate. Several participants expressed interest on receiving an update on the activities of the ABNJ/GEF project, and it was reported that an update on this work will be provided to the Commission at the 2015 Annual meeting.

One participant raised a general question about the development of stable funding mechanisms for research priorities, noting that much depends on voluntary contributions. The general budget might be reexamined as part of considering a more systematic approach to research funding. This idea was supported by several other Working Group participants.

Finally, Dr. Die highlighted several areas of collaboration with other tRFMOs, including MSE development. He mentioned that few CPC scientists have the expertise to work on MSEs, so there is a need to limit the number of case studies undertaken by the SCRS. Models developed through these case studies can then be adapted for other stocks.

Dr. Laurie Kell gave a presentation on the activities of the tRFMOs' MSE Working Group, which stemmed from the Kobe process**.** Dr. Kell discussed the Group's efforts to explore issues related to the quantification and presentation of risk. MSE has been used to evaluate 26 management procedures used worldwide. Most t-RFMOs are using albacore as a case study for MSE; a more formal comparative study could help in identifying operating model scenarios and also offer the benefit of improved methods. To support this effort, the Group is developing combined code repositories.

Dr. Scott, as facilitator of this Agenda item, suggested that it would be helpful for the SWGSM to identify any next steps for SCRS that result from deliberations at this meeting; this could be accomplished under Agenda item 11.

11. Identification of matters for the consideration by the Commission, including any recommendations as well as proposed next steps for SWGSM

11.1 Discussion on the ICCAT Atlantic-wide Research Programme for Bluefin Tuna (GBYP) and the Atlantic Ocean Tropical Tuna Tagging Programme (AOTTP)

It was recalled that an update on these programmes had been provided to the Commission at the 2014 Annual meeting. Since that time, the work plan for bluefin tuna has been slightly modified by the GBYP Steering Committee. Recent progress includes calls for tender on aerial surveys, tagging, and the collection of biological samples. This biological information, as well as the collation of historical data, will eventually go to the bluefin tuna modeling group and be used to support the 2016 stock assessment.

The Executive Secretary expressed appreciation to the EU, which finances the majority of costs for these programmes. It was noted that funding for the AOTTP had been discussed on the margins of the Convention Amendment Working Group in May 2015, and that as a result, ICCAT agreed to make a pre-payment, counting on the future voluntary contributions of the CPCs. Related activities that will soon be underway include the launching of the AOTTP, which will begin by recruiting the first subset of staff required to implement the programme.

11.2 Others

The United States presented a draft workplan to facilitate development of harvest strategies that would help ensure the effective conservation of ICCAT stocks and management of ICCAT fisheries. The proposed workplan suggests that a harvest strategy for northern albacore be developed as a pilot project, and requests that SCRS evaluate example harvest control rules to achieve example management objectives for the stock to inform that process. The workplan includes a provision for Panel 2 to review and, as appropriate, revise the example elements for northern albacore at the 2015 Commission meeting, and, more generally, requests the Panels to begin discussions to identify management inputs for their respective stocks, with priority focus on North Atlantic swordfish, western and eastern Atlantic/Mediterranean bluefin tuna, and tropical tunas. This information would be further considered by the SWGSM at its third meeting. In addition, the SCRS was requested to develop appropriate MSE methods.

The Working Group noted that the European Union and United States proposals provided two different approaches for developing harvest control rules. It was agreed that both proposals were helpful to the discussions and should be appended to the meeting report as reference documents to assist the Commission in considering the issues further during the 2015 Annual meeting (**Appendix 5 and 6,** respectively).

Participants were in agreement that key terms should be defined and there was some discussion of the process that should be used to confirm a common understanding of these definitions. It was noted that preliminary definitions of the reference points (target, limit and threshold) had already been established in the ICCAT Glossary.

The SWGSM agreed that these definitions (as contained in **Appendix 7**) should be the basis for future discussions regarding reference points.

Some CPCs supported the idea of a particular focus on northern albacore, given that the MSE work of SCRS is more advanced than that for other ICCAT stocks and that MSE for albacore is the primary focus of the tRFMOs' MSE Working Group. However, there was some concern that designating a single priority stock could slow progress in the development of HCR/MSE for other stocks. One CPC expressed a desire for the Working Group to establish a general framework for appropriate levels of probability and time horizons rather than designating a particular stock as a priority. Another CPC noted that an approach could be taken to identify management objectives as a first step as this will result in analyses by SCRS that can inform decisions related to probabilities and timeframes. Some participants noted that there were likely many ways to approach the issue of establishing HCRs and that there could be utility in trying to illustrate the process by moving from the theoretical to the concrete; identifying example harvest control rule scenarios for a stock or stocks offers one possible approach. It was agreed that these discussions would continue and, as suggested by the SCRS Chair, one approach could be to designate defaults and then modify these default levels as appropriate for specific stocks. Working Group participants expressed support for continuing work by the SCRS on all stocks.

The Working Group agreed that the Commission must provide input to the SCRS as soon as possible on the following questions, in order to operationalize Rec. [11-13] and make progress in the development of harvest control rules: (1) what constitutes a high probability and an appropriate timeframe to stop overfishing, and if a stock is overfished, for rebuilding; (2) what constitutes a high probability for maintaining a stock in the green

quadrant of the Kobe plot; and (3) what management objectives apply to each stock and fishery. This work will be referred to the relevant Panels at the 2015 Commission meeting. SWGSM participants discussed the importance of getting SCRS input when establishing time horizons for rebuilding as this may vary by stock. One CPC suggested that Panel 4 and PWG should work together to consider improvements to ICCAT's statistical document programme for swordfish to help address concerns of IUU fishing, although it was acknowledged that this issue did not fall within the mandate of the SWGSM.

The Working Group agreed that the process of developing HCR/MSE must involve stakeholders and it was noted that one way stakeholders can and should provide input is through their CPC. There was no agreement by the participants on whether to recommend extending the dialogue process to stakeholders beyond the level of their current involvement as accredited observers to SWGSM meetings. It was noted that there could be several ways to involve stakeholders more directly in the process, such as through informal, open format sessions of the SWGSM and/or specialized workshops.

There was some discussion of appropriate sequencing of future actions as the report of the SWGSM meeting must be referred to both the SCRS and the Commission for consideration. It was recognized that while discussions will continue within the SWGSM, the Working Group has no binding decision making authority to establish harvest control rules: this must occur through action by the Commission (i.e., as part of a recommendation). There was general recognition that few CPCs were represented at this meeting of the SWGSM and that, if the Working Group is to meet intersessionally in the future, it will be essential to have the full participation of scientists and managers from many more CPCs. An alternative approach for increasing participation could be to hold a special session of the SWGSM at future annual meetings of the Commission.

It was agreed that adequate time should be set aside at the 2015 Commission meeting in Malta, to explain the issues under discussion by the SWGSM to help ensure a common understanding among all CPCs of the main concepts of harvest control rules, the state of play of the SWGSM's discussions, and to try to reach agreement on a process and timeline for establishing harvest control rules. Several CPCs expressed interest in continuing work intersessionally to develop a document that clearly outlines next steps in the process to establish harvest control rules and develop and implement management strategy evaluation, ideally with a joint proposal to be presented to the Commission for consideration. In this respect, the Working Group encouraged EU and United States to endeavor to consolidate their respective draft proposals into a single one for consideration by the Commission at its next Annual meeting.

The Working Group Chair and the SCRS Chair jointly developed and circulated a proposed summary of outcomes: *SWGSM Recommendations to the Commission and the SCRS*. The SWGSM discussed and revised this document, and recommended to the Commission that:

1. The development of Harvest Control Rules (HCR) and Management Strategy Evaluation (MSE) for stocks under the purview of ICCAT be considered a high priority.

2. The dialogue be maintained among CPCs, scientists and managers, and be extended to stakeholders if considered appropriate.

3. To support the development of HCRs and associated reference point, starting at the 2015 Commission meeting, the Panels commence discussion to identify management objectives, as well as, relevant parameters for HCR and performance indicators on a stock by stock basis, with priority focus on north Atlantic albacore, bluefin tuna, north Atlantic swordfish and tropical tunas;

4. To examine ways to further define the management framework building on Rec. [11-13], in particular in relation to reference points, associated probabilities and timeframes;

5. SCRS be tasked to continue work on development of appropriate MSE methods to allow testing the performance and robustness of different management procedures.

6. A session be allocated at the beginning of the next Commission meeting in Malta to finalise discussion on outstanding issues from the second meeting of the Working Group.

12. Other Matters

No other matters were discussed.

Appendix 1

AGENDA

1. Opening of the meeting

2. Adoption of agenda and meeting arrangements

3. Nomination of Rapporteur

4. Review of the objectives of SWGSM (Rec. 14-13) and expected meeting outcomes

5. Recap of the basic components of precautionary management (from SWGSM-1), including necessary trade-offs between short-term and long term management objectives

6. Consideration of how Harvest Control Rules for ICCAT fisheries might be designed, in the light of specific biological, environmental and socio-economic considerations.

    6.1 Basic elements of Harvest Control Rules
    6.2 Conservation considerations: How F_{MSY} and B_{MSY} should be considered (e.g. are they target of limit reference points? which probability and timeframe should be associated to these reference points in each case? should we define reference points based on the precautionary approach?
    6.3 Ecosystem considerations (e.g. by-catch, impact on other stocks): what are the most appropriate ecosystem indicators that have impact on of from tuna fisheries?
    6.4 Socio-economic considerations: What socio-economic indicators should be associated to the different fisheries affecting a same stock, given the diversity of metiers.
    6.5 Possible needs for social and economic data and research projects.

7. Management Strategy Evaluations (MSE) and examples in managed fisheries

8. Detailed examination of case studies already proposed in 2014 in relation to the objectives already established for the management of these stocks and a critical assessment on how appropriate these reference points (including the associated probabilities and levels of risks) have shown to be so far.

    8.1 N-ALB,
    8.2 N-SWO
    8.3 SKJ
    8.4 BFT

9. Possible proposals on how to further develop the current provisions under Rec. [11-13]

    9.1 Lessons learnt from fisheries other than ICCAT
    9.2 Possibility of establishing in ICCAT non-arbitrary measures that are proportional to the deviations from the original objectives (for example a reduction/increase in F within fixed maximum limits.

10. Management input/ feedback to the SCRS on program of work

    10.1 Possible updates to the SCRS Strategic Plan on Science adopted during the 2014 SCRS Meeting, in the light of SWGSM meeting results

11. Identification of matters for the consideration by the Commission, including any recommendations as well as proposed next steps for SWGSM

    11.1 Discussion on the ICCAT Grande Bluefin Tuna Year Program (GBYP) and the new Tropical Tuna Tagging Program

12. Other matters

13. Adoption of Report and adjournment

Appendix 2

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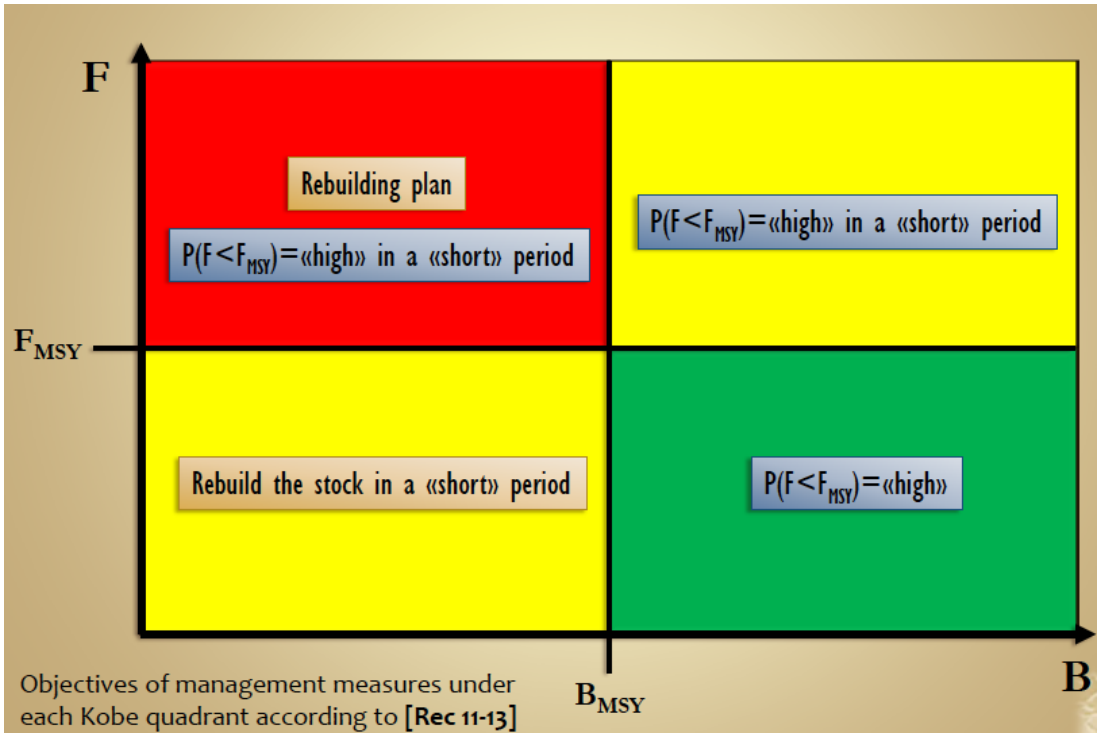
Appendix 3

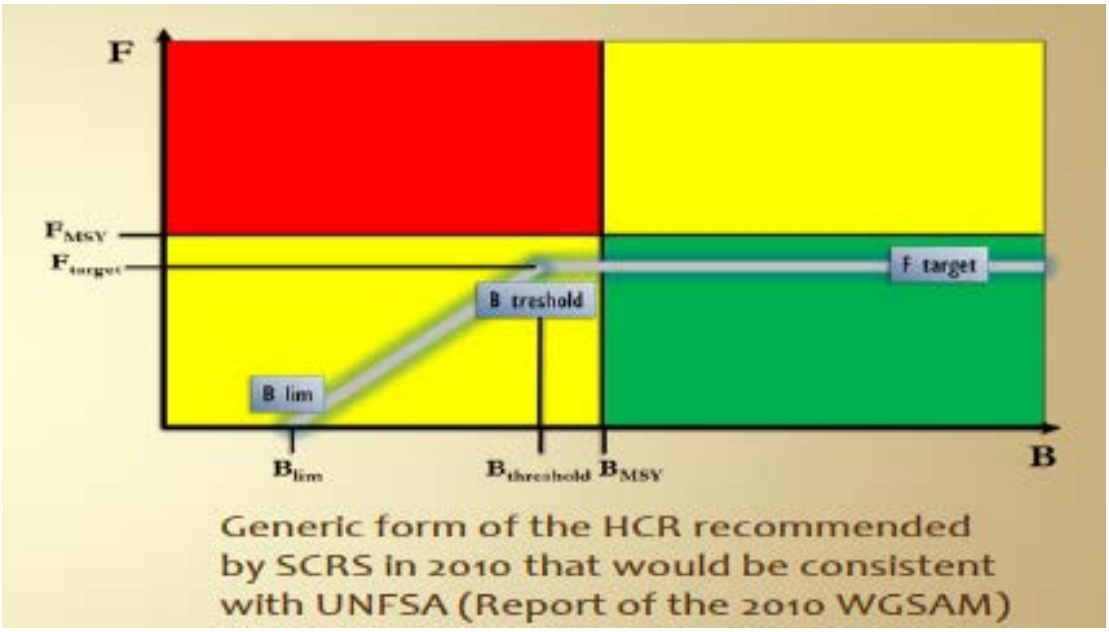
SUMMARIES OF THE PRESENTATION GIVEN UNDER ITEMS 6 TO 10

6. Consideration of how Harvest Control Rules for ICCAT fisheries might be designed, in the light of specific biological, environmental and socio-economic considerations

6.1 Basic elements of Harvest Control Rules (Gerald Scott)

ICCAT's HCR Framework





An Anonymous Survey to be Completed by Participants at the end of Day 1

1. Harvest Control Rules

1.1 Which one of these definitions better explains to you what a Harvest Control Rule is?

a) An automatic rule to control the fishery
b) A set of rules for CPCs to decide what to do
c) A fixed catch ceiling that does not change every year
d) A vision for where the fishery should be and how to get there considering uncertainty.

2. Control Mechanisms

2.1 What kind of management control would you prefer?

a) Output (*i.e.* catch quotas)
b) Input (effort limitations, time-area closures)
c) A combination of the two

2.2 Any particular reasons for that choice?

3. Management Objectives

3.1 Please list one or more management objectives that matter the most to you

a) Maximize long-term catch
b) Maximize long-term employment
c) Maximize long-term profit
d) Maximize social happiness
e) Maximize economic health
f) Minimize the impacts of fishing on the ecosystem
g) Minimize risk of spawning stock size going below the target Biomass level that achieves MSY
h) Minimize chance of the stock size going below the level at which successful recruitment is compromised (*i.e.* a limit reference point, LRP).
i) Other:_____

3.2 Do you expect any conflicts among them? Please tell us

3.3 Can you rank them in order of importance?

1: ___ 2: ___ 3: ___ 4: ___

4. Risks and probabilities

Key sections of Rec. 11-13 which need clarity:

1. For stocks that are not overfished and not subject to overfishing (*i.e*., stocks in the green quadrant of the Kobe plot), management measures shall be designed to result in a high probability of maintaining the stock within this quadrant.

2. For stocks that are not overfished, but are subject to overfishing, (*i.e*., stocks in the upper right yellow quadrant of the Kobe plot), the Commission shall immediately adopt management measures, taking into account, *inter alia*, the biology of the stock and SCRS advice, designed to result in a high probability of ending overfishing in as short a period as possible.

3. For stocks that are overfished and subject to overfishing (*i.e*., stocks in the red quadrant of the Kobe plot), the Commission shall immediately adopt management measures, taking into account, *inter alia*, the biology of the stock and SCRS advice, designed to result in a high probability of ending overfishing in as short a period as possible. In addition, the Commission shall adopt a plan to rebuild these stocks taking into account, *inter alia*, the biology of the stock and SCRS advice.

4. For stocks that are overfished and not subject to overfishing (*i.e*. stocks in the lower left yellow quadrant of the Kobe plot), the Commission shall adopt management measures designed to rebuild these stocks in as short a period as possible, taking into account, inter alia, the biology of the stock and SCRS advice.

4.1 What would you consider to be a 'high probability' of achieving a target?

a) 25%
b) 50%
c) 75%
d) 90%

4.2 What do you think should be 'as short a period as possible' for recovery?

a) 1 year
b) 2 years
c) 3-5 years
d) 5-10 years
e) 10-20 years

5. Overfishing

5.1 Do you think it is clear what 'overfishing' and 'being overfished' means?

6. Any other comments

6.1 Please feel free to give us any other comments or feedback on the dialogue process, or on the development of Management Procedures which incorporate Harvest Control Rules for ICCAT.

6.2 Conservation considerations: How should F_{MSY} and B_{MSY} should be considered (are they target or limit reference points)? (Victor Restrepo)

The apparent contradiction between the UNFSA Annex II Guidelines and the RFMO Conventions such as ICCAT's has caused considerable confusion as to whether FMSY should be a limit or a target.

At the time UNFSA was negotiated, it was common for stock assessment methods to assume perfect knowledge in many parameters and to ignore important sources of uncertainty. In situations like these, it is reasonable to view the estimate of F_{MSY} with caution and to consider a target F that is less than F_{MSY} so as to provide the precautionary buffer envisaged by the UNFSA Guidelines (Anon., 2015[1]). In common practice today, F_{MSY} is estimated taking a more realistic account of data and biological uncertainties, variability in productivity, stock status and fishery selectivity. Whether or not such an estimate of FMSY is a reasonable target in a particular situation could be studied by simulation (Management Strategy Evaluation), as recommended by the ICCAT ad hoc Working Group on the Precautionary Approach (ICCAT, 2000[2]). Both the Inter-American Tropical Tuna Commission and the Indian Ocean Tuna Commission have set an interim target of F_{MSY} (and B_{MSY}) for several of their stocks, but they have not conducted simulation tests to-date.

It should be noted that, if F_{MSY} is set as a target and F is maintained at that level, stock biomass will fluctuate above and below B_{MSY} due to recruitment variation and other factors. These fluctuations can be considerable for some stocks (Restrepo, 2009[3]). Therefore, the limit reference point should not be set at B_{MSY}, or very close to it, because it would trigger management actions unnecessarily.

6.3 Ecosystem considerations (e.g. by-catch, impact on other stocks): What are the most appropriate ecosystem indicators that have impact on tuna fisheries?

Managing ICCAT fisheries within an EBFM framework (SCRS Sub-Committee of Ecosystems)

Ecosystem based fisheries management (EBFM) has been promoted as the tool of the future and ICCAT recognizes this and tasked the SCRS Sub-committee on Ecosystems with developing a framework tailored to ICCAT's mandate. Development of this framework requires input from all ICCAT stakeholders and the SWGSM is ideally suited for this role. In the presentation we introduce possible components of an EBFM framework: Ecological, Economic, Social/Cultural and Institutional. Each of these components and subcomponents needs a conceptual

[1] Anonymous. 2015. Report of the 2015 ISSF Stock Assessment Workshop: Characterizing uncertainty in stock assessment and management advice. ISSF Technical Report 2015-06. International Seafood Sustainability Foundation, Washington, D.C., USA.
[2] ICCAT. 2000. Report of the meeting of the ICCAT ad hoc Working Group on the Precautionary Approach. Col. Vol. Sci. Pap. ICCAT, 51: 1941-2056.
[3] Restrepo. 2009. Red, green and yellow: Thoughts on stock status and the ICCAT Convention objectives. Col. Vol. Sci. Pap. ICCAT, 64: 2663-2673.

management objective, and these have to be linked to specific operational objectives. These operational objectives require development of measurable indicators of state, reference points and should also define possible actions required to achieve each objective. Examples are provided for the ecological components of the framework to promote discussion. The Sub-committee proposes that the structure of this framework is adopted by the SWGSM and that participants develop a preliminary list of conceptual management objectives for the ecological components of the framework, as means to illustrate how the overall framework would be developed within ICCAT.

The ecosystem approach to fisheries management: What indicators for what objectives? The case of the European Union (Patrick Daniel)

The need to take into account the dynamics of marine ecosystems and implement an ecosystem approach to fisheries management has been referred to since 1995 in the FAO Code of Conduct for Responsible Fisheries[4]. It was reiterated in 2001 in the Reykjavik Declaration on Responsible Fisheries[5]. Finally, in 2002, during the World Summit on Sustainable Development, it was suggested to maintain 2010 as the objective for the operative development of the ecosystem approach to fisheries management[6].

In 2003, FAO[7] defined the ecosystem approach to fisheries management as a process aimed at a good environmental status and human wellbeing and should take into account the different components of marine ecosystems and their interactions. FAO also stressed the importance to favour an integrated approach, implying the need to carry out arbitrations and to obtain the necessary consensus taking into account objectives which are sometimes contradictory related to the access to marine ecosystems and their utilization.

In 1983, when the first regulation establishing the European Union's Common Fisheries Policy (CFP) was adopted[8], no specific mention was made in the legislation to possible ecosystem considerations. These considerations were taken into account progressively and clearly emerged in the 1992 reform of the CFP[9], before being strengthened in the text of the 2002 reform[10] and establishing a clear link between fisheries policy and EU environmental policy of the 2012 reform[11]. The CFP from there on would respond to the main objective established by the EU Strategy for the marine environment in 2008[12], namely creating and maintaining a good ecological state of the marine environment no later than 2020.

The increased account being taken of the dynamics of marine ecosystems in fisheries management and the implementation by the EU of an ecosystem approach to fisheries management were made possible as the framework of data collection implemented by the EU in 2008[13] had already integrated the fields linked both to the state of the components of the marine ecosystem which support the fishing activity and the results of the fishing activity. Accordingly, 9 indicators were defined within the framework of the data collection[14] to reflect the status of the fish stocks exploited, to describe the activities and characterise the fishing strategies, to measure the impact on certain habitats or the level of unwanted catches or even the energy efficiency of the fishing activities.

Within the framework of the EU environmental policy, the EU marine environment strategy therefore establishes a general objective based on a series of 11 criteria transcribed in an equivalent number of qualitative descriptors, essentially covering the ecological focus of the ecosystem approach. These criteria and descriptors cover the fields

[4] FAO, 1995; *FAO Code of Conduct on Responsible Fisheries*. Rome, FAO, 46 p.
[5] FAO, 2002; *Report of the Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Reykjavik, Iceland, Spain, 1-4 October 2001*. FAO Fisheries Report No. 658. Rome, FAO. 128p.
[6] UN, 2002; *World Summit on Sustainable Development, Johannesburg (South Africa), 26 August-4 September 2002*. New York, UN. 189 p.
[7] FAO Fisheries Department, 2003; *Fisheries Management. 2. Ecosystem Approach to Fisheries.* FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 2. Rome, FAO. 120 p.
[8] Council Regulation (EEC) No. 170/83, dated 25 January 1983 establishing a community system of conservation and management of fishery resources. JO L 24, 27.1.1983, p. 1-13.
[9] Council Regulation (EEC) No. 3760/92, dated 20 December 1992 establishing a community system for fisheries and aquaculture. JO L 389, 31.12.1992, p. 1-14.
[10] Council Regulation (EC) No. 2371/92, dated 20 December 2002 regarding the conservation and sustainable exploitation of fishery resources within the framework of the Common Fisheries Policy. JO L 358, dated 31.12.2002, p. 59-80.
[11] Regulation (EU) No. 1380/2013 of the European Parliament and of the Council, dated 11 December 2013 regarding the Common Fisheries Policy, amending regulations (EC) No. 1954/2003 and repealing the regulations (EC) No. 2371/2002 and (EC) No. 639/2004 of the Council and the 2004/585/EC Council decision. JO L 354, dated 28.12.2013, p. 22-61.
[12] Directive 2008/56/EC of the European Parliament and of the Council, dated 17 June 2008 establishing a community action framework for the marine environment (Marine Strategy Framework Directive). JO L 164, dated 25.6.2008, p. 19-40.
[13] Council Regulation (EC) No. 199/2008, dated 25 February 2008 concerning the establishment of a community framework for the collection, management and utilisation of data in the fisheries sector and the support to scientific advice on Common Fisheries Policy. JO L 60, dated 5.3.2008, p. 1-12.
[14] Decision of the Commission of 18 December 2009 adopting a community multi-annual programme for collection, management and utilisation of data in the fisheries sector for the period 2011-2013. JO L 41, dated 16.2.2010, p. 8-71.

relating to the different components of the marine ecosystems, biotic and abiotic, to their productive capacity and to their sustainability and to the impact of human activities on these ecosystems. For each criterion and descriptor, a series of indicators has been fixed, the CFP mainly contributing to addressing the issues of criterion 3, which aims to ensure that the fishery populations exploited for commercial purposes are within safe biological limits, while presenting a population distribution by age and size which attests to the good health of the stocks. The main indicators associated with descriptor 3 do not differ essentially from those usually employed in fisheries management, in particular fishing mortality F or biomass B. The same applies to the reference points utilised, F_{MSY} or B_{MSY}. They are further completed by indicators describing the structure of fishery populations and catches (average size, maximum size, size at first sexual maturity). However, the way of taking account of these indicators, in particular the reference points associated to them, is not only linked to the dynamics of the different fishery populations, but also their position and their interactions in the food webs and in the marine ecosystems. Therefore, the EU marine environment strategy clearly states that in mixed fisheries and where interactions between ecosystems are significant, long-term management plans can ensure that exploitation of certain stocks is below the F_{MSY} levels so as not to undermine exploitation at F_{MSY} level of other species. The CFP also contributes to fulfilling the objectives set out in the EU marine environment strategy under criteria 1 (maintain biological diversity), 4 (ensure the long-term abundance of species and full maintenance of their reproductive capacity by ensuring abundant presence and normal diversity of all the components of the marine food web) or 6 (ensure the preservation of the structure and functions of the marine ecosystems without undermining the integrity of the seabeds). It should be noted that all the indicators proposed in the EU marine environment strategy, including those linked to descriptor 3, are not systematically associated to reference points and that some continue to evolve as a result of the assessments and recommendations provided by scientists.

Regarding the implementation of an ecosystem approach applied to fisheries management, ICCAT's Scientific Committee has already launched a reflection process[15]. However, the operational implementation of such an approach would necessarily require the Commission to meet several challenges in particular relating to:

- Adoption or clarification of the main and specific management objectives pursued, biological, ecological, even economic and social ones, as well as the deadlines to be met;
- Definition of the scope of the marine ecosystems taken into account;
- Adoption of possible indicators associated with specific objectives – monitoring indicators or indicators utilised to aid decision-making and therefore associated with reference points yet to be fixed; and
- Definition of the possible rules of exploitation.

Finally, all these objectives and indicators should also be assessed in light of their sensitivity to changes in the marine environment, so as to eventually be able to measure and anticipate the impact of changes in marine ecosystems on the evolution of fishing activities.

6.4 Socio-economic considerations: What socio-economic indicators should be associated to the different fisheries affecting a same stock?

Current EU provisions for the collection of socio-economic data and their use in the context of the EU fisheries management framework and in management strategy evaluations (Antonio Cervantes)

Fisheries management is a complex matter requiring information on the different aspects affecting the fishery (biological, environmental, social and economic). Managers need objective arguments to support their decisions and the availability of appropriate socio-economic indicators are an important part of these objective arguments. To this end, the collection of appropriate and reliable socio-economic data is crucial to estimate the economic performance of the fleets such as profits, gross value added or employment. In summary these indicators are essential to measure the industry's economic sustainability in the provision of advice to managers. However the access to socio-economic information is often difficult and requires appropriate methodology.

In the context of the EU Data Collection Framework, socio-economic data related to the fishing industry are being systematically collected since the early 2000's. Previously a number of studies and concerted actions aiming at identifying relevant socio-economic data were undertaken. The current framework covers more than 90% of the EU fleets and the information collected supports most of the decisions regularly taken in the implementation of the EU Common Fisheries Policy.

[15] SCRS, 2014. *2014 Inter-sessional meeting of the Sub-Committee on Ecosystems, Olhão, Portugal, 1-5 September 2014*. ICCAT, Madrid. 25 p.

On the basis of solid socio-economic data, Management Strategies Evaluations should include socio-economic targets agreed by managers. This would provide managers with a clearer picture of the socio-economic consequences of a given resource evolution and, at the same time, increase stakeholders involvement and ownership of the management measures.

7. Management Strategy Evaluations (MSE) and examples in managed fisheries

Management strategy evaluations for Norwegian spring spawning herring (Per Sandberg)

This is a presentation of how Management strategy evaluations were used to establish the Harvest rule (also called Harvest Control Rule) for the stock of Norwegian spring spawning herring. The fish stock has its distribution in the Northeast Atlantic and is utilised by 5 states/parties. The fishery collapsed in the late 1960s, and it took nearly 20 years for the stock to recover. In the late 1990s the managers saw the need to establish a harvest rule for this stock that could determine the annual level of Total Allowable Catch (TAC). This was done by first identifying possible management strategies and thereafter asking their scientific advisor (ICES) to calculate the consequences of the various management strategies. A small working group of scientists and managers evaluated the consequences of various management strategies, and advised the managers from the five parties which to choose. With this as a background, the managers chose a harvest rule for the stock, which has now been in operation for 16 years.

The presentation starts with some background information about the stock and the fishery. It then shows how work was organised, and which elements were seen as important, to establish the harvest rule.

8. Detailed examination of case studies already proposed in 2014

ICCAT case studies related to HCR and MSE (David Die)

We present a summary of the work conducted by the SCRS on HCR and MSE for three case study stocks: northern swordfish, skipjack and bluefin tuna. The northern swordfish work highlights the importance to acknowledge that MSE that can only be considered a subset of all the uncertainties of the system. Furthermore, it demonstrates the challenges of communicating the results of MSE in the face of multiple performance indicators. Skipjack research shows how, for data-poor stocks, harvest control rules can be developed on the basis of indicators of stock status that are less data hungry - based on average length of fish in the catch. The work on bluefin tuna is being coordinated through the modelling group of the GBYP. This research is guided by specific Commission needs regarding the 2016 Bluefin Tuna Stock Assessment. The work of this Group has now delivered some generic tools for implementing MSEs for ICCAT stocks and these tools are being currently tested by the Group by applying them to the bluefin tuna stocks.

Preliminary assessment of harvest control rules for north Atlantic albacore (Gorka Merino)

In this work we use an MSE framework based on the Albacore Working Group stock assessment to evaluate how three candidate HCRs (applied in combination with the current ICCAT assessment based on a biomass dynamic SA model) perform in achieving the management objective of maintaining the highest long-term average catch with a high probability of being in the green quadrant of the Kobe plot and a low probability of being outside biological limits.

We assess the performance of HCRs in relation to the Pareto frontiers, which are a set of choices (or levels of F) in which it is impossible to improve the performance of one variable without worsening the other. If we had absolute control and knowledge of the system, we could not achieve better probability of being in the green zone for a given level of catch than that determined by this trajectory. We believe that this figure can facilitate managers and stakeholders' guidance on terms such as acceptable probability levels for management targets and limits.

In relation to the HCR tested, we find that a precautionary F_{target} of 0.7 F_{MSY} in combination with a $B_{threshold}$ of 0.8 B_{MSY} and a B_{lim} of 0.4 B_{MSY}, allows achieving high long term catches, maintains the stock in the green quadrant of the Kobe plot with a probability of 86%, and within safe limits with a probability of 100% during the 30 years of the simulation. Among the three HCR, this also produces the most stable catches and levels of fishing effort.

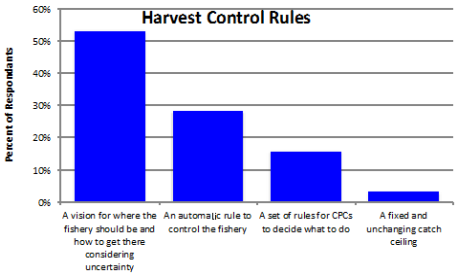
Appendix 4

SUMMARY RESULTS FROM THE QUESTIONNAIRE DISTRIBUTED TO PARTICIPANTS AT SWGSM-002

Our Survey

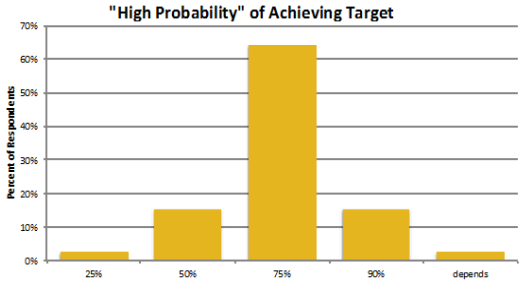
- 35 Respondents – a high proportion of attendees and a very positive outcome of the meeting.
- Can be used to guide/refine dialogue regarding management issues and potential policy choices

What are HCRs?



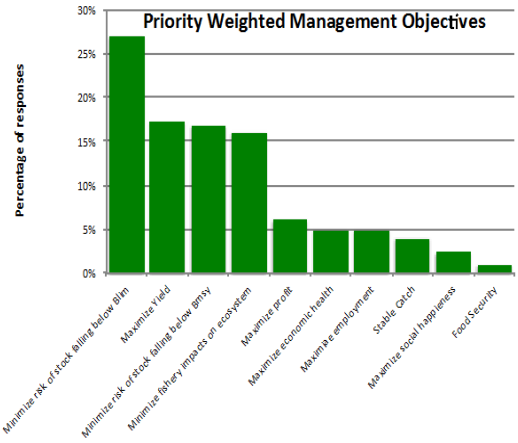
- The dominant view by Participants is of HCRs as a vision for where the fishery should be and how to get there considering uncertainty

What is High Probability of Achieving a Target



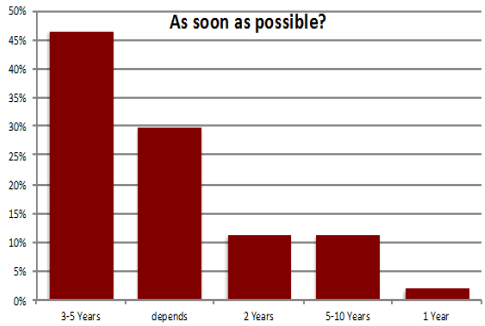
In keeping with other organizations, the majority view by participants is that ~75% (or 3 chances out of 4) is a high probability for achieving a target.

Management Objectives



- Considering priority given to the management objectives noted by Particiants, those related to 'Safety', 'Yield', and P(green) aka 'Sustainability' ranked highest followed by minimizing ecosystem impacts.

Time Frames?



- Most participants view a time frame of 3-5 years in this context, although a high proportion of respondents indicated it depends on the stock of concern. Others indicated that time frames for managing fishing intensity should be different from rebuilding biomass to desired levels.

Appendix 5

DRAFT RECOMMENDATION BY ICCAT ON THE DEVELOPMENT OF HARVEST CONTROL RULES AND OF MANAGEMANT STRATEGY EVALUATION ON SPECIES UNDER THE PURVIEW OF ICCAT

(Proposal by the European Union)

RECALLING Recommendation by ICCAT on the Principles of Decision Making for ICCAT Conservation and Management Measures [Rec. 11-13] to support the achievement of the ICCAT Convention objective;

NOTING that the ICCAT Working Group for Stock Assessment Methods held in April 2010 in Madrid (Spain) endorsed the definitions on reference points presented during the 1999 *ad hoc* Meeting of the ICCAT Working Group on Precautionary Approach held in Dublin (Ireland) in May;

ACKNOWLEDGING that the First Meeting of the ICCAT Working Group to Enhance the Dialogue between Fisheries Scientists and Managers suggested that a dialogue of a general nature should continue on issues such as acceptable levels of risk, targets, limits and time horizons based on Rec. [11-13] and that a strong dialogue should take place between scientists and managers on the use of Management Strategy Evaluation (MSE) to assess Harvest Control Rules (HCR).

FURTHER ACKNOWLEDGING that one of the main goals of the SCRS Science Strategic Plan 2015-2020 is to evaluate precautionary management reference points and robust HCR through MSE;

THE INTERNATIONAL COMMISSION FOR THE CONSERVATION OF ATLANTIC TUNAS (ICCAT) RECOMMENDS THAT:

1. In the context of ICCAT, the following definitions for target, limit and threshold reference points should apply:

   a) A target is a management objective based on a level of biomass (B_{tar}) or a fishing mortality rate (F_{tar}) that should be achieved with a determined probability, on average. This generally means that the probability of being above B_{tar} and below F_{tar} should be at least 50%. Targets should be set sufficiently far away from limits so that there is low probability that the limits will be exceeded.

   b) A limit is a conservation reference point based on a level of biomass (B_{lim}) or a fishing mortality rate (F_{lim}) that should be avoided with high probability because it is believed that the sustainability of the stock may be in danger.

   c) A threshold is a level of biomass (B_{thresh}) or a fishing mortality rate (F_{thresh}) between the limit and target reference points that should trigger particular management actions designed to reduce fishing mortality.

2. By 20[XX], the SCRS shall provide options of HCR with, where possible, the associated limit, target and threshold reference points for species under purview of ICCAT, in particular for albacore, bluefin tuna, swordfish, bigeye, yellowfin tuna and skipjack. In doing so, the SCRS shall also perform population projections using those HCR to provide the probability of being in the green quadrant of the Kobe plot and the relevant timeframes.

3. SCRS is also requested to develop appropriate MSE methods to allow testing the robustness of different management procedures, including options of HCR to achieve management objectives and to estimate the associated probabilities and timeframes.

Appendix 6

DRAFT WORKPLAN BY ICCAT FOR ESTABLISHING HARVEST STRATEGIES

(Presented by United States)

To facilitate development of harvest strategies that help ensure the effective conservation of ICCAT stocks and management of ICCAT fisheries, the SWGSM proposes the following work plan to the Commission for endorsement:

1. SCRS shall complete the process of revising the ICCAT glossary to include, *inter alia*, definitions of the following:

   a) Reference points (target, threshold, and limit)
   b) Harvest control rules
   c) Management strategy evaluation

2. Given the relatively data rich nature of the northern albacore stock and the work that has already been completed by the SCRS to develop reference points and harvest control rules, a harvest strategy for this stock should be developed as a pilot project. To support this work, SCRS will, no later than [2016], evaluate alternative harvest control rules, incorporating as appropriate various combinations of reference points, with respect to the achievement of the following management objectives as working scenarios for northern albacore:

   a) rebuild the stock by 2020;
   b) when the stock in the green quadrant of the Kobe plot (*i.e.*, is no longer overfished, nor subject to overfishing), maintain the stock within this quadrant with at least: 1) 70%, 2) 80%, and 3) 90% probabilities (as examples);
   c) maintain stock levels above the biomass limit reference point (B_{lim}) with at least [90%] probability;
   d) maximize average catch;
   e) minimize inter-annual fluctuations in TAC levels.

3. The SCRS will report the outcomes of the work carried out under paragraph 2 for discussion at a third meeting of the SWGSM to inform on the process of establishing harvest strategies for northern albacore.

4. To support development of reference points and harvest control rules, starting at the 2015 Commission meeting, the Panels will, for their respective stocks, begin discussions to identify the following management inputs on a stock-by-stock basis, with priority focus on North Atlantic swordfish, western and eastern Atlantic/Mediterranean bluefin tuna stocks and tropical tunas:

   a) Management objectives;
   b) Acceptable level(s) of probability of achieving target reference points and avoiding limit reference points;
   c) Pre-agreed management actions that are triggered if reference limits are breached, including the timeframes for halting overfishing on a stock and/or to rebuild an overfished stock so that it; returns to the green zone of the Kobe plot in as short a time as possible. In the case where a stock falls below the biomass limit reference point (B_{lim}), the pre-agreed management action will be to suspend the fishery and institute scientific monitoring

   In addition, Panel 2 should review the working scenario regarding northern albacore specified in paragraph 2 at the 2015 Commission meeting and may revise it, as appropriate.

5. The Panels will report the progress of these deliberations to the SWGSM in advance of its third meeting. Based on this input as well as its experience with the pilot stock, the SWGSM will develop work plans and timeframes for developing harvest strategies for other ICCAT stocks and fisheries for consideration by the Commission. The SWGSM will present the results of this work for consideration at the [2017] Commission meeting.

6. In addition, SCRS is requested to develop appropriate MSE methods to allow testing the robustness of different management procedures, including options of HCR, to achieve management objectives and to estimate the associated probabilities and timeframes.

Appendix 7

DEFINITIONS OF REFERENCES POINTS