REPORT OF THE 2018 ICCAT WORKING GROUP ON STOCK ASSESSMENT METHODS MEETING (WGSAM)

(Madrid, Spain 7-11 May, 2018)

1. Opening, adoption of agenda and meeting arrangements

The meeting was held at the ICCAT Secretariat in Madrid, 7-11 May 2018. Dr. Michael Schirripa (USA), the Working Group ("the Group") rapporteur and meeting Chair, opened the meeting and welcomed participants. Dr. Miguel Neves dos Santos (ICCAT Assistant Executive Secretary) adressed the Group on behalf of the ICCAT Executive Secretary, welcomed the participants and highlighted the importance of the issues to be discussed by the Group aiming the work of the different SCRS Species Groups. The Chair proceeded to review the Agenda, which was adopted with a few changes (**Appendix 1**).

The List of Participants is included in **Appendix 2**. The List of Documents and presentations given at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents and presentations are included in **Appendix 4**. The following served as rapporteurs:

Sections	*Rapporteur*
Items 1, 9	M. Neves dos Santos
Item 2	M. Schirripa
Item 3	D. Die
Item 4	K. Gillespie
Item 5	M. Schirripa
Item 6	G. Bal
Item 7	D. Die, M. Schirripa
Item 8	G. Bal

2. CPUE standardization/incorporation of oceanographic and environmental changes into the assessment process

2.1 Presentation of new CPUE standardization methods by CPUE Standardization Study Group

Presentation SCRS/P/2018/031 gave a review of the GLM standardization blind study which was presented along with an overview of the Species Distribution Model (SDM) and longline simulator (LLSIM). The presentation reviewed the now completed study that compared the many types of GLM standardization used by ICCAT CPCs. The presentation was used as a reminder of the many different techniques and methods which are being used in ICCAT and how each of them can give results with varying degrees of similarities. The presentation also reviewed work presented at the 2018 blue marlin data preparatory meeting regarding the use of habitat covariates in the GLM process. This work demonstrated that methods that included habitat (environmental) covariates were superior to those that did not and made the case for their use on a regular basis. While the results of the blind study were enlightening, they were not able to prescribe a "best practices" approach to CPUE standardization. To accomplish this a factorial designed study would need to be conducted. This design would need to use a systematically laid out grid of various approaches to CPUE standardization now is use (i.e. data grouping, inclusion criteria, error structure, etc.).

Presentation SCRS/P/2018/033 showed a method for standardizing CPUE data to changes on the habitat suitability and non-linear responses on other fishing operation descriptors such "hour of the day". The delta lognormal approach was based on a binomial and a lognormal GAM. Means and deviation parameters were computed from a random resample of the original data set. The method was tested on a larval abundance data set of albacore in the Balearic Sea.

The Group discussed about the differentiation of the habitat effect on the catchability and on the abundance of the population.

It was clarified that the habitat variables included in the models do not affect the total larvae abundance and instead affect the spatial distribution. The Group discussed whether the habitat standardization should be applied at the year aggregated data or at the fishing set level, this question remained open. The main discussion focused on the adequateness of the use of a prediction matrix from a random resample of the original data set for computing the standard error, but a specific method to approach a solution was not decided. One of the suggestions to better assess the representatively of the ichthyoplankton surveys for providing larvae abundance indices was to develop model of spawning locations and larval habitats and evaluate the percentage of total area covered by the survey.

The method presented sought to use a non-linear approach to CPUE standardization GLM in an effort to alleviate the need for subjectivity categorizing response variables with known non-linear relations. The author was looking for feedback from the Group, either positive or negative, regarding the methodology and whether it should be used in the future. The work generated much discussion, especially those regarding the resampling of the data over all of the available years combined in order to estimate the standard error. The Group concluded that resampling overall years is not valid for estimating the standard error. The Group noted that the current way to estimate error was not appropriate.

The results of the two modeling approaches of interest (linear vs. non-linear) were rather similar due to the fact that the relationship of CPUE and salinity was rather linear within the range of observed salinity values. Thus, it was suggested that perhaps the author could demonstrate the potential problems of subjective categorization by applying different categorization methods to the data, using the linear approach, and reporting the range of results one might obtain as a result of those subjective decisions.

It was discussed that it is very important to know whether you are modeling how the environment may be effecting larval abundance, or, how the environment may be effecting catchability. The distinction between the two has very different ramifications in interpreting the model outputs.

The Group also brought up the question of how well this single study site index may or may not index the population considering the other known spawning sites, assuming that it does make the assumption that the proportion of spawning occurring between the three areas is constant each year. However, this study was focused more on the modeling methodology and not the veracity of its use in stock assessments.

During the last decades, fisheries ecology has focused on the study of the response of fish populations to environmental variability, with the aim of designing optimal or sustainable harvesting strategies of marine living resources. At the same time operational oceanography has been advancing fast, propelled by the implementation of new multi-platform observing systems and also by the improvement of the data quality, quantity and accessibility. Nevertheless, the initiatives directed to facilitate and promote the integration of operational oceanography into the current fisheries assessments in a systematic way are scarce. The activities of the OOSTOP task group (IMBER/CLIOTOP, Ref: 2016/04, https://oostop.wixsite.com/oostop) were presented, which works as an open network of scientists. The network aims at improving the knowledge transference between researchers working on operational oceanography, species biology and management. The Group discussed the possibility of linking working groups from fisheries and oceanography, and the author expressed the need of well validated hydrodynamic models for time series matching the CPUE time series. One suggestion to provide useful information for operational oceanography was to identify the temporal and spatial scales of interest in the framework of the assessments developed within ICCAT.

2.2 Design of a CPUE standardization factorial study

Recognizing that the recent CPUE standardization blind study was not ideal for prescribing advice regarding "best practices" for the task of standardization, the Group discussed the design of a more rigorous factorial study to create more effective advice. The Group carried on an in depth discussion of the use and design of such a study. The Group came to the realization that there was essentially an infinite number of factorial designed were possible, but that a clear question of hypothesis had not yet been identified. Further deliberations by the Group resulted in a design that would examine how the level of catch and effort data aggregation effects the accuracy and bias of the resulting index of abundance. The details of this proposed study design are in **Appendix 5**.

The Group discussed the Species Distribution Model for blue marlin and its integration into the Longline Simulator, which was used for the previous CPUE standardization approach testing, and which will be used for the factorial design studies. The Group noted that this could potentially be used to address several other difficulties in CPUE standardization, including the characterization of targeting as well as how to handle conflicts between longline indices that cover different parts of the stock distribution. To facilitate such future analyses, the Group recommended that fishing patterns (time/area coverage, gear configuration, bait, etc.) from additional fleets (e.g. Spanish and Portuguese longline fleets) be incorporated into the model, if possible. Also, it was recommended that the habitat preference information, derived from electronic tags, be incorporated from SWO, YFT, and SMA, if possible. This would better reflect the diversity of strategies of the ICCAT longline fleets.

2.3 Discussion of a study design to address localized CPUE

One of the common issues in ICCAT is that we assess stocks that are widely distributed, but many of the fisheries we get CPUE data from are local. In this situation, different CPUE series in different parts of the Atlantic might show different (even conflicting) signals. In this situation, the working groups are tasked to judge and select whether to use some, or all the available CPUEs.

The Group addressed other gears, such as some baitboat that share an important proportion of the total catch of given stocks in the Atlantic. The strategy of such baitboat vessels is restricted to oceanic waters close to coastally distribution bait that must be kept alive onboard. Migratory species follow oceanographic gradients, such as sea surface temperature and salinity. Accordingly there is an inter-annual variation on the spatial and time distribution of the tuna resource available at regional level to this gear. Therefore the analysis of the CPUEs of those baitboat fleets is affected by the random oceanographic features forcing the presence or absence at regional area. Those effects are difficult to tackle in the standardization method applied to obtain relative abundance indices. Ideally this problem should be subject of closer study through a simulation process similar to the longline fishery.

Since the spatial distribution of the population can (at least partly) be driven by the habitat, the Group considered useful to use the Species Distribution Model to conduct a simple experiment to explore this problem where a widely distributed stock is sampled with local fisheries in different areas. The trends observed in each area would be compared to the original population trend. At the end, the Group might be able to investigate different ways to correct the local indices for the environmental effects on resource distribution. The details of the design of this investigation are detailed in **Appendix 5**.

3. Review of relative indices of abundance (CPUEs)

3.1 Harvest Control Rules, Limit Reference points and Management Strategy Evaluation (MSE)

Document SCRS/2018/064 presented an analytical approach to evaluate management procedures and harvest control rules. The method is based on a set of stochastic differential equation which predict the equilibrium probability density of biomass of a stock. The stock is assumed to be managed by a "hockey stick" harvest control rule. The method allows for solving for the parameters of this rule, B_{lim}, $B_{threshold}$, F_{target} which maximize catch and minimize inter-annual variation in TAC.

The Group noted that it would be interesting to check whether this method could be used to evaluate HCRs of the same type as it was done through simulation with the ALBN MSE. It was pointed out that the method assumes that all uncertainty can be subsumed in a single "process error-like" term. It also acknowledges that the dynamics of the operating model can be described through the production model even though the dynamics are inherently based on age structure. Some members in the Group expressed concern over the assumption that production model dynamics could accurately describe population dynamics even at very low biomass and therefore that the optimum Blim could be solely dependent on the objective of reducing the variation in catch. The author noted that the method allows for constraints, based on life history knowledge, to be put on Blim. He also noted that production model dynamics imply that harvests are maximized at intermediate biomass levels, and thus that any attempt to manage to maximize harvests would keep the biomass away from very low levels.

3.2 Report from the NALB Study Group on current status and progress of NALB MSE

The albacore tuna rapporteur made a brief presentation over what was advised by the SCRS in 2017, what was adopted by the Commission [Rec. 17-04], and the work that the SCRS needs to do to respond to the Commission requests included in Rec. 17-04. This work includes: conducting a peer review of the ALBN

MSE, start defining exceptional circumstances, and test the effect of some modifications to the adopted interim HCR.

The Group noted that the peer process is in place, the exceptional circumstances were to be addressed in this meeting, and that the requested modifications to the MSE would be tested before the next ALB SG.

One of the requests to the SCRS included in Rec. 17-04, is to explore additional management procedures including some considering the ability to carry-over, according to [Rec. 16-06 parag 7], catches for albacore tuna (this provision allows transfer of unused CPC quota portions -up to 25% of the quota). In the case of North Atlantic albacore, the bulk of the catch is caught by traditional surface fisheries operating in the Bay of Biscay and surrounding waters. Thus, it is likely that the fluctuations in catches reflect the fluctuations in the availability of the resource to those local fisheries, and the carry over allows to compensate for years where the stock might be less available. In practice, the catch has been below the TAC in all but three years, where the catch was slightly above the TAC.

The Group discussed ways to simulate the effect of the carry over on the stock, and suggested that a straight forward way could be to model deviations (between catch and TAC) by resampling from the observed deviations since the first TAC was implemented. However, the Group also noted that the degree of imperfect implementation of the TAC might increase after the recent TAC increase. Therefore the Group recommended to also consider values of catch deviates in excess of those observed in the historical time series.

3.3 Review of the recent decision on ALB Harvest Control Rule and other MSE processes: lessons learned

It is impossible to perfectly simulate real data, such as CPUE series, within an operating model. All simulations will represent approximations of the real data. For instance the N-ALB MSE used an MP with four CPUE indices representing the range of CPUE indices (for different areas and age groups) available for the NALB stock assessment. Although the SCRS agreed that the simulated MP did reasonably well represent the real process, it could be argued that the MP does not sufficiently represent the five CPUE indices that were used in the last NALB assessment. It could also be argued that it is unclear whether such MSE-tested MP would be sufficiently representative of an MP that uses the five real indices, the MP that was used to establish the current TAC in 2017.

This clearly shows that, it is essential to reach an agreement that the MP tested is an acceptable representation of the MP used. It must be noted that the same agreement must be obtained for every aspect of the MSE simulations: the OM set must be an acceptable representation of the plausible dynamics of the system, the implementation model of the management and harvest dynamics of the real system, etc.

The Group then discussed on the importance to properly plan and communicate the MSE building and adoption process, because this will help alleviate the problems reflected in the above paragraph, as well as others. Likewise the Group agreed that, a strong commitment and broad participation in the process at early stages are essential for the success of any future MSE development within ICCAT.

3.4 HCR "exceptional circumstances", what they are and what to do if they occur (Rec. 17-04)

Rec. [17-04] requests the SCRS to develop, in 2018, criteria for the identification of exceptional circumstances (ECs). These ECs will define the conditions which would trigger a consideration for reviewing the process by which the TAC is set, for example by not setting it according to the HCR. These ECs should be pre-agreed so that any departure from the adoption of TACs based on the HCR is not subject to inappropriate influences, or subjective decisions. Some examples of such circumstances are provided in Rec. [17-04].

A review of the state of the art regarding exceptional circumstances (ECs) in RFMOs, focusing on how these are defined, who and how often it may be determined whether they exist or not, and what are the type of actions that are taken in case they are detected was provided in SCRS/2018/063. The document contains the definitions for ECs and the process used to invoke ECs in CCSBT, IOTC, WCPFC and NAFO. It is noted that WCPFC have discussed an "emergency rule" for Pacific bluefin tuna, in the context of stock assessment because there is no HCR for Pacific bluefin tuna. The most detailed definition of ECs seems to be that of NAFO which defines a process defining the action to be taken on the basis of the severity of exceptional circumstances. It is also worth noting that some ECs have been defined for stocks that only have an adopted HCR (IOTC) whereas other ECs have been defined for stocks with adopted MP (CCSBT). Some of the indicators used to identify exceptional circumstances are linked to data which are part of an adopted MP (e.g. CPUE) other indicators are not necessarily tied up to the MP data. Also noted was that the MSEs used to support the adoption of HCRs were developed at quite different levels of complexity (e.g. IOTC/SKJ, ICCAT/NALB).

Determination of exceptional circumstances

The Group noted that, in general, ECs should be invoked only according to some clear principles such as:

1. When there is evidence that the stock or the fishery is in a state not previously considered as plausible in the context of the MSE;
2. When there is evidence that the data required to apply the HCR is not available or not appropriate any more;
3. When management objectives have changed or new management objectives have been added so that the performance indicators used in the MSE are not sufficient or appropriate for the new objectives,
4. Defining ECs must be part of the development, and on-going review of the MSE and HCR setting process.

It is essential to define the criteria that will be used to determine what constitutes acceptable evidence for item 1 above. This criteria should include the indicators to be used as evidence, the process for gathering such indicators, and the normal reference range for the indicators. Only when an indicator is outside such range would the system may be deemed to be in an *exceptional* state. In general such reference range should be defined by the range of values used in the MSE.

For item 2 above one should clearly specify under which circumstances the data will be considered as insufficiently available, or not reliable enough to be used in the MP (e.g. how many data elements need to been missing or how poor the data has to be to be considered as grounds to invoke ECs).

Once ECs are defined, the course of action to be followed has to be agreed upon. This can range from collecting additional information to confirm the exceptional state of the system, to partially halt the application of the HCR, or even abandoning the HCR totally and conduct a new MSE to revise the HCR. In all cases, the process for adopting a TAC has to be clearly defined.

For the process to be effective, it needs to be recognized that the determination of ECs is tied to the timing and schedule of application of HCRs, the frequency of assessments and the ability to monitor the indicators that can be used as evidence for changes in the state of the system. Invoking that data is not sufficient or appropriate for the application of the HCR can only be done at the time that the HCR needs to be applied to calculate a new TAC. In contrast, calling for ECs associated with a change in management objectives can be evaluated after the management change has been adopted. On the other hand, the determination of ECs based on new evidence that the current state of the system was not considered as part of the range of hypotheses tested in the MSE will depend of when such evidence can be gathered. New evidence on population parameters (e.g. natural mortality, growth) will only come after new and comprehensive research programs have been completed. Evidence that the indices of stock biomass or the estimates of harvest used in the MP are outside the bounds considered in the MSE, can come as often as these indices are estimated: at most annually, more likely just before the application of the HCR.

Potential indicators of the state of the system that are not part of the MP will need to be defined and pre-agreed and the schedule of estimation of each indicator determined (Table 1 to Appendix 5). It is foreseen that one of the purposes of a full assessment, to be conducted after a few cycles of application of the HCR, is to confirm that the stock dynamics continue to fall within the range of dynamics considered in the MSE. Such full assessment is also likely to be a source of estimates of many indicators that could be used to trigger the determination of ECs (e.g. new estimates of recent recruitment, selection pattern, etc. It was also mentioned that some data-poor stock assessment methods could provide candidate indicators that may be more readily available for continuous monitoring of the state of the system. If found useful a table such as Table 1 to Appendix 5 should be prepared for each stock managed under an MP or with an HCR.

It was pointed out that it is not possible to predict all future circumstances that could trigger the potential determination of ECs. Examples of that may be drastic changes in the ecosystem, like changes in the ecological regime, or increasing impacts of climate change in the oceanography, or major changes in fishery operations, where new fisheries develop or important fisheries disappear. In most cases such changes are not often considered as part of the realities considered in the MSE. Before such changes can be used to justify a declaration of ECs, it is important that the ecological, biological, or oceanographic process(s) which link stock productivity to the process are clearly identified. Additionally a clear justification that such new perceptions on productivity have not been previously considered in the MSE. Ideally, simulations should be run to show how much such new hypotheses may impact the performance of the adopted MP, prior to invoking the need to make a determination of ECs.

Course of action to be taken when exceptional circumstances have been invoked

Once the determination has been made that ECs can be invoked, first an assessment will be made by the SCRS of the severity of such determination. The severity level will determine which one or a combination of the following actions should be taken:

a) collect additional information to confirm such determination of EC, possibly including new/additional indicators or additional year(s) of estimates of the indicator that trigger the determination;
b) trigger a new full assessment to confirm the presence of such EC;
c) start a new MSE process which will incorporate a broader range of system states, including the system state that has been newly accepted as plausible;
d) continue using the HCR for the estimate of the TAC until EC have been confirmed or a new HCR developed;
e) halt the use of the HCR and define a new way to estimate the TAC until a new HCR can be adopted.

3.5 How can we help prepare for the Standing Working Group to Enhance Dialogue between Fisheries Scientists and Managers (SWGSM)?

The Group agreed that its main contribution to the SWGSM is contained within the section on exceptional circumstances.

3.6 Determination of what work should be accomplished in 2018 to continue progress

The Group discussed the topic of the role of the WGSAM in the overall ICCAT MSE effort. There is a recognition that the SCRS needs to be more involved in the review of MSE initiatives. The Group agreed that there is current gap in the MSE process in as much there is no explicit internal technical review of the various MSE ICCAT processes established through the SCRS (the current terms of reference for the WGSAM do not include explicit reference to MSE). In the last few years, the WGSAM has been one of the Groups that have partially helped fill this gap, by maintaining an ongoing agenda item on MSE at all its meetings. All groups developing ICCAT MSE applications have presented regular updates of their work to the WGSAM, however, such interactions have not been considered to be true reviews of the MSE work by either the WGSAM or the developers. Although, MSE developers have also regularly updated the Species Working Groups of their progress, such updates have failed to entice thorough review of MSE products as Working Groups have not been able to:

- devote enough time and resources to the review because of their competing responsibilities of conducting assessments and responding to other Commission requests,
- limited expertise to conduct the technical review.

In the past, WGSAM played an important role in the review of the ALB MSE. However, the Group expressed concern that if WGSAM were expected to have more over-arching responsibility towards MSE, the volume of work would hamper the ability of the Group to carry out its originally stated mission. Some members of the Group also expressed that the lack of a structured review process for MSE, has partially undermined the confidence of the SCRS on the quality of the MSE work and also slowed down its progress, as many issues are attempted to be addressed late in the process rather than early.

The Group agreed that the MSE process and its demands on resources and intersessional meetings requires to be given a priority similar to that of the current stock assessment process. In that light the SCRS and its Working Groups should develop their annual work plans considering the demands of both stock assessments and MSE. Open intersessional Species Group meetings focused on the MSE process could be held, supplemented as needed by webinar's enabling broad participation, particularly during the initial development of the MSE work plan and OM structure.

One approach to establishing a structured review process for MSE would be to establish a new SCRS Working Group on MSE whose role would be, perhaps among others, the on-going review of each MSE effort. The Group recognized, however, that the creation of such new Working Group would increase the intersessional work of the SCRS, and would likely place the burden of work on the few SCRS scientists that have sufficient technical knowledge on MSE to be reviewers.

Another approach would be to create an MSE study group within the WGSAM or as an ad-hoc group of the SCRS that would focus on general MSE issues. It was noted that developing standards for MSE is as challenging as developing standards for stock assessment methods. For instance, the WGSAM has, in the past reviewed individual stock assessment software, but only established guidelines for CPUE standardization. If such a Group on MSE was created it's goals and schedule of work would have to be carefully designed to ensure it would support rather than interfere with the ongoing processes of MSE. In either case, Terms of Reference for the ad-hoc group or the new working group would have to be developed.

The Group also notes that there already is a technical tRFMO MSE Group (http://www.tuna-org.org/mse.htm) that has as objectives relevant to reviewing MSE methods and that such Group has the ability to draw from a wider set of experts than those that traditionally work at the SCRS.

In conclusion, the Group agreed that it must have some role in the on-going review of MSE processes at ICCAT. The Group suggests, however, that its role should be restricted to specific methodological questions about MSE and not be seen to have the responsibility of reviewing MSE applications to specific stocks. This is akin to the role that the Group fulfill regarding stock assessments, where it has the responsibility to review methods upon request by the SCRS, but not to review specific stock assessments. Under the present SCRS process the role of reviewing a stock assessment falls first with the Working Group in charge of that stock, then with the plenary. The Group thinks that the same should apply for MSE. MSE applications to a specific stock(s) should be reviewed by the Species Group, and then by the SCRS plenary. It must be also noted that the continued review of assessments methods conducted by WGSAM will always be a valuable contribution to the MSE process.

4. Data Limited Methods of stock assessment

The WGSAM was presented with length based, data-limited approaches for assessing changes to population health. The catch length frequency methods rapidly provide indictors of population health in stocks where fisheries independent indices are lacking or are highly uncertain.

Document SCRS/2018/065, described the application of the NZ50 a new metric to ICCAT blue marlin length frequency data (Goodyear, 2015). The NZ50 method builds on the understanding that mean and maximum sizes are indicators of population health because fishing tends to progressively reduce the abundance of older, larger fish in the population. For ICCAT data-limited stocks such as blue marlin, high degrees of uncertainty surround many of the CPUE trends. The author argued that length information is a good candidate for population health assessment in these stocks because of the relatively high degree of certainty of the data.

The NZ50 metric differs from mean size analyses in that it examines the abundance of large size fish in the stock - a metric often ignored. The Group was presented with methodology behind the outputs of the analysis which estimates the smallest number of observations which will include a fish ≥ a given size threshold at least half the time.

In the analysis of Atlantic blue marlin, there were a number of hypotheses to explain the observed trend of decreasing mean size followed by a slight increase and then leveling off in the mid-2000s. Hypotheses explaining the trends include: increased fishing mortality, an increase in recruitment, and a change in gear configuration. NZ50 was estimated for each year and estimates of the trends in fishing mortality were compared to landings and estimates from the preliminary 2018 continuity stock assessment.

In the presenter's findings, blue marlin landings trends and NZ50 estimates were similar: both trends generally increase during the late 1990, after which both depict a declining trend. There was strong agreement between the trend in NZ50 and the trend in F/Fmsy from the preliminary stock assessment in the early years but they are opposite after 2000 with the NZ50 trend following the trend in landings more closely than it does with the assessment model.

The Group indicated agreement that the NZ50 statistic could be used to monitor fishing mortality in data-limited stocks, as a check to more complex assessments, and to serve as a potential indicator for "exceptional circumstances" where focused examination of stock health is needed. The inclusion of priors (e.g. B/B0) into the analysis was discussed. A question was raised on the influence of selectivity in this analysis. It was a suggested that selectivity may be shifting size frequencies of the stock due to increased fisheries selectivity in larger fish in the population. The presenter noted the lack of change in longline gear selectivity in this analysis.

The Group was presented with a brief overview (SCRS/P/2018/035) of methodology for estimating the spawning potential ratio (SPR) of a stock using length frequencies of catch (Hordyk e*t al.* 2016). Based on von Bertalanffy growth and Beverton-Holt life history ratios, the method accounts for size-dependent mortality through use of a length-structured per-recruit model. The sample is split into sub-cohorts which are each assigned their own mortality rate, dependent on size. Application of size-dependent mortality helps avoid overestimation of fishing mortality and a negatively biased estimation of SPR. The method requires few life history inputs (asymptotic length, length at maturity, and the ratio of natural mortality to von Bertalanffy growth - M/K) and simply needs length frequency data for one or more years.

The Group was given a brief opportunity to test this method in the LBSPR package in the R environment. Participants produced simulation models, where they specified life history parameters for an ICCAT species and produced plots that compared the following outputs for fished and unfished stocks: size structure, length at relative age, relative fishing mortality, and proportion of the stock that has reached maturity in comparison to fishery selectivity. The package allows the user to fit empirical data to the simulation model, easily make comparisons, and evaluate the simulation.

Due to time constraints, the Group was unable to thoroughly examine the methodology of these data limited techniques or fit empirical data to the simulation models. The Group agreed that these methods warrant further examination for use in data-poor species under the ICCAT preview such as the small tunas. A "Data Limited Methods of Stock Assessment" Study Group has been formed with the objective of identifying, developing and testing data limited methods for tracking change in stock status of data poor species (and for data rich species that are between assessment years). The study group will present these findings at the 2019 WGSAM.

5. JABBA assessment software: Discussion/demonstration

The Group received a presentation of the JABBA stock assessment model (SCRS/P/2018/034) that has been used in several ICCAT stock assessments (swordfish, Mediterranean albacore and shortfin mako shark) and will be used in the upcoming 2018 blue marlin and bigeye tuna assessments. A detailed and thorough explanation of the mathematics behind the model as well as the generated output diagnostic plots and management graphs were presented and discussed. It was noted that JABBA is distributed through the global open-source platform GitHub, which aids to ensure reproducibility and transparency. A full formal documentation of the JABBA stock assessment model has been published in Fisheries Research (Winker *et al.*, 2018). It was emphasized that the model runs relatively quickly and is not intended to replace any other existing modeling platform but rather to complement these modeling approaches. One of the desirable features of the model is that it incorporates both process error as well as observation error. Diagnostics and management graphics are automatically generated, thus helping to streamline the assessment task.

The Group concluded that the JABBA assessment model should undergo formal review towards inclusion in the ICCAT stock assessment catalog.

6. Software catalog

The software catalogue aims primarily at providing the Species Groups with a list of validated stock assessment software. It was also designed to integrate data, fisheries assessment models, results and software to allow for replication of assessments.

Its current version can be found on the following GitHub link: https://github.com/ICCAT/software/wiki

The Group expresses concerns about the process to include and update the list of accepted models, therefore it proposes the following:

1. To establish an advisory SCRS scientific group (e.g. Chair of the SCRS, Chair of the Methods Working Group) to collaborate with the Secretariat's Population Dynamics expert.

2. This new group should coordinate the process by:
   a) Identifying scientists able to review the software if necessary. A permanent review group does not appear ideal as technical and scientific skills necessary to review a new software are highly specific. The work of the reviewers should be acknowledged on the catalogue webpage
   b) Presenting the review results to the methods group for acceptance
   c) Updating the list of software and associated versions

3. Requirements for new software submission should be extended. Although the current questionnaire helps in grasping the specificities of the software, this is not sufficient to allow for an efficient evaluation process. The Group recommend every submission goes to the ICCAT Population Dynamics expert and should include:

   a) Questionnaire form
   b) Model code
   c) Model documentation and relevant literature
   d) Model examples
   e) Reviews if available (e.g. performed by third party such as NOAA)

4. Reviews sent and/or evaluations made by the experts should include:

   a) Mathematical soundness
   b) Statistical robustness
   c) Simulations testing to identify possible misspecifications / caveats / limits

While reviewing the current catalogue, the group also identified a set of issues to be resolved as soon as possible.

1. Some link are not up to date (Stock Synthesis for instance)
2. Some software such as FLR are not easy to install because of unspecified library dependencies. Relevant documentation should be available before accepting a new software
3. Stock assessment software and generic diagnostics and graphical tools should be clearly separated

7. Recommendations

To the Group:

1. The Group recommended to itself the formation of a Data Limited Study Group (SG). The formation of the SG was justified on the basis of the large number of ICCAT assessments being done with limited amounts of data. This SG would devote effort to introduce existing data limited methods to the WGSAM and Species Groups as well as create new techniques that could be adapted to meet Species Groups specific needs.

2. The Group felt that the experiment of conducting a hands-on experience with various software packages during the meeting had a positive outcome. The Group agreed that this agenda item should

continue as needed. The WGSAM meeting will serve to demonstrate the software, get familiar with its use, and evaluate it for possible inclusion into the software catalog. The Group noted that ample time and prior planning would help ensure such sessions would run smoothly.

3. The Group recognized that not all CPC scientists can commit to regular attendance to the WGSAM meeting and thus it is difficult for them to commit to participating in the various SGs. In an effort to remedy this situation the Group recommends that each SG make attempts to carry out their work using a cloud based platform (i.e. Github, OwnCloud, etc.). This would allow for broader participation and foster a more open environment.

To the SCRS:

1. After reviewing the standards regarding exceptional circumstances in other tuna and non-tuna RFMOs, the WGSAM made a proposal to identify exceptional circumstances in ICCAT stocks once that a HCR or MP has been adopted. This proposal identifies general criteria that can be fine-tuned on a stock by stock basis in the future. The Group recommends that the proposal developed by the Group be presented to the Commission, at the 2018 SWGSM meeting as a response to the Commission request regarding exceptional circumstances made in Recommendation 17-04 (see section 3.4).

2. The Group recommends that an age and growth workshop be created to facilitate the exchange and agreement of age techniques, the establishment of reference ageing sets, and the quantification of the error and bias inherent in this science.

3. The Group has long recognized the importance of the ICCAT software catalog in carrying out consistent and reproducible stock assessments. However, the current review process put in place to ensure the quality and accuracy of each software package entails a degree of time, effort and expertise. In an attempt to ensure quality in this process the Group recommends that an advisory group be formed to assist and support the Secretariat with this task (see Section 6).

4. The Group recognized the need for a process, one that currently does not exist, that helps ensure that current and future MSE efforts maintain an open and transparent environment and encourages regular review of the work as it progresses and before methodology andresults are considered final and ready to proceed to the next step. Furthermore, allowing for such review and input at the initial stages of developing the MSE work plan and OM structure is likely to improve the efficiency of the process. Towards this end, the Group recommends that a more formalized approach be put into place (see section 3).

5. Open intersessional Species Group meetings focused on the MSE process must be held, supplemented as needed by webinar's enabling broad participation, particularly during the intial development of the MSE work plan and OM structure.

6. The Group further recommends that as a first step a Terms of Reference would be created outlining the roles and authorities of this group.

8. Other matters

The Group recognizes the need for accuracy and consistency in the multiple ageing efforts being conducted within and between ICCAT species. However, there are currently no formal means in which to ensure that the ageing of fish is being conducted in a consistent and unbiased manner across CPCs. Although ICCAT GBYP, ICCAT AOTTP and the Small Tuna Species Group are conducting separate efforts to standardize ageing techniques, there still remains a need for a more inter-species comparison of techniques and methodologies.

Request to this Group made by the bigeye data preparatory meeting could not be considered at this meeting.

9. Adoption of the report and closure

The report was adopted by the Group and the meeting was adjourned.

References

Goodyear C.P. 2015. Understanding maximum size in the catch: Atlantic blue marlin as an example. Trans. Am. Fish. Soc. 144(2): 274–282. Wiley Online Library.

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Winker H., Carvalho F., Kapur M. 2018. JABBA: Just Another Bayesian Biomass Assessment. Fish. Res. 204, 275–288.

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements

2. CPUE standardization/incorporation of oceanographic and environmental changes into the assessment process

   2.1 Presentation of new CPUE standardization methods by CPUE Standardization Study Group
   2.2 Discussion of recommendations for CPUE standardization and reporting of results
   2.3 Discussion of a study design to address localized CPUE

3. Harvest Control Rules, Limit Reference points and Management Strategy Evaluation (MSE)
   3.1 Report from the NALB Study Group on current status and progress of NALB MSE
   3.2 HCR "exceptional circumstances", what they are and what to do if they occur (Rec. 17-04)
   3.3 Review of progress of the BFT MSE effort and decision on ALB Harvest Control Rule: lessons learned
   3.4 How can we help prepare for the SWGSM meeting?
   3.5 Identification of work the WGSAM could/should accomplish in 2018 to contribute to progress
   3.6 What does the Group think the role of WGSAM should be in the overall MSE effort?

4. Data Limited Methods of stock assessment

5. JABBA assessment software: Discussion/demonstration

6. Software catalog

7. Recommendations

8. Other matters

9. Adoption of the report and closure

Appendix 2

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Appendix 3

List of Papers and Presentations

Reference	Title	Authors
SCRS/2018/063	Characterizing exceptional circumstances in iccat: a summary of experience in other RFMOs	Arrizabalaga H., Merino G., Murua H., and Santiago J.
SCRS/2018/064	Analytical approach for management strategy evaluation	Mikhaylov A.
SCRS/2018/065	Trends in total mortality using a length-based indicator applied to Atlantic blue marlin (*Makaira nigricans*)	Schirripa M. and C.P. Goodyear
SCRS/2018/066	A method for nonlinear standardization of zero-inflated CPUE to account for mesoscale oceanographic variability	Alvarez-Berastegui D., Ingram Jr. G.., Rueda L., and Reglero P.

SCRS/P/2018/031	Using a longline simulator to examine different methods of CPUE standardization with Atlantic blue marlin as an example	Forrestal F., Schirripa M. and C.P. Goodyear
SCRS/P/2018/032	Performance evaluation of CPUE standardization procedures to account for multispecies targeting	Winker H.
SCRS/P/2018/033	Operational Oceanography for supporting Sustainability of Top Predators, an open network	Alvarez-Berastegui D., on behalf of the OOSTOP members
SCRS/P/2018/034	JABBA: Just Another Bayesian Biomass Assessment	Winker H., Carvalho F., and Parker D.
SCRS/P/2018/035	Testing data limited approaches for HCRs and indicators in small tunas	Gillespie K.

Appendix 4

SCRS Document Abstracts

SCRS/2018/063 - Recommendation 17-07 requests the SCRS to develop, in 2018, criteria for the identification of exceptional circumstances. In response to this request by the Commission, and in order to introduce the discussion of the WGSAM, in this paper we made a small review of the exceptional circumstances (what they are considered to be, how it is determined whether they apply or not, and what actions are taken if they apply). In the review, we have included CCSBT, IOTC, WCPFC and NAFO. These RFMOs essentially treat exceptional circumstances as circumstances where the reality clearly diverges from what was simulated, either in the stock trajectories/values, or on biological assumptions (regime shifts, natural mortality…), or when there is no new observation (e.g. survey) allowing to apply the MP to set a new TAC. In general, examples are provided rather than clear definitions, and it is left up to the Scientific Committee to judge whether the exceptional circumstances apply and their severity. Clearly defining what exceptional circumstances are, whether they apply or not, their severity, and what to do in each case might take several years and a feedback process, as it is difficult to anticipate all possible situations.

SCRS/2018/064 – The analytical approach for management strategy evaluation is discussed. The results of computer simulations of biomass dynamic is predicted from stochastic differential equation. The equilibrium probability density of biomass is finding from Fokker-Plank equation. The efficiency coefficients of control are calculated for three-zone precautionary harvest control rule.

SCRS/2018/065 – The maximum sizes in the catches were examined for changes in fishing mortality using ICCAT length data. Individuals sampled from longline gear were combined across ICCAT areas. Thresholds for the test statistic, NZ50, were set at 175 and 200 LJFL (lower jaw fork length). Trends in NZ50 exhibited a strong similarity to the trend in total landings as well as recent estimates in F/F_{MSY} and B/B_{MSY}. The declining trend in NZ50, F/F_{MSY} and an increasing trend in B/B_{MSY} suggest that the decrease in landings is due to a decrease in fishing mortality and not one of a decline in overall population size. This suggests that recent ICCAT conservation measures for billfish maybe having the desired effect.

SCRS/2018/066 – Larval abundance indices result from standardized abundances of larval densities from ichthyoplankton surveys. These indices have been used to assess the trends of the spawning stock biomass of various species and nowadays they have been incorporated to the population models applied by ICCAT. Pelagic species live in highly dynamic habitats, characterized by constant environmental variability. Hence, the delta-lognormal models used for the calculation of the abundance indices have been improved to account for such oceanographic changes. They have been recently applied in the Balearic Sea to obtain a larval index for different tuna-like species such as bluefin tuna (*Thunnus thynnus*) and albacore (*T. alalunga*) from surveys conducted from 2001 to 2015. Here we apply the same methodological approach to calculate the larval index of albacore (*T. alalunga*) using the same data source but using nonlinear modelling methods. It is well known that fish habitats are described by nonlinear relationships of oceanographic variables, therefore, applying nonlinear approaches can improve our ability to investigate the relationships between environmental drivers and ecological processes. Accounting for oceanographic changes in pelagic habitats by means of nonlinear responses can help in the calculation of more accurate and precise larval indices, which is crucial for the management of tuna species.

SCRS/P/2018/031 – Not provided by the author.

SCRS/P/2018/032 –Many fisheries frequently adjust their fishing strategies to optimise catch rates of specific target species. To estimate abundance indices from such multispecies catch and effort data, a range approaches have been put forward that aim to remove the resulting variability in catchability from catch-per-unit-effort (CPUE) data. These include: (1) objective subsetting to remove non-target zeros, (2) using CPUE of non-target species as predictor targeted effort, (3) clustering catch compositions to derive categorical predictors targeted effort and (4) the 'Direct Principal Component' (DPC) procedure that derives continuous predictors for targeted effort in the form of principal component scores of catch compositions. The target based standardization procedures simulation-tested for their ability to estimate the underlying biomass trends for all species relative to the non-standardized CPUE index based on simulated multispecies catch data from individual fishing trips that exhibit variation in effort allocation across alternative fishing habitats over a time series of 20 years. The results suggest that clustering approaches and the DPC performed best. The presentation concluded by highlighting two of the most recent advancements to adjust for fisher targeting, namely the Spatial Dynamic Factor Analysis (SDFA) and the novel directed residual mixture (DRM) model.

SCRS/P/2018/033 – During the last decades, fisheries ecology has focused on the study of the response of fish populations to environmental variability, with the aim of designing optimal or sustainable harvesting strategies of marine living resources. At the same time operational oceanography has been advancing fast, propelled by the implementation of new multi-platform observing systems and also by the improvement of the data quality, quantity and accessibility. Nevertheless, the initiatives directed to facilitate and promote the integration of operational oceanography into the current fisheries assessments in a systematic way are scarce. Here we present the activities of the OOSTOP task group (IMBER/CLIOTOP, Ref: 2016/04, https://oostop.wixsite.com/oostop), that works as an open network of scientists. The network aims at improving the knowledge transference between researchers working on operational oceanography, species biology and management. The group discussed the possibility of linking working groups from fisheries and oceanography, and the author proposed to include a recommendation in the report to express the need of well validated hydrodynamic models for time series matching the CPUE time series. One suggestion to provide useful information for operational oceanography was to identify the temporal and spatial scales of interest in the framework of the assessments developed within ICCAT.

SCRS/P/2018/034 – The new open-source stock assessment tool 'Just Another Bayesian Biomass Assessment' (JABBA) was presented to Group. JABBA has emerged from the development of a Bayesian State-Space Surplus Production Model framework, already applied in stock assessments of sharks, tuna, and billfishes around the world. JABBA presents a unifying, flexible framework for biomass dynamic modelling, runs quickly, and generates reproducible stock status estimates and diagnostic tools. Specific emphasis has been placed on flexibility for specifying alternative scenarios, achieving high stability and improved convergence rates. Default JABBA features include: 1) an integrated state-space tool for averaging and automatically fitting multiple catch per unit effort (CPUE) time series; 2) data-weighting through estimation of additional observation variance for individual or grouped CPUE; 3) selection of Fox, Schaefer, or Pella-Tomlinson production functions; 4) options to fix or estimate process and observation variance components; 5) model diagnostic tools; 6) future projections for alternative catch regimes; and 7) a suite of inbuilt graphics illustrating model fit diagnostics and stock status results. The group discussed in particular the JABBA model diagnostics and the interpretation stock status outputs based on a number of presented case studies. The group recommended JABBA to be included into the ICCAT software catalogue.

SCRS/P/2018/035 – Measures of fish growth and size frequency at capture can provide information on stock health with relatively few data inputs. This is pertinent given the current scarcity of stock status indicators in small tunas. This presentation provides an overview of animal growth-based, data-limited approaches for developing stock indicators and harvest control rules. Methodology is drawn from Beverton-Holt and von Bertalanffy theory and tested on simulated populations and empirical data to estimate size of optimal length at harvest and spawning potential ratio (SPR). The latter method accounts for size-dependent mortality through use of a length-structured per-recruit model. This helps avoid overestimation of fishing mortality and a negatively biased estimation of SPR. The method presented requires few life history inputs (asymptotic length, length at maturity, and the ratio of natural mortality to von Bertalanffy growth—M/K) and simply needs length frequency data for one or more years. The presentation provides an example of the application of this method in small tunas in the LBSPR package in the R environment.

Appendix 5

Proposed Study Design

1. Design of a factorial study for CPUE level of aggregation

Question: How does the level of aggregations (time/space) effect the accuracy/precision of the estimated abundance trend?

(1) Creation of the baseline model
   a. Trending population trend
   b. Delta Gamma from blind study
   c. Start with minimally complex standardization model (i.e. can some covariates be dropped?)

(2) Time x Area Aggregations
   a. Lat x Lon 5 degree grids + average SST for grid for time period) (represents ICCAT)
   b. ICCAT BIL Areas + average SST for Area for time period
   c. Finer area designation + SST (e.g. SEFSC areas)

   d. set (all covariates)
   e. month (total number of hooks, average HBF)
   f. quarter (only total number of hooks)

Results to be quantified with R2 of regression (true vs. estimated)
Expected recommendations on what level of aggregation is in appropriate for CPUE analysis
Analyst Team: David, Haritz, Diego, Craig, Henning

2. Problem associated with use of localized CPUE and/or Shifting Distributions

The idea of small boxes representing the stock as a whole is a universal problem. It's also related to the problem of conflicting CPUE's and how to resolve it. This work only requires the SDM output of relative densities by grid x month x year. So densities would summed over all depths. This data already exists as it was used to create the existing BUM maps.

Question:
How to track stock abundance in widely distributed stock, sampled with local fisheries, under environmental influence?
Simulated data: Species Distribution Model, BUM, no population trend (it can be multiplied by any trend).
   (Check whether there are trends on spatial distribution (due to habitat))
Local abundance:
- Africa
- Brasil
- Caribbean-Sargasso

Compare:
- Population abundance
- 3 local abundances
- Combined Africa-Brazil-Caribbean
- 3 "Habitat corrected" local CPUEs:
  - ✓ Correct for the % overlap between fishery and habitat core area
  - ✓ Other correction factors

Analyst Team: Haritz, Michael, Denham, Guillaume

Table 1. Guidance on a range of appropriate management responses should those exceptional circumstances be found to occur (see Recommendation 17-04). Possible candidates of indicators and criteria used to evaluate exceptional circumstances (EC). Exceptional circumstances would be invoked if indicators are estimated outside the normal range and would allow for variance when applying the Harvest Control Rule.

Principle	Indicator	Frequency of estimation	Normal range criterium	Frequency of evaluation of EC
System State	Stock Biomass, Spawning stock biomass	Each full assessment	As defined by full range of values in the OMs used in MSE	Each full assessment
	Recruitment			
	S/R relationship, Steepness			
	fishing mortality			
	selection pattern			
	Growth parameters	After completion of new study		After completion of new study
	Maturity schedule			
	Natural mortality			
Application of MP (which includes the HCR)	CPUE indices	Potentially annual	As defined by full range of values in the OMs used in MSE*	Each time MP is to be applied (which includes the HCR)
	harvest (catch) estimates			
	Stock biomass (for MPs that do estimate it)			
Change of objectives	List of management objectives and associated performance indicators	Annual	List of performance indicators calculated in the MSE and used to evaluate MP performance	Annual

* Note that the ECs may be also triggered when data required to apply the MP is not sufficiently available or appropriate