Report of the 2023 Intersessional Meeting of the Working Group on Stock Assessment Methods
(Madrid/hybrid, 15 - 18 May 2023)

The results, conclusions and recommendations contained in this Report only reflect the view of the Working Group on Stock Assessment Methods. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revises them at its annual meeting. Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission.

1. Opening, adoption of agenda and meeting arrangements and assignment of rapporteurs

The 2023 Intersessional Meeting of the Working Group on Stock Assessment Methods (WGSAM, "the Group") was held in Madrid/hybrid from 15 to 18 May 2023. Dr Michael Schirripa (U.S.), the WGSAM Chair, opened the meeting and served as meeting Chair. The ICCAT Executive Secretary and the SCRS Chair welcomed and thanked the participants. The WGSAM Chair proceeded to review the Agenda which was adopted after some changes (**Appendix 1**).

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

Sections	*Rapporteur*
Items 1, 9	A. Kimoto
Item 2	C. Peterson
Item 3	R. Scott, A. Kimoto
Item 4	G. Diaz, E. Babcock
Item 5	M. Ortiz
Item 6	M. Ortiz, A. Kimoto
Items 7, 8	M. Schirripa

2. Review the progress on current MSE efforts

Northern albacore MSE

The Rapporteur of the Atlantic albacore (ALB) stocks presented an update of the northern albacore (N-ALB) MSE (SCRS/P/2023/049). The presentation included: a review of management objectives, a description of the management procedure (MP), including the harvest control rule (HCR), stock status determination, and exceptional circumstances (EC) protocols, and a history of the N-ALB MSE process to date. Following the *Recommendation by ICCAT on a Harvest Control Rule for North Atlantic albacore supplementing the Multiannual conservation and management programme, Rec. 16-06* (Rec. 17-04), new analyses were conducted to explore different HCR parameterizations and evaluate the number of the CPUE series that would trigger ECs; the results of these analyses were presented. Continuing work will include measuring the effects of underreporting, checking for EC using all indicators, iterating the MP to set Total Allowable Catch (TAC) advice for the years 2024-2026, and updating the reference operating models (OMs) to reflect the dynamics of the ongoing Stock Synthesis stock assessment.

The Group discussed the need for continual updates to, and subsequent reviews of, the code. Consequently, full consideration should be given to the mechanism of code updating, reviewing, storing and archiving, and determining who has access, all of which should be clearly outlined and published in the trial specification document (TSD) for each MSE. These materials could be linked on the MSE tab of the ICCAT webpage, following practice for stock assessments. The need for frequent code reviews may be particularly challenging considering that the code is not standardized between each ICCAT MSE application, and may be simplified in the future by utilizing a standardized coding framework. Further consideration should be given to the need to invest in continued MSE maintenance, including MSE and MP updating as fishery dynamics (e.g. allocations) change, and standardization of communication over time, particularly given personnel turnover in each of the major MSE participating bodies: ICCAT, CPCs, and the SCRS.

Atlantic bluefin tuna MSE

The Rapporteur of the West Atlantic bluefin tuna (BFT) stock presented an update of the BFT MSE (*Recommendation by ICCAT establishing a Management Procedure for Atlantic bluefin tuna to be used for both the western Atlantic and eastern Atlantic and Mediterranean management areas* (Rec. 22-09)), highlighting key decision points, including: the use of dynamic reference points to account for simulated changes in productivity, years over which performance metrics were calculated to allow for rebuilding, and delaying the adoption of EC provisions until 2023 following the Management Procedure (MP) adoption in 2022. The update reviewed the details of the accepted MP (Butterworth-Rademeyer Candidate Management Procedure (CMP)). Operational management objectives were presented, distinguishing biological objectives (which included stock status) and safety objectives versus management preferences (which reflect fishery yield and stability metrics). Lessons learned from the MSE include: the importance of communication with stakeholders in informing MP development, the value in clearly presenting trade-offs to managers to motivate and inform the decision-making process, clearly outlining the schedule for MP implementation to managers and stakeholders, and to focus on CMP performance rather than preconceptions about the CMP algorithm.

Group discussions followed on the need to explore OMs reflecting a depleted state at the beginning of the projection period for Atlantic bluefin, and consequently, the associated years over which performance metrics were calculated.

The Group discussed the inherent differences in the MSE reflecting the testing of empirical (such as the ones used in the BFT MSE) versus model-based MPs, particularly the concept of adaptive versus passive reference points (e.g. utilization of B_{LIM}). The specifications for performance metric calculations for bluefin tuna were considered relative to other ICCAT species.

Northern Atlantic swordfish MSE

The Rapporteur of the North Atlantic swordfish (N-SWO) stock presented an update of the N-SWO MSE (SCRS/P/2023/052). The update included an overview of the N-SWO MSE progress and identified key items for input from the Group. Details of the OM reference and robustness grid were provided, including additional robustness OMs planned based on input from Panel 4. The multi-step process of tuning, culling, and selecting the MP was presented, along with operational management objectives and associated performance metrics, proposed limit reference point, tentative MP implementation schedule, communications, and the Splash page and SLICK tool online resources. Desired guidance from the Group included methods for updating abundance indicators, methods for estimating reference points, feedback on MP communication, and development of ECs.

The Group discussed the importance of including non-stationary projections in the MSE to provide an explicit test of climate-readiness of the CMPs, which could include the elevation of climate-change OM scenarios from the robustness to the reference grid. The Group agreed that testing potential implications of climate change is important regardless whether or not the mechanistic link between climate indicators and stock response has been identified. Notably, if the MPs are not robust in the face of non-stationarity, then indicators of non-stationarity should be examined as part of the evaluation of exceptional circumstance (EC) for the stock. The challenges associated with simulating non-stationary were discussed, particularly the associated challenges with calculating dynamic reference points.

The importance of the way in which performance metrics were calculated was stressed, and analysts should make sure that managers understand these metrics and their associated trade-offs clearly so they can make informed decisions determining acceptable risk. The uncertainties associated with the regulatory discards (e.g. minimum size) should be considered within the MSE.

Western skipjack MSE

The Rapporteur of the western skipjack (W-SKJ) stock presented an update for the W-SKJ MSE (SCRS/P/2023/058). The presentation included the history of the western skipjack MSE progress, details of the stock and fishery, and preliminary results and plots (Mourato *et al*., 2022). Details of the OMs in reference and robustness grid were also presented. The goal of the MSE is to evaluate potential candidate management procedures (CMPs) for adoption by the Commission in November 2023 and to develop ECs in

2024-2025. Updates from the most recent meeting with Panel 1 were presented, including the operationalization of conceptual management objectives, manager preferences on management cycle and CMP type, and a preference to explicitly include climate change considerations as OMs to be included in the robustness set of OMs.

The Group discussed how OM scenarios are designated as part of the reference or robustness set of OM development**.** The Group also considered the role of each reference and robustness OM scenarios in the designation of ECs. For the W-SKJ MSE, this process has been related to the axes of uncertainty that are most probable and based on the stock assessment development; the MSE developers were open to further discussion on this issue. The motivation for assigning OM scenarios to either reference or robustness set should be properly explained in the MSE documentation. Use of a robustness set of OMs is flexible, and can serve to highlight scenarios for which CMP performance is particularly poor, and flag these scenarios for subsequent MSE revisions or to inform the development of EC.

The Group further discussed whether the composition of uncertainties that are considered reference versus robustness tests should or should not be conserved across ICCAT species.

Tropical tuna multi-stocks MSE

The Contractor of the tropical tunas multi-stock MSE presented an update for the multi-stock MSE (Merino *et al*., 2023). This update included an overview on progress to date, an overview of the steps of the current MSE, and a description of the future work. The independent OMs have been built and conditioned for each species: Atlantic bigeye tuna (BET), yellowfin tuna (YFT), and East Atlantic skipjack (E-SKJ), and future work will consider linking the species-specific OMs, identifying multi-stock management objectives and multi-stock CMPs. Simulations are expected to start in 2024.

It was clarified that the interactions of the stocks will be limited to the fisheries related rather than biological or ecological interactions, with the understanding that management regulations may operate on multiple species. The Group discussed how abundance indices will be projected within the MSE.

Climate change considerations

The Group agreed that the potential implications of climate change on MP performance should be considered during the MSE process, noting that many stocks may increasingly experience various aspects of non-stationarity as a consequence of climate change. There are multiple different ways climate change could be incorporated ranging from explicit, mechanistically-linked processes in the reference grid operating models, consideration in robustness tests or deemed to be a second-order uncertainty that may not need explicit incorporation in the MSE.

One option is consideration of climate change leading to non-stationarity within the reference grid, allowing Candidate Management Procedures (CMPs) to be tuned to maximize performance in achieving management objectives across a range of plausible scenarios that include (and are therefore robust to) potential impacts of climate change. As a result, it may be possible to identify management procedures that improve stock safety and status with marginal reductions in yield or stability. Furthermore, it was argued that it was important to incorporate climate change scenarios in the reference grid even if it is not yet possible to identify the specific mechanism leading to non-stationarity, nor the specific life history aspect affected, nor the scale of the effect. It was suggested that including trends or shifts in the scale of recruitment deviations was one way to test the MP's robustness to climate change because the effects of changes in multiple population dynamic factors may be reflected in recruitment. One proposed solution, in the absence of any putative mechanistic link, was to simply invert the existing stock-recruitment assumptions in the reference grid (e.g. high steepness shifts to low; low to high) at some point in the future. This would place no inherently higher or lower probability on positive or negative scenarios and does not require any further parameterization of existing OMs but would simply and efficiently entertain non-stationarity in the stock recruitment relationship. This would then allow for development and tuning of CMPs to be able to handle this key form of non-stationarity, should it occur.

On the other hand, the Group identified concerns that, with no information by which to define or constrain the range of possible hypotheses on the nature and scale of potential effects of climate change, the construction of OMs intended to incorporate climate change effects would be highly speculative and challenging to include as 'plausible' operating models in the reference grid. Inclusions of such speculative OMs in the reference sets would require that the CMPs be tuned to account for those presumed effects. Depending on the assumptions in the climate change OMs, the resulting CMP performance may be impacted substantially when tuning to these OMs, and CMPs would be tuned differently and performance impacted substantially in different ways if different OM climate change scenarios are speculated. There were concerns regarding endorsing specific CMPs which are tuned to specific scenarios for which there is no clear supporting evidence. Therefore, an alternative option could be the inclusion of climate change scenarios in robustness tests to identify if CMP performance is unacceptably impacted under those climate change conditions. As a result, indicators related to those climate change scenarios or the impacts on the population could be highlighted for monitoring and taken into account during the identification and evaluation of exceptional circumstances. The regularly scheduled stock assessment health checks could also serve to identify whether (or not) climate-induced changes in stationarity have occurred.

The Group agreed that further research to improve the understanding of the mechanistic relationships between climate and stock dynamics as well as the expected impacts of climate change should be prioritized so that they can be better accounted for in subsequent MSE revisions. As an example, it was suggested that basin-wide hypotheses on productivity may be included in ecosystem report cards from the Subcommittee of Ecosystems and Bycatch. It was noted that the considerations of climate change impacts should not be one-directional unless there is information to support such a hypothesis (e.g. both decreases and increases in productivity should be considered), particularly if climate change scenarios are included in reference sets as tuning targets will be impacted by this decision. A justification for the decision should also be provided to assist evaluation. The Group also acknowledged that potential avenues to incorporate climate into OMs could be specific to each species, as they have unique ecological and biological characteristics. The Group also noted the recent *Resolution by ICCAT on climate change* (Res. 22-13), which states that ICCAT is "… *COMMITTED* to developing effective management and other strategies and approaches to adapt to changing conditions and improve the resilience of ICCAT stocks…". It might reasonably be considered that development of CMPs robust to climate change would be an important component in meeting this objective.

Reference points

The presentation SCRS/P/2023/051 reviewed the Reference Points, Objectives, and Performance Standards at different tuna Regional Fisheries Management Organizations (tRFMOs). Within this presentation, a distinction between limit reference points in the 'best assessment paradigm' (wherein management advice is altered when the stock crosses the limit reference points) versus the 'MSE paradigm' (wherein limit reference points indicate stock behaviour or dynamics that should be avoided with a high probability) was made. The use of limit reference points is not consistent across species or tRFMOs with respect to biomass, fishing mortality rate, or yield. Further, the Inter-American Tropical Tuna Commission (IATTC) defined a plausible scientific basis for their choice of limit reference points, and all performance metrics were more varied in terms of yield. Future research will consider status objectives, variability in yield objectives, and timeframes over which performance metrics are calculated.

The Group highlighted that for some tRFMOs there is a trade off between how limit reference points were calculated and the associated risk willing to be accepted for exceeding these values.

Standardized empirical HCRs: To update or not to update?

The Group discussed the update of CPUE indices in the context of the MSE. There are two options: a strict update, i.e. update the most recent year of the index only; or to update the entire index time series. One potential problem is that when CPUE-based indices of abundance are re-standardized, the value of previous index years may change, likely reflective of changes in the estimated values of the model parameters due to additional data. This poses challenges for the implementation of empirical MPs where the new index is no longer the index that was simulation tested in the MSE. It remains an issue for stock assessments as it challenges the ability to provide continuity of advice. While it could be assumed that the 'updated' index with more data is now closer to the 'true' index, the reality is that an index that changes substantially each time it is re-standardized means that it is not a reliable indicator of relative abundance. This issue is most pronounced for short indices for which the model factors are not well determined. The proposal under this

agenda item is to develop a methodology to update indices with only additional data, such that previous model parameters and hence the historical index values (to which the OM were conditioned) remain unchanged. While conceptually straightforward, this may be a challenging undertaking due to lack of available software packages designed for this purpose. A small group is exploring a solution to this issue, with the goal of identifying a solution ahead of September 2023, during which time the indices should be updated for the empirical BFT MP.

The Group recommended adding a retrospective diagnostic procedure (e.g. retrospectively pull off several terminal years of data) on the generation of indices of abundance, similar to the retrospective diagnostics applied to stock assessment models, with the understanding that if an index shows a strong retrospective pattern, the index or standardization protocol may be inappropriate to serve as the indicator for an empirical MP. Changing indices are often attributed to a change in the standardization protocol (e.g. where additional covariates are considered within the model) and may have strong justifications; however, the fact that they alter the historical time series poses a problem for the continuity of advice based on that index. Such a problem exists both for MPs as well as in its use in stock assessments.

If historical index variability is an uncertainty that cannot be resolved, it should be included as an axis of uncertainty within the MSE analyses. The Group heard some consideration of the idea that CPUE standardization is designed to get the truest index possible, and if a new covariate is found to explain more variability, then this standardization approach should be pursued even if it changes the index.

The Group agreed that update of indices of abundance (CPUE) within the context of the MSE projection should be further investigated.

Review of ToRs for the "external review of the ICCAT MSE process"

The WGSAM Chair presented an overview of the terms of reference for reviewing the overall ICCAT MSE process. The purpose of this review is to understand: i) whether the scale and magnitude of effort allocated towards the MSE process is appropriate for ICCAT; ii) whether the process is sufficiently inclusive of stakeholders and managers; iii) whether there is sufficient overlap in methods and communication; iv) whether the time commitment for each MSE process is appropriate; v) evaluate the effectiveness of communication between stakeholders, Panels, and managers; and vi) review the resources invested in each MSE application.

It was clarified that this review will *not* be a code review and is designed to be a 1-year project. This review is not intended to develop "best practices" for MSE within ICCAT. Additional discussions served to refine the text within the ToRs document.

Polling the MSE stakeholders

The Group briefly heard a proposal to poll each CPC on their approach to stakeholder outreach relative to MSE. Due to time limitations and the scope of the interest and participants input for this poll the Group suggests a more inclusive participation from the different MSE species groups.

3. Stock assessment good practices

SCRS/2023/091 presented the study of using the number of hooks between floats (HBF) as a covariate in the CPUE standardization. The validity of the assumption that depths fished increased with increase in the number of HBF was examined using the 1986-2015 hook-depth distributions for 128 longline configurations from U.S. logbooks. The authors found that HBF was not a good predictor for fishing depth of gear in the U.S. longline fleet.

The Group noted that several factors interact in the actual relationship between fishing depth and HBF (such as currents, gear deployment speed, gear materials, distance between gangions, etc.) besides the theoretical implied depth by the catenary model. It was clarified that the authors used only the theoretical depth by the catenary curve model in the study, the Group encourages the authors to conduct further analysis using actual data on the depth of operations of hooks from depth-bait recorders to contrast the study results and conclusions. It was further noted that the study is limited to longline fishing gears with up to 6 HBF, while other operations for deep longlining normally use 18+ HBF when targeting species such as bigeye tuna (BET). It was also suggested that the authors review assumptions about catenary depth related to the number of HBF.

The Group pointed out that the U.S. longline fleet operates on relatively shallow depths and uses a lower number of HBF than other fleets and suggested that considering only the U.S. fleet for this type of analysis does not provide enough contrast for drawing general conclusions. The authors agreed that it would be useful to examine these relationships in regions with larger HBF values if logbooks were available, but reminded the Group that the focus of this presentation was specifically the U.S. longline fleet.

The Group requested more quantitative clarification when using terms such as 'deep' and 'shallow' gear depth as these distinctions can vary greatly with fishing fleets/countries. The Group acknowledged the importance of investigating the relationship between fishing depth and HBF, although the findings from this study should not be assumed to apply in other regions and fleets without further investigation.

SCRS/2023/080 presented an index of changes in the vessel fishing power for the U.S. billfish tournament fleet between 1982 and 2021. A multitude of changes in vessel size, conservation attitudes, and electronic equipment has led to changes in the recreational fishery for billfish over time, which has an impact on the fishery's ability to catch fish. The fishing power changes estimated in this analysis will be applicable to not only sailfish, but also for other billfish fisheries.

The Group expressed concern about the use of 'fishing vessel size' as the response variable in the Generalized Linear Model (GLM), and, while it was acknowledged that vessel size was used as a proxy for catchability changes, perhaps 'fishing power' would be a more appropriate terminology. The Group pointed out that the current method of quantifying the electronic support explanatory variable could lead to confounding categorization, but it was acknowledged that including each type of electronic as its own predictor in the model was not feasible due to data structure. Possible concerns in model formulation were raised and the Group recommended the authors to revise alternative methods. The Group acknowledged that an assumption of the presented method is that the vessels in the compiled dataset are representative of those operating in the fishery through the time period and producing CPUE data.

The Group discussed the application of this index of increasing catchability (q) over time in the upcoming Atlantic sailfish assessment to help relieve conflicts in CPUE data. The utility of this index for assessments could be tested by including the parameter in a model to see if fit significantly improves. However, the Group deferred the discussions and decisions to the Billfish Species Group (BILSG).

The Group pointed out that a similar approach has been used to quantify fishing power of different fleets in the Bay of Biscay for Atlantic bluefin tuna (Rodriguez-Marín *et al*., 2003), and that external reviews have recommended taking into consideration changes in catchability associated with increasing fishing power through time in assessments. While there were some concerns about the specific statistical methodology and data components presented in this paper, the Group acknowledged that this study showed evidence that an index of changing q should be considered in the U.S. recreational fishery index and would be preferable to an ad hoc assumption of a fixed level of q increase each year. The Group recommended to continue investigations into changes in q and potential inclusion in assessments.

SCRS/2023/088 presented stock assessment model diagnostics for the 2016 sailfish assessment and their possible use in model weighting. The document proposes an approach for weighting two or more stock assessment models based on model diagnostics to address conflicting indices in stock assessments. Using this method would result in the ability to combine the models with an objective weighting and to arrive at a more conclusive declaration of status.

It was noted that the Group has reviewed model weighting procedures in the past. There is also a growing body of literature on this subject (e.g. Peterson *et al*., 2021, Thorson *et al*., 2015, and Zuur *et al*., 2003). The Group acknowledged that is preferable to address data and/or CPUE conflicts prior to the model assessments, so as to avoid alternate models and the need for weighting results when combined. It was further noted that indices of abundance should represent the stock with the widest and most comprehensive spatial and temporal coverage.

The Group expressed concern that this model weighting approach would introduce subjective decisions on some of the diagnostics by selecting scores (0 or 1) that might not consistently be replicated by different groups/scientists, and would not be appropriate for models that are using different input data sets. The Group discussed the approach of making 2 model scenarios by grouping CPUEs showing similar trends (e.g. positive correlation among CPUEs). This is based on the hypothesis that CPUEs showing an opposite trend are wrong and not representative of the stocks. The Group highlighted the importance of understanding what kind of information the stock available abundance indices is providing including their temporal-spatial coverages (availability) and selectivity patterns, that may correctly explain apparently conflict trends, and for the SCRS species groups to consider scrutinizing some indices before including all indices in the stock assessment model(s). The Group recommended that the species groups investigate temporal-spatial arrangement of data by fleet to understand assumptions at the data preparatory meetings.

The Group reiterated the recommendation of investigating the creation of a joint index of abundance among similar fleets by main gear type from multiple CPCs to provide improved indices of abundance to stock assessments. It was acknowledged that any spatial or combined modeling approach would require all data to be available in one database, which may lead to confidentiality issues. The Group recommended that a diagnostic analysis and potential weighting scheme of models be discussed at data preparatory meetings before stock assessments.

SCRS/2023/089 presented effects of fleet structure on reference points. Changes of fishing fleet structure will affect the overall selectivity of multi-fleet fishery, which may further affect the reference points. In this study, a simulation and a case study based on Atlantic bigeye tuna were used to study the effects of changing composition of the fishing fleet on MSY-based reference points.

The Group acknowledged the potential utility of the presented methodology to test the assumption of 40% of B_{MSY} as B_{LIM}, and for testing the hypothesis that this is relatively conserved across stock-recruitment curves. The Group recognized that the SCRS needs to justify scientifically the current B_{LIM} that has been used for multiple species in ICCAT. The Group highlighted a previous Group recommendation that assessments with changing allocations should have a figure of year-specific MSY and B_{MSY} to show trends. Some suggestions from the Group included testing a logistic shape for longline selectivity for Atlantic BET, testing with 'free-school' purse seine fleet, and using SPR_{MSY}/SPR_0 as a different way to look at the impact of fishing activity on the reproductive capacity of the stock.

SCRS/P/2023/059 presented a summary of the Center for the Advancement of Population Assessment Methodology (CAPAM) workshop on tuna stock assessment good practices in New Zealand, including some highlights from the other CAPAM workshops.

The Group extended its gratitude to Dr Maunder for his attendance and presentation on best practices.

The Group raised the question discussed earlier at this meeting to the author regarding whether to eliminate CPUE datasets or include all data in potentially multiple models in the case of conflicting indices. The author suggested that indices must be representative of the population in some way and that indices limited in their spatial distribution may therefore be inappropriate for inclusion in assessment. The spatiotemporal extent of indices should be expanded to cover as much of the population distribution as possible by combining fleets that share similar characteristics of gear configurations and size range of fish (e.g. Atlantic BET and YFT for longline indices). It was noted that it is possible in spatiotemporal models to model the selectivity of different nations using an interaction term and that this is something that could be explored further. It was suggested that if multiple indices cannot be made similar by selectivities, then they should be included as separate models.

The author clarified that a grid uncertainty model is not his preferred approach because each model in the grid would not be reviewed thoroughly, and a final result would be biased by the inclusion of some unreasonable models. The Group questioned what action to take when no models could be accepted using the presented system to construct an ensemble of models for fisheries stock assessment. The author noted that the suggested system would not be applicable for a data-limited stock, and suggested considering the data-limited stock assessment methods.

The Group inquired as to any ongoing MSE work at CAPAM and was informed by the author that CAPAM does not currently conduct MSEs because it falls outside the CAPAM focus. It was also noted that a good assessment model could be used as an operating model for an MSE, and that MSEs are beneficial for encouraging conceptual thinking of system components.

4. Bycatch estimation tool

Document SCRS/2023/025 presented an update of the bycatch estimation tool that was presented in Babcock *et al*. (2022), which is available as an R package at https://ebabcock.github.io/BycatchEstimator/ to estimate bycatch in fisheries simulated using the species distribution model and longline simulator (LLSIM) developed by Goodyear (2021).

The Group acknowledged the large amount of work involved in these simulations. The Group discussed the utility of the tool beyond the species and gears this study used for the testing, and the author clarified that the tool can be useful for other species, and other gears.

The tool performed very well with fairly common bycatch species like blue marlin (BUM) in the U.S. pelagic longline. It has been also used with rare species (i.e. loggerhead sea turtles). If a species is very rare in that there are few non-zero observations, a binomial model may be appropriate. The negative binomial models also work well for data with many zeros. It is also possible to specify year as a numerical variable rather than a factor, perhaps using polynomial terms (e.g. year-squared) in the model-based approaches if the species is too rare or sample size is too small to estimate year effects.

Since currently the tool was used with pelagic longline gear the Group inquired if it can be adapted to other gears. This was of particular interest because ICCAT has a large observer programme for purse seine tropical tuna fisheries. It was explained that the tool could be used for other gears, as long as it is possible to get consistent measures of fishing effort between the observer data and the logbook data and the unit of effort is defined.

With regard to the spatial models, the Group questioned if a comparison between the spatial maps and the species habitat maps was conducted and if this spatial tool could be used to identify hot spots. The author commented that it might be interesting to compare geostatistical models to independent species distribution models and geostatistical models might be useful for identifying bycatch hotspots to avoid. The geostatistical model seems to pick up the spatial pattern in blue marlin distribution in the simulated data, although bycatch is a function of effort and gear configurations as well as species distribution. It was noted that potentially large bycatch events can occur in areas of low BUM abundance if the fishing effort in that area is high.

The Group discussed the approach of pooling data across years and the option to pool across areas and quarters as well. An analysis of the U.S. data found that quarter and area have a larger effect on the GLM than year and that is why it is preferably to pool across years. While the results showed a good agreement between the U.S. reported BUM bycatch and those estimates from the tool, differences prior to 2010 were identified. It was informed that this is most probably due to the fact that the U.S. used a different methodology to estimate bycatch before 2010.

The Group discussed that the model set up seems to be species specific. But, once the models are set for each species, then the following years it will not be necessary to set up the models from scratch. It was also indicated that the tool can estimate bycatch for a number of species all together. The Group discussed how often bycatch estimates should be updated. With design-based estimates, adding more years of data does not change the older estimates, past the range of years that are pooled in under sampled strata so bycatch estimates would be final after 2-3 years. However, with model-based approaches, re-running the analysis might slightly change the estimates in previous years if any of the coefficients change. It would depend on if the CPC scientists use the tool, and it is important to decide how often to update for their use.

The Group also reiterated that there is additional value in the bycatch prediction by the spatial modeling which would allow to detect areas of high bycatch that could be avoided to decrease bycatch. This approach was argued to be better than just using species spatial distribution and fishing effort. Finally, the Group asked if the tool could be applied to estimate bycatch for small areas. It was explained that the spatial extent of the model should be the same as the spatial extent of the fishery.

5. Reports of study groups

Standardized CPUE diagnostics

The Group discussed CPUE standardization diagnostics and reviewed a recent example for North Atlantic albacore (Lauretta, 2023). The basic approach outlined the steps conducted and set of diagnostics used in index development, which included data plotting, filter criteria, model convergence, and influence diagnostics. The influence diagnostics were considered particularly useful as they plot the sample distribution across factor variables over time, estimate model coefficients, and the overall effect on the annual mean CPUE observations compared to the standardized index. The Group reviewed a presentation on proposed items to be included with any CPUE standardization to better understand the features and characteristics of the proposed indices of abundance and to evaluate indices and their appropriateness for inclusion in assessment models.

After the presentation, the WGSAM Chair provided a proposal of minimum requirements to be included in an SCRS CPUE standardization document to be considered as a relative index of abundance for stock assessments, either in single species assessment models or the MSE processes. It was noted by the WGSAM Chair that the proposed list of items for SCRS CPUE documents is intended to gather clear information for the species groups to properly evaluate the available indices, and it is not intended to become a guide of best practices for CPUE standardization. Nonetheless, the Group suggested adding to the list of requirements more information on the filtering criteria applied to the input data if applicable, as well as adding the basic assumptions of the model used for the standardization (e.g. functional distribution of the response variable, factor balance, zero catch positive effort observations, etc.).

The Group recommended the following list of minimum requirements to be included in an SCRS CPUE document for stock evaluation.

1. Data descriptions

    - Catch definition (e.g. retained only, retained and discarded)
    - Effort definition (e.g. set, trip)
    - Unit of catch (numbers or biomass)
    - Data filter methods if applied
    - A characterization of the length or weight frequencies of the catch if available
    - A discussion of historic/recent targeting by the fleet
    - Map of the annual distribution of the sample/fishing effort including area definitions
    - Proportion of the data from the fleet being used to construct the index, e.g. representativeness

2. Model descriptions for standardization

    - Model assumptions
    - Model selection criteria and process

- Description of the full model (i.e. model considers all variables evaluated)

3. Model diagnostics and outputs

   - Estimates of the coefficient, including coefficient plots
   - Residual plots
   - Factor Influence plots
   - Variance Tables
   - Retrospective pattern analysis (similar to a stock assessment technique)
   - Table of sample size, number of observations, nominal and standardized CPUE, variance
   - The corresponding items of the species group CPUE Evaluation Table (example in Lauretta, 2023, Appendix 1)

The WGSAM Chair clarified that these requirements for SCRS documents will *not* replace the evaluation CPUE tables currently used by the species groups in preparation for assessments. The Group noted that the current CPUE Evaluation Table and the above requirements for SCRS CPUE documents are intended to be elements for the species groups to make well-informed decisions on what proposed indices of abundance should or should not be used in the assessment models and/or restrictions for its use if that is the case (e.g. only for a subset of models, or sensitivity runs).

The Group highlighted that is the final responsibility of the SCRS species groups to decide what set of indices will be used for the stock assessment models and avoid, to the extent possible, including conflicting information in the models. It was noted that the CPUE table is a tool with mostly qualitative information for the species groups, without a numeric scale for including/excluding CPUEs. The Group agreed that if the species groups request more quantitative guidelines for the inclusion/exclusion of CPUEs, these should be based on further research and simulation studies, stressing that the final decision should be made by the species groups.

The Group further discussed the proposal for a retrospective analysis of the CPUE standardized series, similar to the retrospective analysis done for the assessment models. It was noted that strong retrospective patterns likely are indicating poor or non-convergence of the standardization model, or highly unstable data/model, which become particularly important within the MSE and the testing of MPs.

The Group noted that standardized fishery-dependent CPUE series are key in almost all ICCAT assessments, in part due to the limited availability of surveys. The Group recommended that species groups evaluate the spatial and time assessment model structure in comparison with the different CPUEs spatial temporal distribution, giving priority to indices with wider spatio-temporal coverage. Also, to inform on the size distribution and potential changes in the CPUE fisheries data that could indicate different components of the stock being represented in the standardized index throughout the time series. The Group discussed factors included in the standardization models and recommended that time area factors be consistently evaluated, as normally these will have a strong influence on standardization results. Furthermore, it was noted the need to clarify better the attempt or approach to include the target factor into the standardization models. It was proposed to consider cluster analysis on the species composition of the catch data and to integrate changes in the target species within the time series. It was recommended that influence diagnostic plots, become standard elements of diagnostic reports of a standardized index. The influence diagnostic plots should be for the final standardization model selected.

The Group noted the importance of defining the level of aggregation of the response variable (e.g. nominal catch rates) if they represent a single set of information, a summary by trip, or aggregation by month-area, etc.

The Group suggested that scripts and examples of diagnostic applications for CPUE standardization be developed to be included in the ICCAT software catalogue. This will include R-scripts to facilitate standardization, mapping, summary, and presentation of diagnostic results from commonly used CPUE standardization models in order to assist CPCs to adhere to the above-mentioned minimum requirements.

6. Other matters

Document SCRS/2023/090 was presented by the Secretariat on the recommendation to include the stochastic surplus production model in continuous time model (SPiCT) in the ICCAT Software catalogue. SPiCT is a surplus production state-space model that includes process and observation-error widely used in the International Council for the Exploration of the Sea (ICES) and with ample documentation, testing, and applications examples. Within ICCAT this model has been used in the 2022 joint assessment of the Atlantic Northeast porbeagle shark and compared with the Just Another Bayesian Biomass Assessment (JABBA) model (Winker *et al*., 2018) for the provision of management advice (Ortiz *et al.*, 2022).

In ICES (SPiCT ICES) this software is commonly used for the assessment of ICES species Category 2 with technical support, manual, examples, and complete R-based diagnostics and Shiny-App tools. SPiCT is an assessment tool commonly used by national scientists involved both in ICCAT and ICES. The Group recommended including SPiCT in the ICCAT software catalogue.

Based on the discussions and recommendations from Section 5 on CPUE standardization and diagnostics requirements for consideration of indices of abundance for stock assessments, the Group recommended that R script be developed and added to the ICCAT software catalogue to assist with CPUE standardization, mapping of catch and effort, diagnostics of model fitting, plotting of results, retrospective analysis and overall comparison of indices of abundance proposed for stock evaluations.

In addition, it was recommended that the Bycatch Estimator tool web page be added to the ICCAT software catalogue to maintain updated versions and examples of this tool for easy access to CPCs.

7. Recommendations

Recommendation with financial implications

1. The Group recommends that a workshop be held on the use of the Bycatch Estimator Tool in 2024. This workshop shall be organized in cooperation with the current contractor. Details of the workshop will be developed within separate Terms of Reference that will be forthcoming.

Recommendation without financial implications

2. The Group appreciated the increased attendance offered by the hybrid meeting option. It made possible the attendance of important speakers that otherwise would not have been able to attend. However, the hybrid approach also made for a number of difficulties, such as audio challenges, scheduling of speakers, the requirement of important participants to attend at odd hours of the day for an extended period. The Group recommends that the hybrid approach be continued and continue to be improved upon via investment in better audio/visual technology.

3. The Group recommended that the impact of climate change be considered in all ICCAT MSE applications, in either the reference or robustness set of OMs. These considerations could come in the form of generalized changes in productivity (e.g. extended periods of higher/lower than average recruitment) or, if possible, changes that have been shown to have a direct mechanism associated with them (e.g. changes in the spatial distribution of a stock). The Species Groups should consider recommending including "climate readiness" as a MSE management objective as a means of addressing Res. 22-13, paragraph 2 as the Group interprets its adoption of Res. 22-13 as elevation of 'climate readiness' to be an additional Commission management objective.

4. The Group recognized the lack of information contained in some papers about indices of abundance and the subsequent difficulties that have ensured from including a large number of often times conflicting indices. Thus, the Group recommended that all future SCRS papers that propose the use of a CPUE index adhere to the list of minimum requirements put forth at this meeting so that better informed decisions can be made as to whether to include those indices in the stock evaluations.

5. The Group continued recommending developing joint indices of abundance among similar fleets/gears by multiple CPCs as a mean to provide improved indices of abundance to stock evaluations.

6. The Group recommended that the Secretariat should maintain an archive of the computer software and documentation used in the various MSEs.

7. The Group recommended that the Secretariat update the MSE webpage of ICCAT's website to include capacity building materials and information pertinent to each of ICCAT's current five MSE processes, including trial specification documents, results summaries, Commission decisions and links to code and Shiny apps.

8. Work Plan and Agenda 2024

The Group reviewed their preliminary workplan for 2024, and will finalize it at the SCRS Plenary meeting.

9. Adoption of the report and closure

The Report of the 2023 Intersessional Meeting of the Working Group on Stock Assessment Methods was adopted. Dr Michael Schirripa thanked the participants and the Secretariat for their hard work and collaboration to finalize the report on time. The meeting was adjourned.

References

Babcock, E.A., Harford, W.J., Gedamke, T., Soto D., Goodyear, C.P. 2022. Efficacy of a bycatch estimation tool. Collect. Vol. Sci. Pap. ICCAT, 79 (5) 304-339.

Goodyear, C.P. 2021. Development of new model fisheries for simulating longline catch data with LLSIM. Collect. Vol. Sci. Pap. ICCAT, 78(5): 53-62.

Lauretta, M.V. 2023. Standardized indices of albacore, *Thunnus alalunga*, from the United States pelagic longline fishery. Collect. Vol. Sci. Pap. ICCAT, 80(3): 145-174.

Merino, G., Urtizberea, A., Laborda, A. 2023. Atlantic tropical tunas management strategy evaluation (MSE). Presentation at the Second ICCAT Intersessional Meeting of Panel 1 (on western skipjack MSE) (online, 5 May 2023).

Mourato, B., Cardoso, L.G., Sant'Ana, R. 2022. Management strategy evaluation for the western Atlantic skipjack tuna with operating model conditioning based on the stock synthesis model. Collect. Vol. Sci. Pap. ICCAT, 79 (1) 851-906.

Ortiz, M., Taylor, N.G., Kimoto, A., Forselledo, R., Coelho, R., Arrizabalaga H. 2022. Additional analyses on the stock assessment of northeastern Atlantic porbeagle (*Lamna nasus*) using the SPiCT Surplus Production Model. Collect. Vol. Sci. Pap. ICCAT, 79(4): 167-182.

Peterson, C.D., Courtney, D.L., Cortés, E., Latour, R.J. 2021. Reconciling conflicting survey indices of abundance prior to stock assessment. ICES Journal of Marine Science, 78(9), 3101–3120. https://doi.org/10.1093/icesjms/fsab179.

Rodriguez-Marín, E., Arrizabalaga, H., Ortiz, M., Rodriguez-Cabello, C., Moreno, G., Kell, L.T. 2003. Standardization of bluefin tuna, *Thunnus thynnus*, catch per unit effort in the baitboat fishery of the Bay of Biscay (eastern Atlantic). ICES Journal of Marine Science, 60: 1216–1231. doi:10.1016/S1054–3139(03)00139-5.

Thorson, J.T., Shelton, A.O., Ward, E.J., Skaug, H.J. 2015. Geostatistical delta-generalized linear mixed models improve precision for estimated abundance indices for West Coast Groundfishes. ICES Journal of Marine Science, 72(5), 1297–1310. doi:10.1093/icesjms/fsu243.

Winker, H., Carvalho, F., Kapur, M. 2018. JABBA: Just Another Bayesian Biomass Assessment. Fisheries Research 204: 275-288. doi:10.1016/j.fishres.2018.03.010.

Zuur, A.F., Tuck, I.D., Bailey, N. 2003. Dynamic factor analysis to estimate common trends in fisheries time series. Canadian Journal of Fisheries and Aquatic Sciences Vol. 60No. 5pp. 542–552. https://doi.org/10.1139/f03-030.

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements and assignment of rapporteurs
2. Review the progress on current MSE efforts
3. Stock assessment good practices
4. Bycatch estimation tool
5. Reports of study groups
6. Other matters
7. Recommendations
8. Work Plan and Agenda 2024
9. Adoption of the report and closure

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Appendix 3

List of papers and presentations

Number	Title	Authors
SCRS/2023/025	Simulation-testing model-based and design-based bycatch estimators	Babcock E.A., Harford W.J., Gedamke T., Anderson S., Goodyear C.P.
SCRS/2023/080	An index of vessel fishing power for the billfish tournament fleet (1982-2021)	Schueller A.M., Snodgrass D.J.G., Orbesen E.S., Schirripa M.J.
SCRS/2023/088	Stock assessment model diagnostics for the 2016 sailfish assessment and their possible use in model weighting	Schirripa M.J.
SCRS/2023/089	Effects of fleet structure on reference points	Zhang F.
SCRS/2023/090	Review of stochastic surplus production model in continuous time (SPiCT) methodology for the ICCAT software catalogue	Kimoto A., Ortiz M., Taylor N.G.
SCRS/2023/091	HBF is an unreliable index of fishing depth for US longlines	Goodyear C.P., Forrestal F., Schirripa M.J.
SCRS/P/2023/049	Updated summary on North Atlantic albacore MSE	Arrizabalaga H., Merino G.
SCRS/P/2023/051	A review of reference points, objectives, and performance standards at tRMFOs	Taylor N.G., Miller S.
SCRS/P/2023/052	Northern swordfish MSE – Update to WGSAM	Gillespie K.
SCRS/P/2023/058	Western Atlantic skipjack MSE	Sant'Ana R.
SCRS/P/2023/059	Tuna stock assessment good practices workshop	Mauder M., Hoyle S.

Appendix 4

SCRS document and presentations abstracts as provided by the authors

SCRS/2023/025 - The Bycatch Estimator tool developed by Babcock (2022) was used to estimate bycatch in fisheries simulated using the species distribution model and longline simulator (LLSIM) developed by Goodyear (2021). To compare the effectiveness of several design-based and model-based estimators that are used to estimate bycatch in a realistic context, an observer program similar to the U.S. pelagic observer program was simulated, including the area and season stratification used to allocate observer coverage. The estimates of total bycatch were precise and unbiased for all methods during recent years with high observer coverage. However, in the early years with lower observer coverage, the design-based methods (delta lognormal and ratio) performed somewhat worse than the delta lognormal model. The results were sensitive to how observers were allocated to trips. A geostatistical model, applied to both the USA-like fleet, and all three simulated fleets, showed that total bycatch estimates were much more precise when spatial and/or spatiotemporal random effects were included in the model. The Bycatch Estimator tool was also applied to the real data from the U.S. pelagic longline observer program. The tool was able to recreate the U.S. Task 1 estimates in recent years, but the estimates further back in time, when observer coverage was lower, were sensitive to decisions made in data cleaning and how strata with low sample sizes were pooled.

SCRS/2023/080 - A multitude of changes in vessel size, conservation attitudes, and electronic equipment has led to changes in the recreational fishery for billfish over time, which has an impact on the fishery's ability to catch fish. The majority of these changes have originated from or been heavily influenced by USA participants. For much of the history of the recreational fishing fleet, media outlets have included stories that are intended to educate and involve the fishers. The utilization of the content of these forms of media could be a data mining source for representative information pertaining to the evolution of the billfish fishery. The available magazine media were used to collect data on the size of vessels in new and brokerage advertisements (new and used boat sizes), conservation attitudes, and electronic aids or assistance. These data were used to estimate a change in the mean vessel size over time of the fleet mediated by factors such as electronic assistance, which can serve as a proxy of changes in catchability of the fishery fleet for the stock assessment. The changes estimated in this analysis will be applicable to not only sailfish, but also for other billfish fisheries.

SCRS/2023/088 - The last sailfish assessment developed two models representing different hypotheses based on grouping all available CPUE time series into those with similar trends, one increasing and one decreasing. Each model was given equal consideration to arrive at an overfished/overfishing status of "not likely". This paper proposes a simple and objective method for weighting two stock assessment models based model diagnostics. The method uses a "win-lose-draw" approach in which either one of the models is declared to have a diagnostic result that is superior to the other model (one "wins" and the other "loses") or neither is superior (both are considered a "draw"). The method attempts to emphasize simplicity, objectivity and repeatability. Using this method would result in the ability to combine the two models with objective weighting and to arrive at a more conclusive declaration of status.

SCRS/2023/089 - Many fish populations are harvested by multiple fishing fleets with different types of fishing gears. Changes of fishing fleet structure will affect the overall selectivity of multi-fleet fishery, which may further affect the reference points. In this study, a simulation and a case study based on Atlantic bigeye tuna were used to study the effects of changing composition of fishing fleet on MSY-based reference points. Results indicated that when fishing fleets become increasingly dominated by those targeting younger fish, the MSY decreased while F_{MSY} and B_{MSY} showed nonlinear and non-monotonic variations. Changing fleet structure has no effects on B_0, so cautions need to be taken when using a fixed ratio of B_0 to represent B_{MSY} in situations where fleet structure varies over time. Furthermore, the explicit effects of changing fleet structure on MSY based reference points are context specific, so simulation analyses are recommended when fleet structure varies for specific populations and fisheries.

SCRS/2023/090 - The SCRS in 2022 recommended that the SPiCT model (stochastic surplus production model in continuous time) be considered for inclusion in the ICCAT software catalogue in 2023. SPiCT by Pedersen and Berg (2017) incorporates dynamics in both biomass and fisheries and observation error of both catches and biomass indices, and based on the generalized surplus production model. The model has a general state-space form that can contain process and observation-error as well as state-space models that assume error-free catches. This method has been widely applied to the ICES (International Council for

the Exploration of the Sea) stocks as well as international migratory species. The Guideline for SPiCT provides a checklist for the acceptance of a SPiCT assessment by ICES, the Rpackage of SPiCT and ShinyApp are available with the Handbook as a user guide in github. The authors fully recommend ICCAT to register this SPiCT methodology in the ICCAT software catalogue.

SCRS/2023/091 - Statistical models for estimating abundance trends for pelagic species are often fitted to CPUE data using the number of hooks between floats (HBF) as a covariate. This convention was originally based on observations indicating depths fished increased with HBF. The validity of this assumption was examined using the 1986-2015 hook-depth distributions for 128 longline configurations from U.S. logbooks estimated in a previous study. Time at depth and mean depth fished varied greatly for gears with the same number of HBF. Additionally, large annual variations were observed in the proportions of sets configured to fish at different depths and in the average depths fished by gears with the same number of HBF. A significant negative correlation predicted its appearance as a covariate in statistical models; however, the original basis for stratifying CPUE data by HBF was invalid for the US fishery. Fishing depth decreased with HBF in contrast to the traditional belief that it should increase. Expectations that HBF will be a surrogate for fishing depth should be accepted with skepticism until confirmed by analysis.

SCRS/P/2023/049 - Presentation provided an update of the ALB MSE process that led to the adoption of the first "full" management procedure (MP) for northern albacore (Rec. 21-04), including a harvest control rule, the way to determine stock status and a protocol for exceptional circumstances. The MSE process lasted more than 10 years, since the Commission requested the SCRS to develop a limit reference point for this stock (Rec. 11-04). The presentation showed a summarized chronology of key actions by Panel 2 (e.g. definition of management objectives in 2015, the adoption of performance statistics in 2016), the interactions between scientists and managers (e.g. communication of results about MP performance and advice to develop the exceptional circumstances protocol), and some technical characteristics of the MSE framework (e.g. Reference set of Operating models and characteristics of MPs tested, see consolidated report in Merino *et al*., 2020). In 2023 it is scheduled to check exceptional circumstances using all criteria, iterate the MP, build a new reference case for the second MSE round, and complete the analyses for the effects of underreporting.

SCRS/P/2023/051 - Presentation of Reference Points, Objectives, and Performance Standards at tRFMOs. Within this presentation, the distinction between limit reference points in the 'best assessment paradigm' (wherein management advice is altered when the stock crosses the limit reference points) versus the 'MSE paradigm' (wherein limit reference points indicate stock behavior or dynamics that should be avoided with a high probability) was made. The use of limit reference points is not consistent across species or RFMOs with respect to biomass, fishing mortality rate, or yield. Further, only IATTC defined the scientific basis for their choice in limit reference point, and all performance metrics were more varied in terms of yield. Future research will consider status objectives, variability in yield objectives, and timeframes over which performance metrics are calculated.

SCRS/P/2023/052 - Presentation provided an update of the swordfish MSE. The update included an overview of the NSWO MSE progress and identified key items for input from the Group. Details of the OM reference and robustness grid were provided, including additional robustness OMs planned based on input from Panel 4. The multi-step process of tuning, culling, and selecting the MP was presented, along with operational management objectives and associated performance metrics, proposed limit reference point, tentative MP implementation schedule, communications, and the Splash page and SLICK tool online resources. Desired guidance from the Group included methods for updating abundance indicators, methods for estimating reference points, feedback on MP communication, and development of ECs.

SCRS/P/2023/058 - Presentation included an update for the W-SKJ MSE. The presentation included the history of the western skipjack MSE progress, details of the stock and fishery, and preliminary results, including SLICK plots. Details of the OMs in reference and robustness grid were also presented. The goal of the MSE is to adopt an MP for implementation in November 2023 and develop ECs in 2024-2025. Updates from the most recent meeting with Panel 1 were presented, including the operationalization of conceptual management objectives, manager preferences on management cycle and CMP type, and a preference to explicitly include climate change considerations as OMs to be included in the robustness set of OMs.

SCRS/P/2023/059 - The CAPAM workshop series has been conducted for about 20 years. It started as the IATTC October Stock Assessment Workshop series in 2002 with a workshop on diagnostics and moved to the CAPAM series when CAPAM was founded in 2012. Due to funding for inviting keynote speakers, participation increased under the CAPAM framework. The workshops have covered all the main topics in fishery stock assessment and have cumulated in a workshop on Stock Assessment Good Practices in 2022. In addition, a workshop specializing on Tuna Stock Assessment Good Practices was held in 2023 in coordination with NIWA and ISSF. The chairs' initial views on stock assessment good practices are presented. These views will be updated for the report based on several knowledge sources including the recordings of the two good practices workshops, the manuscripts in the special issue, and recent reviews of tuna stock assessments. Creating a conceptual model is an important initial step that identifies hypotheses about the stock and fishery dynamics. These hypotheses are then translated into stock assessment models using the good practices. The stock assessment models are then fixed or rejected based on diagnostics and the retained models are included in the model assemble under some form of model weighting to provide management advice. Topics discussed include stock structure, CPUE analysis, recruitment, natural mortality, growth, selectivity, model weighting, data weighting, process variation, diagnostics, and tagging. Close-kin mark-recapture was emphasized as a possible solution to some of the remaining issues. Much more work is needed to make diagnostics more useful and objective to fix and eliminate models. We refer to www.capamresearch.org for more information on the CAPAM workshops including recordings and special issues.