Report of the 12th Session of the IOTC Working Party on Methods

Online, 18 - 20 October 2021

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ACRONYMS

ABNJ	Areas Beyond National Jurisdiction
ALB	Albacore
B	Biomass (total)
B_0	Unfished biomass
BET	Bigeye tuna
B_{MSY}	Biomass which produces MSY
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
ETP	Endangered, threatened and protected
F	Fishing mortality
FAD	Fish aggregating device
FOB	Floating Object
F_{MSY}	Fishing mortality at MSY
IOTC	Indian Ocean Tuna Commission
MP	Management Procedure
MPD	Management Procedures Dialogue
MSE	Management Strategy Evaluation
MSY	Maximum Sustainable Yield
OM	Operating Model
P	Probability
SC	Scientific Committee, of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY (sometimes expressed as SSB_{MSY})
SKJ	Skipjack tuna
SWO	Swordfish
TCMP	Technical Committee on Management Procedures
WPM	Working Party on Methods
WPNT	Working Party on Neritic Tunas
WPTT	Working Party on Tropical Tunas of the IOTC
YFT	Yellowfin tuna

GLOSSARY OF TERMS

The WPM decided to utilise the MSE Glossary developed by the Joint Tuna RFMO MSE Working Group in 2018**.**

Average Annual Variation - (in catch/TAC) The absolute value of the proportional TAC change each year, averaged over the projection period.

Biomass - Stock biomass, which may refer to various components of the stock. Often spawning stock biomass (SSB) of females is used, as the greatest conservation concern is to maintain the reproductive component of the resource.

Candidate Management Procedure - An MP (defined below) that has been proposed, but not yet adopted.

Conditioning - The process of fitting an Operating Model (OM) of the resource dynamics to the available data on the basis of some statistical criterion, such as a Maximum Likelihood. The aim of conditioning is to select those OMs consistent with the data and reject OMs that do not fit these data satisfactorily and, as such, are considered implausible.

Error - Differences, primarily reflecting uncertainties in the relationship between the actual dynamics of the resource (described by the OMs) and observations. Four types of error may be distinguished, and simulation trials may take account of one or more of these:

- Estimation error: differences between the actual values of the parameters of the OM and those provided by the estimator when fitting a model to the available data;
- Implementation error: differences between intended management actions (as output by an MP) and those actually achieved (e.g. reflecting over-catch);
- Observation error (or measurement error): differences between the measured value of some resource index and the corresponding value calculated by the OM;

- Process error: natural variations in resource dynamics (e.g., fluctuations about a stock-recruitment curve or variation in fishery or survey selectivity /catchability).

Estimator - The statistical estimation process within a population model (assessment or OM); in a Management Strategy Evaluation (MSE) context, the component that provides information on resource status and productivity from past and generated future resource-monitoring data for input to the Harvest Control Rule (HCR) component of an MP in projections.

Exceptional circumstances - Specifications of circumstances (primarily related to future monitoring data falling outside the range covered by simulation testing) where overriding of the output from a Management Procedure should be considered, together with broad principles to govern the action to take in such an event.

Feedback Control - Rules or algorithms based, directly or indirectly, on trends in observations of resource indices, which adjust the management actions (such as a TAC change) in directions that will change resource abundance towards a level consistent with decision makers' objectives.

Harvest Control Rule - (also Decision Rule) A pre-agreed and well-defined rule or action(s) that describes how management should adjust management measures in response to the state of specified indicator(s) of stock status. This is described by a mathematical formula.

Harvest Strategy - Some combination of monitoring, assessment, harvest control rule and management action designed to meet the stated objectives of a fishery. Sometimes referred to as a Management Strategy (see below). A fully specified harvest strategy that has been simulation tested for performance and adequate robustness to uncertainties is often referred to as a Management Procedure.

Implementation - The practical application of a Harvest Strategy to provide a resource management recommendation.

Kobe Plot - A plot that shows the current stock status, or a trajectory over time for a fished population, with abundance on the horizontal axis and fishing mortality on the vertical axis. These are often shown relative to BMSY and to FMSY, respectively. A Kobe plot is often divided into four quadrants by a vertical line at B=BMSY and a horizontal line at F=FMSY.

Limit Reference Point - A level of biomass below, or fishing mortality above, which an actual value would be considered undesirable, and which management action should seek to avoid.

Management Objectives - The social, economic, biological, ecosystem, and political (or other) goals for a given management unit (i.e. stock). These typically conflict, and include concepts such as maximising catches over time, minimising the chance of unintended stock depletion, and enhancing industry stability through low inter-annual variability in catches. For the purposes of Management Strategy Evaluation (MSE) these objective need to be quantified in the form of Performance statistics (see below).

Management Plan - In a broad fisheries governance context, a Management Plan is the combination of policies, regulations and management approaches adopted by the management authority to reach established societal objectives. The management plan generally includes the combination of policy principles and forms of management measures, monitoring and compliance that will be used to regulate the fishery, such as the nature of access rights, allocation of resources to stakeholders, controls on inputs (e.g. fishing capacity, gear regulations), outputs (e.g. quotas, minimum size at landing), and fishing operations restrictions (e.g. closed areas and seasons). Ideally, the Management Plan will also include the Harvest Strategy for the fishery or a set of principles and guidelines for the specification, implementation and review of a formal Management Procedure for target and non-target species.

Management Procedure - A management procedure has the same components as a harvest strategy. The distinction is that each component of a Management Procedure is formally specified, and the combination of monitoring data, analysis method, harvest control rule and management measure has been simulation tested to demonstrate adequately robust performance in the face of plausible uncertainties about stock and fishery dynamics.

Management Strategy - Synonymous with harvest strategy. (But note that this is also used with a broader meaning in a range of other contexts.)

Management Strategy Evaluation - A process whereby the performances of alternative harvest strategies are tested and compared using stochastic simulations of stock and fishery dynamics against a set of performance statistics developed to quantify the attainment of management objectives.

Maximum Economic Yield - The (typically annual) yield that can be taken continuously from a stock sustainably (i.e. without reducing its size) that maximizes the economic yield of a fishery in equilibrium. This yield occurs at the effort level that creates the largest positive difference between total revenues and total costs of fishing (including the cost of labor, capital, management and research etc.), thus maximizing profits.

Maximum Sustainable Yield - The largest (typically annual) yield that can be taken continuously from a stock sustainably (i.e. without reducing its size). In real, and consequently stochastic situations, this is usually

estimated as the largest average long-term yield that can be obtained by applying a constant fishing mortality F, where that F is denoted as FMSY.

Observation Model - The component of the OM that generates fishery-dependent and/or fishery-independent resource monitoring data from the underling true status of the resource provided by the OM, for input to an MP.

Operating Model(s) - A mathematical–statistical model (usually models) used to describe the fishery dynamics in simulation trials, including the specifications for generating simulated resource monitoring data when projecting forward in time. Multiple models will usually be considered to reflect the uncertainties about the dynamics of the resource and fishery.

Performance statistics/measures - A set of statistics used to evaluate the performance of Candidate MPs (CMPs) against specified management objectives, and the robustness of these MPs to important uncertainties in resource and fishery dynamics.

Plausibility (weights) - The likelihood of a scenario considered in simulation trials representing reality, relative to other scenarios also under consideration. Plausibility may be estimated formally based on some statistical approach, or specified based on expert judgement, and can be used to weight performance statistics when integrating over results for different scenarios (OMs).

Precautionary Approach - An approach to resource management in which, where there are threats of serious irreversible environmental damage, lack of full scientific certainty is not used as a reason for postponing cost-effective measures to prevent environmental degradation.

Reference case - (also termed reference scenario or base case) A single, typically central, conditioned OM for evaluating Candidate MPs (CMPs) that provides a pragmatic basis for comparison of performance statistics of the CMPs.

Reference set - (also termed base-case or evaluation scenarios) A limited set of scenarios, with their associated conditioned OMs, which include the most important uncertainties in the model structure, parameters, and data (i.e. alternative scenarios which have both high plausibility and major impacts on performance statistics of Candidate MPs).

Research-conditional option - Temporary application of an MP that does not satisfy conservation performance criteria, accompanied by both a research programme to check the plausibility of the scenarios that gave rise to this poor performance and an agreed subsequent reduction in catches should the research prove unable to demonstrate implausibility.

Robustness tests - Tests to examine the performance of an MP across a full range (i.e. beyond the range of the Reference Set of models alone) of plausible scenarios. While plausible, robustness test OMs are typically considered to be less likely than the reference set OMs, and often focus on particularly challenging circumstances with potentially negative consequences to be avoided.

Scenario- A hypothesis concerning resource status and dynamics or fishery operations, represented mathematically as an OM.

Simulation trial/test - A computer simulation to project stock and fishery dynamics for a particular scenario forward for a specified period, under controls specified by a HS or MP, to ascertain the performance of that HS or MP. Such projections will typically be repeated a large number of times to capture stochasticity.

Spawning Biomass, initial - Initial spawning biomass prior to fishing as estimated from a stock assessment.

Spawning Biomass, current - Spawning biomass (SSB) in the last year(s) of the stock assessment.

Spawning Biomass at MSY - The equilibrium spawning biomass that results from fishing at FMSY. In the presence of recruitment variability, fishing a stock at FMSY will result in a biomass that fluctuates above and below SSBMSY.

Stationarity - The assumption that population parameter values are fixed (at least in expectation), and not varying systematically, over time. This is a standard assumption for many aspects of stock assessments, OMs and management plans.

Stock assessment - The process of estimating stock abundance and the impact of fishing on the stock, similar in many respects to the process of conditioning OMs.

Target Reference Point - The point which corresponds to a state of a fishery and/or resource which is considered desirable and which management aims to achieve.

Trade-offs - A balance, or compromise, achieved between desirable but conflicting objectives when evaluating alternative MPs. Trade-offs arise because of the multiple objectives in fisheries management and the fact that some objectives conflict (e.g. maximizing catch vs minimizing risk of unintended depletion).

Tuning - The process of adjusting values of control parameters of the Harvest Control Rule in a Management Procedure to achieve a single, precisely-defined performance statistic in a specified simulation test. This reduces confounding effects to allow the performance of different candidate MPs to be compared more readily with respect to other management objectives. For example, in the case of evaluating rebuilding plans, all candidate

MPs might be tuned to meet the rebuilding objective for a specified simulation trial; then the focus of comparisons among MPs is performance and behaviour with respect to catch and CPUE dimensions.

Weight(s) - Either qualitative (e.g. high, medium, low) or quantitative measures of relative plausibility accorded across a set of scenarios.

Worm plot - Time series plots showing a number of possible realizations of simulated projections of, for example, catch or spawning biomass under the application of an MP for a specific OM or weighted set of OMs.

STANDARDISATION OF IOTC WORKING PARTY AND SCIENTIFIC COMMITTEE REPORT TERMINOLOGY

SC16.07 (para. 23) The SC **ADOPTED** the reporting terminology contained in Appendix IV and **RECOMMENDED** that the Commission considers adopting the standardised IOTC Report terminology, to further improve the clarity of information sharing from, and among its subsidiary bodies.

HOW TO INTERPRET TERMINOLOGY CONTAINED IN THIS REPORT

Level 1: ***From a subsidiary body of the Commission to the next level in the structure of the Commission:***
RECOMMENDED, RECOMMENDATION: Any conclusion or request for an action to be undertaken, from a subsidiary body of the Commission (Committee or Working Party), which is to be formally provided to the next level in the structure of the Commission for its consideration/endorsement (e.g. from a Working Party to the Scientific Committee; from a Committee to the Commission). The intention is that the higher body will consider the recommended action for endorsement under its own mandate, if the subsidiary body does not already have the required mandate. Ideally this should be task specific and contain a timeframe for completion.

Level 2: ***From a subsidiary body of the Commission to a CPC, the IOTC Secretariat, or other body (not the Commission) to carry out a specified task:***
REQUESTED: This term should only be used by a subsidiary body of the Commission if it does not wish to have the request formally adopted/endorsed by the next level in the structure of the Commission. For example, if a Committee wishes to seek additional input from a CPC on a particular topic, but does not wish to formalise the request beyond the mandate of the Committee, it may request that a set action be undertaken. Ideally this should be task specific and contain a timeframe for the completion.

Level 3: ***General terms to be used for consistency:***
AGREED: Any point of discussion from a meeting which the IOTC body considers to be an agreed course of action covered by its mandate, which has not already been dealt with under Level 1 or level 2 above; a general point of agreement among delegations/participants of a meeting which does not need to be considered/adopted by the next level in the Commission's structure.
NOTED/NOTING: Any point of discussion from a meeting which the IOTC body considers to be important enough to record in a meeting report for future reference.

Any other term: Any other term may be used in addition to the Level 3 terms to highlight to the reader of and IOTC report, the importance of the relevant paragraph. However, other terms used are considered for explanatory/informational purposes only and shall have no higher rating within the reporting terminology hierarchy than Level 3, described above (e.g. **CONSIDERED**; **URGED**; **ACKNOWLEDGED**).

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 12th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Methods (WPM) was held online on Zoom from 18 - 20 October 2021. A total of 55 participants (55 in 2020, 37 in 2019 and 23 in 2018) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Hilario Murua (ISSF) who welcomed participants.

The following are the recommendations from the WPM12 to the Scientific Committee, which are provided in Appendix VII.

Consideration of Exceptional Circumstances

WPM12.01: 82. The WPM **RECOMMENDED** that the SC should consider adopting these guidelines (Appendix IV) for dealing with exceptional circumstances while further **NOTING** that these guidelines are a living document and revisions may still be required in the future. The WPM **NOTED** these guidelines should provide a basis for the consideration of exceptional circumstances in future IOTC resolutions on the adoption of management procedures (Para. 82)

Revision of the WPM Program of work (2022–2026)

WPM12.02: The WPM **NOTED** that the schedule is still ambitious but that the technical work could, in principle, be completed within the proposed timeframes with minor adjustments. The MSE schedule is included are included in Appendix V. The WPM **RECOMMENDED** that the SC consider the revised timetable and endorse it for consideration by the Commission. (Para 109)

WPM12.03: The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2022–2026), as provided in Appendix IV (para. 114).

Date and place of the 13th and 14th sessions of the WPM

WPM12.04: The WPM **NOTED** that the global Covid-19 pandemic has complicated international travel and with no clear end to the pandemic in sight, it was not possible to finalise arrangements for the meeting in 2022. The Secretariat will continue to liaise with CPCs to determine their interest in hosting these meetings in the future when this becomes feasible. The WPM **RECOMMENDED** the SC consider mid October 2022 as a preferred time period to hold the WPM13. As usual it was also **AGREED** that this meeting should continue to be held back-to-back with the WPTT, with the WPM taking place before the WPTT (Para. 116)

Development of priorities for Invited Expert(s) at the next WPM meeting

WPM12.05: Given the importance of external peer review, the WPM **RECOMMENDED** that the Commission continues to allocate sufficient budget for a regular invited expert to be invited to meetings of the WPM (para. 118).

Review of the draft, and adoption of the Report of the 12th Session of the WPM

WPM12.06: The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM12, provided in Appendix VII (para. 124).

1. OPENING OF THE MEETING

1. The 12th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Methods (WPM) was held online on Zoom from 18 - 20 October 2021. A total of 55 participants (55 in 2020, 37 in 2019 and 23 in 2018) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Hilario Murua (ISSF) who welcomed participants.

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION

2. The WPM **ADOPTED** the Agenda provided at Appendix II. The documents presented to the WPM12 are listed in Appendix III.

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 23rd Session of the Scientific Committee

3. The WPM **NOTED** paper IOTC–2021–WPM12–03 which outlined the main outcomes of the 23rd Session of the Scientific Committee (SC23), specifically related to the work of the WPM.

4. The WPM **NOTED** that in 2020, the SC made a number of endorsements and recommendations in relation to the WPM11 report. These are provided below for reference

*(Para 91) The SC **NOTED** that in 2020 the Commission stated that:*

> *The Commission **SUPPORTED** the ongoing Management Strategy Evaluation work and **NOTED** the revised workplan endorsed by the Scientific Committee in Appendix 6 of the 2019 Scientific Committee Report. The Commission particularly **NOTED** the importance of the work to specify the skipjack tuna harvest control rule as a full Management Procedure (MP) as well as the need to finalise the MP development for yellowfin tuna to provide sound management advice for this species.*

*(Para 92) The SC **NOTED** that this schedule of work is once again included as Appendix 6 to this report to clarify the revised MSE schedule.*

Albacore MSE

*(Para. 93) The SC **NOTED** that the project was initiated in 2020 to further develop the ALB MSE. Work has started on updating the simulation platform to the new model structure including a proposal for a new OM grid. The SC **NOTED** the WPM has endorsed a new set of reference OM grid to capture the range of uncertainty identified.*

Skipjack tuna MSE

*(Para. 94) The SC **NOTED** an MSE expert has been contracted in 2020 to undertake review of the skipjack tuna harvest control rule with a view to review and potentially revise the HCR as required by Res 16/02. The work conducted so far included (1) developing an Operating Model based on Stock Synthesis III; (2) developing a simple stock assessment model that can be fitted to simulated data from the skipjack stock assessment grid, and (3) Simulation test model-based Management Procedures. The aim of the review is to develop a full skipjack MP.*

Yellowfin tuna MSE

*(Para. 95) The SC **NOTED** the attempt to conduct a full assessment of the yellowfin tuna has not been achieved this year and the current yellowfin OM is based on the 2018 yellowfin assessment. The SC further **NOTED** that YFT OM development explored a range of modelling issues including retrospective pattern, high F, and revised treatment of recruitment and CPUE auto-correlation.*

Bigeye tuna MSE

*(Para. 96) The SC **NOTED** that bigeye tuna OMs were updated from the 2019 stock assessment, and a Pella-Tomlinson Random Effects surplus production model that includes process and observation errors was developed as a candidate for the MP.*

Swordfish MSE

*(Para. 97) The SC **NOTED** that limited progress had been made on the Swordfish MSE. The modeller working on the MSE was currently not available. As such, very little progress had been made since the 2019 SC meeting. The work is expected to resume in late 2020, early 2021.*

Stock status guide and other business

(Para. 98) The SC were made aware that:

> *The Commission **NOTED** the ongoing work of the Ad Hoc Reference Point Working Group and **REQUESTED** that the outcomes of this group are presented to the TCMP for its consideration in 2021.*

*(Para. 99) The SC **NOTED** the discussions on whether, for any given species with a harvest strategy, the OM requires reconditioning when there is an updated assessment. The SC **AGREED** that there is a need for deciding on when to stop the reconditioning of the OMs with new assessments. The SC **NOTED** that although there has been some general practice in assisting the decision (e.g. the new assessment biomass estimates fall outside the range of the OM) a more generic set of criteria and guidance is required. Such guidance will help expedite the progress of the MSE process towards focusing on the testing of candidate MPs. The SC further **NOTED** the issue is also related to determining when and whether any exceptional circumstances has occurred.*

3.2 Outcomes of 4th Session of the Technical Committee on Management Procedures

5. The WPM **NOTED** paper IOTC–2021–TCMP04–R which provided the outcomes of the 4th Session of the Technical Committee on Management Procedures (TCMP04).

6. The WPM **NOTED** that in 2021, the TCMP made a number of endorsements and recommendations directly related to the work of the WPM. These are provided below for reference:

SC Proposal for the Standard Presentation of MSE Results

*(Para. 24) The TCMP **RECOMMENDED** that the WPM and Ad-hoc Reference Point Working Group continue to have discussions in order to propose the most suitable and robust types of reference points to be used for stock status determination.*

Albacore tuna

*(Para. 34) The TCMP **NOTED** the final OM and simulation is expected to be reviewed for adoption at the WPM and SC meeting in 2021. The funding for the current albacore tuna MSE is until December 2021.*

Bigeye Tuna

*(Para. 38) The TCMP **NOTED** that the constraint on the maximum TAC change does not need to be symmetric (for example, the constraint can be 15% on the increase and 10% on the decrease). The TCMP **REQUESTED** the issue be discussed in more detail at the WPM prior to the SC.*

Discussion on the Actions Needed for the Adoption of Management Procedures, Including Budget

*(Para. 67) The TCMP **NOTED** the high level of uncertainty in the catches used to condition the operating models. The TCMP further **NOTED** that this uncertainty is not consistent over time. The TCMP therefore **REQUESTED** that the WPM review this problem and potential solutions to reduce this problem in the OM conditioning.*

*(Para. 68) The TCMP **AGREED** to leave several of the technical options, such as the tuning criteria as well as the frequency of quota setting as they currently are applied by the developers. Additional revisions to these options will be deferred to the WPM and SC, **NOTING** that these will again be reviewed by the TCMP in 2022.*

Skipjack Tuna

*(Para. 77) The TCMP **REQUESTED** that the developer consider the same tuning criteria as proposed for other stocks (50%, 60% and 70% with the percentages corresponding to the percentage of time the stock status is in the Kobe green quadrant over the reference years (i.e. 2030-2034 or 11 – 15 years from model terminal year) for consistency. One CPC suggested that the initial tuning criteria should be depletion based, but additional tuning criteria, including MSY based criteria, should also be investigated, and discussed by the WPM and SC and presented to the TCMP in 2022.*

*(Para. 78) The TCMP **AGREED** that the current methodology to generate the CPUE for the MP should be maintained with more comprehensive discussions on this process to occur at the WPM and SC.*

Workplan

*(Para. 85) The TCMP **NOTED** that there have been delays in the MSE development and that this will require a revision to the timetable for the development of Management Procedures. The TCMP **RECOMMENDED** that the*

Commission endorse a request that a revised timetable to be developed by CPCs with assistance from the SC and WPM chairs along with the Secretariat and this could be presented to the SC in 2021.

3.3 Outcomes of the 25th Session of the Commission

7. The WPM **NOTED** paper IOTC–2021–WPM12–04 which provided the main outcomes of the 25th Session of the Commission specifically related to the work of the WPM.

8. Participants to WPM12 were **ENCOURAGED** to familiarise themselves with the previously adopted Resolutions, especially those most relevant to the WPM and **AGREED** to consider how best to provide the Scientific Committee with the information it needs, in order to satisfy the Commission's requests, throughout the course of the current WPM meeting.

3.4 Review of Conservation and Management Measures relevant to the WPM

9. The WPM **NOTED** paper IOTC–2021–WPM12–05 which aimed to encourage participants at the WPM12 to review some of the existing Conservation and Management Measures (CMM) relevant to the WPM and as necessary to 1) provide recommendations to the Scientific Committee on whether modifications may be required; and 2) recommend whether other CMMs may be required.

3.5 Progress on the recommendations of WPM11

10. The WPM **NOTED** paper IOTC–2021–WPM12–06 which provided an update on the progress made in implementing the recommendations from the previous WPM meeting which were endorsed by the Scientific Committee and **AGREED** to provide alternative recommendations during the WPM12 as appropriate given any progress.

3.6 Review of intersessional meetings related to the IOTC MSE process

11. The WPM **NOTED** paper IOTC-2021-WPM12(MSE)-R which provided the report of Report of the 12th Session of the IOTC Working Party on Methods Management Strategy Evaluation Task Force that took place from 1-4 March 2021.

12. The WPM **THANKED** the participants of this workshop for their informative discussions and input on the technical aspects of MSE and related topics. The WPM **NOTED** that the output of this workshop remains very important to the WPM as it provides an informal forum for the highly technical discussions necessary to advance the MSE process in IOTC for which there is insufficient time during the WPM meeting.

4. ALBACORE MSE: UPDATE

4.1 Review of the progress on development new Operating Models based on 2019 ALB stock assessment and Feedback on MSE/OM development

13. The WPM **NOTED** paper IOTC–2021–WPM12–09 which presented an update of the Indian Ocean albacore Operating Model, with the following summary provided by the authors:

> *"The document presents an update of development of the Operating Model for Indian Ocean albacore. A grid of model run has been constructed based on the latest SS3 stock assessment model (WPTmT, 2018) and alternative values for 6 factors: natural mortality, CPUE catchability trends, stock-recruitment steepness, variance in recruitment residuals, choice of LL CPUE, and weight of the length-frequency data. Models were then selected based on prediction skill of the LL CPUE, an upper limit to the estimate of virgin biomass and their ability to explain nominal catches in 2018 and 2019. Remaining model runs were resampled with weights determined by the strength of their prediction skill (p-value of LL CPUE one-step-ahead prediction MASE)."*

14. The WPM **ACKNOWLEDGED** the work that has been done on operating model (OM) conditioning and the preliminary projections for Indian Ocean albacore.

15. The WPM **NOTED** the selection and weigthing procedure applied to the runs in the model grid. Runs are being accepted based on a combination of model convergence, prediction skill for the main CPUE series, as quantified by the MASE value of a retrospective cross-validation exercise, and by their ability to expl;ain the nominal catches of 2018 and 2019, as reported to IOTC. The WPM NOTED that around 30% of model runs could not explain those catches without resorting to unrealistic increases in fishing mortality of greater than 400%.

16. The WPM **NOTED** that the accepted model runs were then resampled based on their relative prediciton skill.

17. The WPM **NOTED** that the OM has been constructed from the totality of the model grid, as the partial factorial design, initially agreed for all OMs, led to a low number of runs once the selection criteria had been applied

18. The WPM **NOTED** that two sets of combinations of factor levels in the grid (Northwest – NW- or Southwest -SW- CPUE, LL CPUE catchability and weight of LF data) produce very different views of the past dynamics of the stock. The WPM **NOTED** that the OM should be constituted of the different stock trajectories, unless there is a specific reason to separate the OM into a reference OM and a robustness OM, for example, through MASE or bi-modal distribution of key quantities (e.g., SSB).

19. The WPM **NOTED** the candidate MPs proposed for this stock. Two different MPs based on fits on a surplus production run, the second of wich applies the HCR employed by CCSBT for Southern bluefin tuna, have been tested. It appears to perform well when stock recovery is needed. This second HCR has not been presented before at IOTC, so the WPM **SUGGESTED** that results from both should be presented at the next TCMP to allow for an easier transition between previous runs of candidate MPs and the current proposed CCSBT HCR.

20. The WPM **NOTED** that a new albacore stock assessment is scheduled for 2022, with the meeting occurring just after the TCMP. The developer proposed that different methods could be attempted in order to have an OM that is not dependent on the stock assessment. Further discussion on these methods was deferred to agenda item 9.

21. The WPM **NOTED** that the current contract with the developer is terminating in December 2021. The Secretariat informed the WPM that funding is available for 2022-2023 for a contract covering both ALB and SWO MSE developments.

5. SKIPJACK TUNA MSE: UPDATE

5.1 Progress on the development of Skipjack MSE/MP

22. The WPM **NOTED** paper IOTC–2021–WPM12–10 which provided the Evaluation of empirical control rules for Indian Ocean Skipjack. The following abstract was provided by the authors:

> "*The primary objective of this work is to develop a Management Procedure (MP) for Indian Ocean Skipjack tuna (SKJ), which includes specification of the data inputs, harvest control rule (HCR) and management outputs, and that has been fully tested using an appropriate simulation framework. Following the presentation of developmental work to the Working Party on Methods (Edwards, 2020a,b, IOTC, 2020a), the MSE Task Force (IOTC, 2021b) and the Technical Committee on Management Procedures (Edwards, 2021, IOTC, 2021c), in which a suitable simulation evaluation framework was proposed, the current work presents further development of an empirical MP with which to recommend a total catch for the fishery.*"

23. The WPM **THANKED** the author for the good progress made in reviewing the skipjack Management Procedure. The WPM **RECALLED** that the project was initiated to review and potentially revise the HCR as required by Res 16/02, with the aim of developing a full skipjack MP, in response to the request from WPM9 (endorsed by the SC).

5.2 Discussion on MSE development

24. The WPM **DISCUSSED** several references in the TCMP04 report to the use of MSY-based reference points and made the following observations.

25. The WPM **NOTED** that the reference in the TCMP04 report to using both the Kobe and Majuro plots to present performance of MPs against reference points (para 25) was not a specific request or recommendation from the TCMP, but was an observation that it could be helpful to either produce both plots or merge the two plots into a single plot.

26. The WPM **NOTED** that presenting results on the performance of MPs against different reference points (i.e. MSY and depletion-based) is likely to make communication of the results more difficult. For example, skipjack tuna is currently assessed against depletion-based reference points given previous problems obtaining sensible MSY estimates, so presenting performance against additional different reference points is likely to complicate the message. The WPM **NOTED**, however, that information on MSY-based reference points could be included in the full table of performance statistics usually presented at TCMP.

27. The WPM **NOTED** that the reference to MSY-based reference points in the TCMP04 report (para 54) was not a specific request or recommendation and that it referred to reference points used within the surplus production model in model-based MPs, which are no longer being evaluated for skipjack.

28. The WPM **NOTED** that a catch-weighted log-scale mean of the two abundance indices (Pole and Line and Purse Seine Log School CPUE) was so similar to an un-weighted log-scale mean that the use of the simpler un-weighted mean index was appropriate.

29. The WPM also **NOTED** that TCMP04 requested (para 77 of report) that the same tuning criteria used for other stocks (i.e. 50%, 60% and 70% probability of being in the Kobe green quadrant over the reference years) should also be used to evaluate the performance of candidate MPs for skipjack tuna.

30. The WPM further **NOTED** the request to investigate the MSY-based tuning criteria. However, achieving the MSY-based tuning objective will lead to a negligible probability of reaching the current agreed depletion based-reference points. Moreover, presenting results on the performance of MPs tunned to different types of reference points (i.e. MSY and depletion-based) will make communication of the results more difficult.

31. The WPM **NOTED** that the current approach for skipjack to select MPs for evaluation involves selecting multiple MPs that achieve each tuning objective within a certain margin. In contrast, the process for other species is to select a single MP within each MP type that achieves each tuning objective precisely. The WPM also **NOTED** that the decision on which a tuning objective is retained for the final MP evaluations will be a decision for the TCMP.

32. The WPM **NOTED** that a 30% positively biased catch implementation error was used in previous iterations of the skipjack MSE, but a symmetric implementation error has been applied in the current analysis, based on a request from the TCMP. The WPM **NOTED** that although positive catch implementation error is more likely for skipjack due to recent overcatch of the previous annual catch limit, it was difficult for developers to decide on a specific level of bias as this is linked to allocation issues and is therefore a decision for managers.

33. The WPM further **NOTED** that some empirical information on catch implementation error is already available from the past 5 years of the skipjack HCR, and that this information could be used to derive a probability distribution of catch implementation error. The WPM **AGREED** that a symmetrical distribution of unbiased implementation error should be used to evaluate candidate MPs for skipjack tuna, but that a probability distribution of catch implementation error observed from the application of Resolution 16/02 skipjack HCR should be used in robustness tests to evaluate the sensitivity of the MPs to this error.

5.3 Future steps and timeline

34. The WPM **NOTED** that no maximum allowable change in TAC in the skipjack MSE is currently included, and that a level of 15% was currently used for other species. The WPM **AGREED** that it will be important to evaluate how often the models are hitting the maximum change constraints, which will help guide the developer to determine an appropriate level for the maximum TAC change constraints.

35. The WPM **AGREED** that applying asymmetric TAC constraints (i.e. different allowed percentage of TAC change when decreasing or increasing the TAC) are an added level of complexity that would need to be explained and are not necessary unless a specific difficulty related to asymmetric TAC constrains is identified. The WPM also **AGREED** that asymmetry in TAC constraint will be better placed within the HCR itself, which is much more dynamic and responsive.

36. The WPM **NOTED** that a recruitment shock robustness test for bigeye tuna is simulated using a level of 55% of the mean recruitment for 8 consecutive quarters, and **AGREED** that this scenario would be a useful starting point for future recruitment robustness tests for skipjack tuna.

6. BIGEYE TUNA MSE: UPDATE

6.1 Bigeye Tuna MSE: Update

37. The WPM **NOTED** paper IOTC–2021–WPM12–11 regarding the Indian Ocean Bigeye Tuna Management Procedure Evaluation Update. The following abstract was provided by the authors:

> "*• The most recent bigeye OMs and candidate MPs were presented at the MSE taskforce meeting (March 2021) and TCMP (June 2021).*
>
> *• The bigeye Operating Models (OMs) and the MP evaluation process are at a reasonably mature stage, with a suite of potentially viable candidate MPs that all achieve current tuning objectives*

• Given this relative state of maturity, we seek a discussion within the WPM on endorsement of the OMs and selection of a set of candidate MPs for adoption of a final MP within the IOTC structure

• We do, however, note that a revision of the length-at-age relationship for this species is to be presented at the WPTT which could have potential implications for the robustness of the current suite of OMs. We discuss this in the context of having a data and OM "guillotine" requirement (as agreed at WPM MSE taskforce 2021) and a well-defined process for handling exceptional circumstances."

38. The WPM **NOTED** the request by the TCMP to examine asymmetric TAC constraints. However, the WPM **NOTED** that, in the case of the bigeye tuna stock which is in a relatively healthy state and the average annual variation in catch is small, the benefit of applying the asymmetric TAC constraint will be marginal, and any impact will likely be absorbed by the tuning process. The WPM further **NOTED** that the situation may be specific to the bigeye tuna.

39. The WPM **NOTED** the suggestion to desynchronize the MP application and the stock assessment so that they are not performed in the same year. This is because the MPs and stock assessment could be based on different model setups and can possibly provide different catch recommendations, which can lead to confusion for managers. However, the WPM **AGREED** that while this is generally good practice, it needs to be considered more carefully on a case-by-case basis, for example, the current HCR of skipjack tuna requires stock assessment estimates as input, and the schedule of MP application and stock assessment has a potential impact on workflow of the IOTC.

6.2 Revision of Management Procedures and Performance Indicators

40. The WPM **NOTED** that the OM for bigeye tuna has been well developed over the years and has been shown to be relatively stable. The WPM further **NOTED** that so far, a suite of MPs has been thoroughly evaluated and they have shown reasonably clear contrast. The WPM **DISCUSSED** the issue of how often the OM should be updated, noting that the current practice appears to be that the OM is revisited when the assessment is updated. The WPM **AGREED** that it is not feasible to change the OM indefinitely and it is essential to establish when an OM can be considered adequate to encompass all major sources of the uncertainty for the concerned stock ("the Butterworth Guillotine" concept). The WPM also **AGREED** that the group should provide the technical guidance to establish the conditions and criteria for the OM updates and to communicate this to the TCMP /Commission so that an agreement can be achieved with fishery managers.

41. The WPM **AGREED** that the OM development of bigeye tuna is currently in sufficient condition to apply the "Butterworth guillotine" and suggested a way to select the MP. Therefore, the WPM REVIEWED a summary of the MP's performance indicators so that the group can make recommendations to the SC on selecting suitable MPs (or narrowing them down to fewer groups) for further testing. The WPM **NOTED** that it will be up to the TCMP/Commission to decide on the final MP.

42. The WPM **NOTED** that a summary of performance indicators for 6 MP/tuning criteria combinations was subsequently provided (Figure 1), including 3 MPs (CPUE, Model-based hockey stick, and Model-based Catch and CPUE projection) tuned to two tuning criteria (60% and 70% probability of being in the Kobe green quadrant over the reference years).

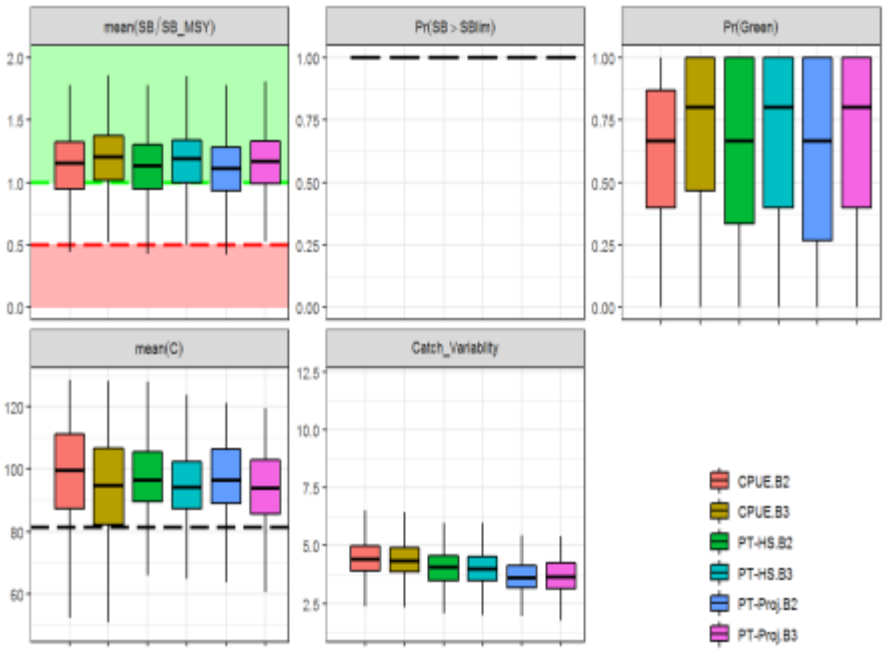

Figure 1: A summary comparison of key performance indicators of the 6 MP/tuning criteria combinations

43. The WPM **NOTED** that all three MPs produce average catches slightly above the current catch. The empirical CPUE rule results in higher annual average variations (AAV) with progressively higher risks for the spawning stock (SSB) of falling below the target, and the PT-PROJ MP has a lower overall AAV and SB risks. The WPM **NOTED** that when selecting MPs, stakeholders can also take into account their familiarity with certain types of MPs. The WPM **AGREED** that both PT-HS and PT-PROJ MPs are recommended to SC for futher testing. The WPM also **NOTED** that most of the contrast in MP performance is determined by the tuning targets and as such, by excluding the CPUE MP, the main signals are not lost. The WPM **PROPOSED** further research on CPUE-based MPs.

44. The WPM **NOTED** MPs with more tuning parameters potentially have more flexibility to achieve the tuning objectives.

45. The WPM **NOTED** that the MSE assumed that the historical catches were known precisely. The WPM further **NOTED** that the IOTC received aggregated catch data from CPCs and it is not possible to determine the precision or bias of the estimates. The WPM **NOTED** the suggestion to include alternative estimates in the robust test or to include uncertainty in the projections.

7. SWORDFISH MSE: UPDATE

7.1 Review the conditioning of Operating Models based on 2020 Stock assessment

46. The WPM **NOTED** paper IOTC–2021–WPM12–12 on the update of the Indian Ocean swordfish operating model. The following abstract was provided by the authors:

> "*This document presents the current status of development of an Operating Model for the Indian Ocean swordfish (Xiphias gladius) stock, with the re-condition of the models to the most recent swordfish stock assessment, conducted in 2020. It explores the role of 9 axis of structural uncertainty, each with 2 to 3 levels. The current grid results in 2592 alternative population trajectories and productivity estimates. To reduce the number of model runs, a partial factorial design of 108 model runs is proposed. A set of diagnostics are then applied, and currently a set of 70 models is considered to compose the OM*"

47. The WPM **WELCOMED** a presentation on the progress of development of an Operating Model for Indian Ocean swordfish. The WPM **THANKED** the developer for her work.

48. The WPM **NOTED** the high productivity runs included in the operating model, given the range of uncertainties being tested it could be expected to have some runs that have a very high productivity, which is different to the situation where the model cannot determine the upper bound of stock biomass. These could still be part of the OM, at most a cut-off on the 5% upper quantile could be used to remove the most extreme estimates.

49. The WPM **WELCOMED** the fact that the ongoing work on the swordfish MSE has been presented to the WPB and feedback was requested and obtained from WPB. The WPM **ENCOURAGED** this communication between MSE developers and the relevant WPs, and **SUGGESTED** for it to be carried out intersessionally through short online informative sessions, which the Secretariat could help to organize.

50. The WPM **NOTED** the request from WPB for the MSE results to refer in particular the status of the South West area of the stock. This is usually considered to be more heavily exploited and under greater risk of overexploitation. The WPM **NOTED** that the OM currently developed does not consider the spatial dynamics that would be required to provide precise measures of stock status on a single area as sufficient data on movement for this stock is lacking. The WPM **ENCOURAGED** the swordfish MSE developers to consider any possible way such metrics, even if approximate, could be generated.

51. The WPM **REQUESTED** the swordfish MSE developers to obtain from WPB a range of possible scenarios of implementation error for this stock and fisheries.

8. YELLOWFIN TUNA MSE: UPDATE

8.1 Review of the progress on development new Operating Models based on 2021 YFT stock assessment

52. The WPM **NOTED** paper IOTC–2021–WPM12–13: Indian Ocean yellowfin tuna management procedure evaluation update. The following abstract was provided by the authors:

> "*• No updates to the IOTC yellowfin Management Procedure (MP) evaluation project have been undertaken since the last WPM given problems in the current Operating Model (OM) which are closely associated with the problems encountered in the yellowfin stock assessment model.*
>
> *• The TCMP (June 2021) agreed to defer discussions on the yellowfin MP evaluation given the updated yellowfin stock assessment due in 2021 which should provide the basis for the updated OM for yellowfin.*
>
> *• Phase 3 of the current yellowfin tuna MP evaluation project ended in June 2021, and funding has been secured from the Australian Department of Foreign Affairs and Trade for the next phase of the yellowfin MP evaluation to June 2023.*
>
> *• To enable progress during the next phase of this project, options to progress the development of the yellowfin tuna OM, given the possible outcomes from the 2021 yellowfin stock assessment are defined.*"

53. The WPM **NOTED** that no new results were presented because the problems with the stock assessment in recent years had not been resolved prior to this meeting, including catch removal issues with the projections which caused similar problems in the OM and diminished the plausibility of the OMs.

8.2 Feedback on MSE OM development

54. The WPM **NOTED** that there are two options for the next steps: 1) If the 2021 stock assessment is endorsed by the Scientific Committee, and there are no obvious issues in the projections that appear likely to manifest in the OMs, then the OMs will be reconditioned and the candidate MP testing will resume; or 2) if the new assessment is not endorsed by the SC, alternative OM conditioning will be explored to resume the evaluation of candidate MPs.

8.3 Future steps and timeline

55. The WPM **NOTED** paper IOTC–2021–WPM12–14 on a work plan for an Indian Ocean yellowfin tuna close-kin mark-recapture design study. The following abstract was provided by the authors:

> "*Recent stock assessments for Indian Ocean yellowfin tuna have been compromised by ongoing uncertainty in catch estimates, catch per unit effort indices, conventional tagging data, and reliant on assumptions about the spatial structure and connectivity. Close-kin mark-recapture (CKMR) offers a promising alternative for estimating key population parameters, such as absolute spawning biomass, total mortality, and connectivity. A CKMR design study for Indian Ocean yellowfin tuna was recently funded and will conclude with the delivery of statistically evaluated design for the implementation of a basin-scale CKMR project. This working paper briefly outlines the work plan and specific issues that will be considered in the design study, including the key research questions, population structure, biological parameters, and sampling design.*" – See paper for full abstract.

56. The WPM **NOTED** that a new study design is being completed to assess the feasibility of conducting Close Kin Mark Recapture (CKMR) to improve the assessment and management of Yellowfin tuna. The WPM supported the proposed approach but discussed a range of issues that the project would need to account for.

57. The WPM **NOTED** the priority research questions discussed in the paper and the capacity of CKMR to help reduce the many uncertainties inherent to the yellowfin stock assessment, by providing fisheries independent estimates of spawning biomass over time, natural mortality and stock connectivity. The WPM did not identify additional priority research questions

58. The WPM **NOTED** that the design project will focus on evaluating and costing alternative sampling designs that enable the identification of both half-sibling pairs and parent-offspring pairs across multiple years. This approach will provide information on the trend in absolute abundance, in addition to providing estimates of adult mortality and connectivity.

59. The WPM **NOTED** that an estimated total of 64,000 – 128,000 fish (adults + juveniles) would need to be sampled to provide the required number of kin pairs to estimate adult biomass with a precision of about 15%. The samples are expected to be collected within a time span of 4 to 5 years.

60. The WPM **NOTED** that while a large number of fisheries are involved in the Indian Ocean and sampling onboard many of them could be difficult, there is also the possibility to collect samples in port. Nonetheless, getting sufficient sampling coverage will be a significant challenge and the project proponents will need to establish sampling partnerships with CPCs early in the project, and examine the spatial and size-based catch data from the Secretariat to inform sampling design.

61. The WPM **NOTED** that there are no specific fish condition requirements (dead, live, frozen, etc.) for CKMR samples as only the tissue sample needs to be taken. The WPM **NOTED** that experiments are being carried out in the Pacific to evaluate the efficacy of different sampling strategies to maintain tissue sample quality and minimise contamination for the extraction of the DNA.

62. The WPM **NOTED** that the misidentification of species would not be a problem in the proposed CKMR study because a thorough identification would be made early after the collection of the tissue samples.

63. The WPM **NOTED** that some separate research is being undertaken to explore if FAD associated catch data can inform indices of juvenile abundance and the potential of this work to link in with the CKMR research.

64. The WPM **NOTED** the CKMR design will include a cost-benefit analysis component to assess the feasibility of the program. It will also develop a population model to assess the precision of the parameter estimates based on the number of samples.

65. The WPM **NOTED** paper IOTC–2021–WPM12–15 which provided information on Model-based estimates of Length composition time series for Indian Ocean yellowfin tuna fisheries. The following abstract was provided by the authors:

> *"This report presents model-based estimates of length compositions using a Bayesian Dirichlet- Multinomial (DM) model. The DM model was applied to the commercial catch samples to derive time series of length distributions for the Indian Ocean yellowfin tuna for the Longline and handline fisheries. The model incorporated spatial variability in the population length distributions at 5x5 longitude latitude (the level of reporting) while accounting for sampling errors amongst fleet and seasonal strata. The results suggested the DM model can be a potentially useful method to provide standardized length composition input for the IOTC stock assessments. However further work is required to better disaggregate and quantify various sources of uncertainty in the commercial length samples".*

66. The WPM **NOTED** the model-based approach uses statistical methods to attribute and account for different sources of variability in the length samples, as opposed to the designed-based method, which is based on stratified-sampling methodology.

67. The WPM **NOTED** that due to the complexity of the fisheries setup, this approach was not implemented when assessing the yellowfin stock. The WPM **NOTED** that it is more appropriate to examine the method first in stocks with a relatively simple data structure and fleet.

68. The WPM **NOTED** that there are additional methodologies that might be used to explore this issue and that finding a way to address spatial temporal gaps in the length data will be important. The WPM **NOTED** the potential need for additional resources and expertise to further develop this work.

9. GENERAL MSE ISSUES

9.1 General discussion

69. The WPM **ACKNOWLEDGED** the uncertainty surrounding the catch data held by the IOTC Secretariat **NOTING** that data are received aggregated and with little information on how they were produced so it is difficult to estimate how precise these data are. The WPM further **NOTED** that over the years there have likely been changes to the systems within CPCs for collating these data before they are submitted to the Secretariat which contributes to the uncertainty surrounding the precision of these data. The WPM further **ACKNOWLEDGED** that bias could be introduced into the catch data as a result of the estimation process conducted by the Secretariat.

70. The WPM **CONSIDERED** methods for accounting for this uncertainty in the development of MSEs and **SUGGESTED** that the preferred option would be to attempt to quantify the level of uncertainty and incorporate this into the model. The WPM **SUGGESTED** that the WPDCS may be able to provide some guidance for quantifying this level of uncertainty.

9.2 Consideration of reconditioning OMs based on recent stock assessments

71. The WPM **NOTED** paper IOTC–2021–WPM12–16 on Strategies for the conditioning of operating models for IOTC stocks. The following abstract was provided by the authors:

> *"• This paper explores the process of conditioning OMs in the IOTC MSE context. The current suite of MSE evaluation work has used the stock assessment as the basis for the suite of OMs used to test candidate MPs*
>
> *• Given issues arising for at least two of the stocks, we outline what could be done to conditions representative OMs if the stock assessment is not accepted and doesn't form a workable OM basis*
>
> *• This does not mean a suggested change to how OMs have been conditioned previously; it is simply a suggested augmentation to the current suite of OM conditioning methods that can deal with insurmountable stock assessment problems".*

72. The WPM **THANKED** the authors for their presentation.

73. The WPM **DISCUSSED** the issue of 'running out of fish' as discussed in the paper in cases when the OM model is showing very high levels of Fishing mortality which suggests that there are problems in the initial setup of the OM. The WPM **NOTED** that this often leads to issues with the projections in which plausible future catch scenarios are not considered to be possible according to the OM. The WPM **NOTED** that these issues cannot be solved with conditioning alone, the problems with the initial model set up must be solved first. The WPM **NOTED** that this issue has been encountered in yellowfin tuna assessments in the past, and in certain runs of the albacore OM grid.

74. The WPM **CLARIFIED** that a well performing OM should be able to consider known historical catches without any issues which will contribute to distinguish between poorly conditioned models which appear to be 'running out of fish' and models which are simply showing that the stock has a poor status. The WPM further **CLARIFIED** that there should be no issues with using conditioning on an OM if there are no problems in the assessment.

75. The WPM **NOTED** that the conditioning approach presented in this paper would be good to stop the development of OMs from stalling as has happened with yellowfin tuna assessments in the past. The WPM **ENDORSED** this approach as alternative for conditioning OMs when stock assessments are not endorsed by the Scientific Committee.

76. The WPM **NOTED** that it would be ambitious to try to introduce this methodology into the OMs within the next cycle of meetings but that it could be introduced in the future if work is to start on its development for IOTC stocks.

9.3 Consideration of Exceptional Circumstances

77. The WPM **NOTED** paper IOTC–2021–WPM12–17 regarding Consideration of Exceptional Circumstances processes in the IOTC. The following abstract was provided by the authors:

> *"The Working Party on Methods (WPM) 2020 meeting requested intersessional work on the definition of exceptional circumstances. This paper defines types of exceptional circumstances conditions and actions that*

can be considered, and the process adopted in other Regional Fisheries Management Organisations (RFMOs). Draft guidelines for the Provision of Exceptional Circumstances in IOTC are provided for consideration as part of the formulation for adoption of a management procedure (MP). The provisions for exceptional circumstances provide a scientific process for handling any concerns with implementing the MP and provide transparency in Total Allowable Catch (TAC) decision making by the Commission".

78. The WPM **THANKED** the authors for their presentation.

79. The WPM **RECALLED** a request from WPM11 in 2020 for a precise definition of the circumstances under which the MP should not be applied and **NOTED** that this request prompted the presented study.

80. The WPM **NOTED** that rules for exceptional circumstances should be adopted within the overall process of developing MPs to ensure that any exceptional circumstances are covered by rules stating the procedures that should be followed in those cases. The WPM **NOTED** that the presented guidelines are relatively broad so they should be able to handle a wide range of unexpected issues.

81. The WPM **NOTED** that other tuna RFMOs appear to be handling exceptional circumstances in a very similar way and these guidelines are drawn from the experience of other RFMOs.

82. The WPM **RECOMMENDED** that the SC should consider adopting these guidelines (Appendix IV) for dealing with exceptional circumstances while further **NOTING** that these guidelines are a living document and revisions may still be required in the future. The WPM **NOTED** these guidelines should provide a basis for the consideration of exceptional circumstances in future IOTC resolutions on the adoption of management procedures.

9.4 MSE Capacity Building

83. The WPM **NOTED** that MSE capacity building activities are important and have been requested several times by the TCMP but further **NOTED** that due to the Covid-19 pandemic, it is not currently possible to travel to CPCs which may be in need of these activities and it is challenging to effectively deliver such activities online.

84. The WPM **NOTED** that based on discussions at the TCMP, Australia has provided contributions to help to develop the capacity building section of the IOTC website which will include an MSE shiny app which has been tailored for IOTC conditions as well as additional tools to support capacity building initiatives.

85. The WPM **NOTED** that useful tools on MSE are also available for free through the website www.harveststrategies.org.

9.5 Internal and External Peer review

86. The WPM **NOTED** that it is necessary to develop a Terms of Reference for an external review of IOTC processes to be conducted by consultants.

10. JOINT CPUE STANDARDISATION

10.1 Update on the development of the joint CPUE indices.

87. The WPM **NOTED** paper IOTC–2021–WPM12–18 on the Outcomes of joint CPUE analysis which provided the outcomes of a trilateral collaborative study among Japan, Korea and Taiwan,China for producing joint abundance index with longline fisheries data for the tropical tuna species in the Indian Ocean. The following abstract was provided by the authors:

"Three distant-water tuna longline fishing fleets, Japan, Korea and Taiwan,China have started a collaborative study since December 2019 for producing the joint abundance indices using integrated fishery data of these fleets to contribute to the upcoming stock assessments of yellowfin tuna in the Indian Ocean. The intention is to produce reliable indices by increasing the spatial and temporal coverage of fishery data. In this paper, results using data up to 2020 fisheries were provided to update the WPTT on the progress of this activity. As an underlying analysis, a clustering approach was utilized to account for the inter-annual changes of the target in each fishery in each region. For this purpose, a hierarchical clustering method with "fastcluster" was used, and the outputs of the finalized cluster were then used to assign the cluster label on fishery target to each catch-effort data. For standardizing the catch-per-unit-effort data, the conventional

linear models and delta-lognormal linear models were employed for data of monthly and 1° grid resolution in each region. In addition to the implicit target species through the clustering, geographical and temporal covariates were used in the regression structures. The models were diagnosed by the standard residual plots and influence analysis."

88. The WPM **THANKED** and **CONGRATULATED** the authors for the work which relies on the sharing of fisheries data available from the main longline fisheries of the Indian Ocean and has proven to be essential for deriving abundance indices for albacore, yellowfin tuna, and bigeye tuna.

89. The WPM **NOTED** that the study was based on data aggregated by month and 1-degree grid areas made available to the chair of the trilateral joint CPUE group as operational data are considered business confidential data that can only be shared at in-person meetings within an intranet system and through a non-disclosure agreement.

90. The WPM **NOTED** with some concern that operational data include more information than aggregated data although the impact of using those latter on the accuracy and precision of the standardised CPUE and results of the stock assessment model has not been quantified.

91. The WPM **NOTED** that data covering the period 2005-2020 were considered in the CPUE analysis for longline fisheries from Taiwan,China, as some issues of data quality have been identified in previous analyses for the data available prior to 2005.

92. The WPM **NOTED** that the authors considered two distinct criteria for the selection of fishing vessels: (i) at least 20 catch/effort aggregated information in the strata considered for the study (i.e., year, month, 1-degree grid area and cluster) and (ii) the top 50% of the vessels in terms of effort exerted, further **NOTING** that these different screening methods did not have any influence on the results.

93. The WPM **NOTED** that targeting was modelled either as the category of cluster (derived from the composition of the catch with the R package fastcluster) or the class of average number of hooks between floats (HBF), further **NOTING** that the standardized CPUEs in the tropical region (areas R1 and R4) showed very similar temporal trends over the whole period although the relative scale over time was slightly different.

94. The WPM **NOTED** that the decreasing patterns in CPUE were overall similar with the results of the standardisation process conducted for the 2018 stock assessment of yellowfin tuna, although with some variability.

95. The WPM **NOTED** the apparent larger declines in the new quarterly indices estimated for the regions 1, 3, and 4, especially in the early years, when compared to the previous indices, **ACKNOWLEDGING** that the differences are difficult to explain in absence of the operational data.

96. The WPM **NOTED** that there was little information from the aggregated data for region R3 (south-east Indian Ocean) and that a delta-lognormal approach was also performed for this region but did not improve the results.

97. The WPM **NOTED** that the authors aim to use a more complex spatio-temporal statistical approach (Vector Autoregressive Spatio-Temporal - VAST) to better account for spatio-temporal changes and size categories in the CPUE in future work and **ENCOURAGED** the authors to report the results to the WPM when they become available.

10.2 Future Workplan.

98. The WPM **NOTED** paper IOTC–2021–WPM12–19 on Rethinking a science-based management of Fishing Aggregating Devices (FADs). The following abstract was provided by the authors:

"The use of drifting FADs by industrial purse seiners raises a number of concerns regarding their impacts on tuna populations, FAD-associated ETP species, as well as on pelagic and coastal habitats due to beaching and marine pollution. This paper discusses a science-based approach for the management of FAD fisheries, relying on indicators and operating models that can be used to support management decisions, predicting and quantifying the effects of increasing number of FADs on tropical tuna and marine ecosystems"

99. The WPM **THANKED** the authors for the presentation which aims to address some of the questions of science-based management of FADs raised during the WGFAD02.

100. The WPM **NOTED** the list of potential indicators proposed to monitor the extent and effects of FADs at three levels: (i) tuna populations (e.g., catches of juveniles of yellowfin and bigeye tuna in association with FADs), (ii) bycatch and ETP species (e.g., total bycatch), and (iii) habitat (e.g., number of FADs beachings).

101. The WPM **NOTED** that the level of entanglement of sharks and other species does not seem to be a pertinent indicator as all FADs deployed at sea should be made of non-entangling materials without netting as per IOTC Res. 19/02.

102. The WPM **NOTED** the interest of developing operating models of FOB trajectories, tuna population dynamics and FOB association dynamics to capture the main effects of FAD-management actions on tropical tuna and marine ecosystems, e.g., to assess changes in tuna catchability as a function of FAD numbers.

103. The WPM **NOTED** that the OMs developed for the three tropical tunas species could be set up to represent fisheries described by different gear selectivity to test different options with regards to the catch of juveniles (e.g., juvenile catch by gears) but for this clear management objectives and share between gears should be established the Commission; however, management option currently considered by the Commission is based on a total TAC while discussions on allocation criteria are still ongoing.

104. The WPM **NOTED** that the questions of purse seine fishing effort and mortality of juveniles of tuna will be addressed and discussed at the WPTT23(AS) based on the results of the 2021 stock assessment of yellowfin tuna.

11. STOCK STATUS GUIDANCE

11.1 Review the approach used to provide stock status and management advice relative to reference points

105. The WPM **NOTED** that the document prepared by the ad-hoc Working Group on Reference points was presented to the TCMP in 2021 but further **NOTED** that little feedback was received on this document and limited progress has been made since the TCMP was held in June.

106. The WPM **NOTED** the request from the TCMP for the WPM and the ad-hoc References Point Working Group to continue to have discussions in order to provide advice on the most suitable and robust types of reference points to be used for stock status determination.

12. WPM PROGRAM OF WORK

12.1 Revision of the WPM Program of work (2022–2026)

107. The WPM **NOTED** paper IOTC–2021–WPM12–20 on a Schedule of work for the development of management procedures for key species in the IOTC Area. The following abstract was provided by the authors:

> *"At its 21st Session in 2017, the Commission adopted the 'Schedule of work for the development of management procedures for key species in the IOTC Area' (the Schedule). In the period since, substantial progress has been made to develop management procedures, ranging from early MSE work for swordfish to the consideration of a draft management procedure measure for yellowfin tuna. At its 25th Session in 2021, the Commission endorsed a request by the Technical Committee on Management Procedures (TCMP) that the Scientific Committee develop a revised work plan for Management Procedure development. This proposed update to the Schedule fulfils this request and is presented for the consideration of relevant scientific working parties and the Scientific Committee in 2021. Based on feedback from the scientific bodies, the update will be revised and submitted for consideration by the TCMP and endorsement by the Commission at their 2022 sessions."*

108. The WPM **WELCOMED** the revised workplan and **THANKED** the authors for providing this plan to guide the future MSE work in the IOTC.

109. The WPM **NOTED** that the schedule is still ambitious but that the technical work could, in principle, be completed within the proposed timeframes with minor adjustments. The MSE schedule is included in Appendix V. The WPM **RECOMMENDED** that the SC consider the revised timetable and endorse it for consideration by the Commission.

110. The WPM **NOTED** that this timetable would be a "living document" and additional revisions or changes should be expected based on future developments.

111. The WPM **NOTED** paper IOTC–2021–WPM12–07 presenting the draft WPM Programme of Work (2022–2026).

112. The WPM **RECALLED** that the SC, at its 17th Session, made the following request to its working parties:

> "*The SC **REQUESTED** that during the 2015 Working Party meetings, each group not only develop a Draft Program of Work for the next five years containing low, medium and high priority projects, but that all High Priority projects are ranked. The intention is that the SC would then be able to review the*

rankings and develop a consolidated list of the highest priority projects to meet the needs of the Commission. Where possible, budget estimates should be determined, as well as the identification of potential funding sources." (SC17, Para. 178)

113. The WPM **REQUESTED** that the Chairperson and Vice-Chairperson of the WPM, in consultation with the IOTC Secretariat, develop Terms of Reference (ToR) for each of the projects detailed on the WPM Programme of Work (2022–2026) that are yet to be funded, for circulation to potential funding bodies.

114. The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2022–2026), as provided in Appendix VI.

115. The WPM reviewed the progress of the MSE work conducted to date, and subject to the comments held in this report, endorsed the MSE conducted thus far and **REQUESTED** additional work to address the reviewed comments made.

13. OTHER BUSINESS

13.1 Date and place of the 13th and 14th sessions of the WPM

116. The WPM **NOTED** that the global Covid-19 pandemic has complicated international travel and with no clear end to the pandemic in sight, it was not possible to finalise arrangements for the meeting in 2022. The Secretariat will continue to liaise with CPCs to determine their interest in hosting these meetings in the future when this becomes feasible. The WPM **RECOMMENDED** the SC consider mid October 2022 as a preferred time period to hold the WPM13. As usual it was also **AGREED** that this meeting should continue to be held back-to-back with the WPTT, with the WPM taking place before the WPTT.

117. The WPM also **NOTED** the MSE task force meeting to be held in 2022 should continue take place. If physical meetings are still not possible, this meeting should take place virtually. The WPM **AGREED** that this task force meeting is crucial for providing technical feedback to the TCMP.

13.2 Development of priorities for Invited Expert(s) at the next WPM meeting

118. Given the importance of external peer review, the WPM **RECOMMENDED** that the Commission continues to allocate sufficient budget for a regular invited expert to be invited to meetings of the WPM.

119. The WPM **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPM in 2022, by an Invited Expert(s):

- **Expertise**: Management Strategy Evaluation.

13.3 Election of a Chairperson and Vice-Chairperson for the next biennium

Chairperson

120. The WPM **NOTED** that the first term of the current Chairperson, Dr Hilario Murua (ISSF) expired at the close of the WPM12 meeting and, as per the IOTC Rules of Procedure, participants are required to elect a new Chairperson of the WPM for the next biennium.

121. **NOTING** the Rules of Procedure, the WPM **CALLED** for nominations for the position of Chairperson of the IOTC WPM for the next biennium. Dr Murua was nominated, seconded and re-elected as Chairperson of the WPM for the next biennium.

Vice-Chairperson

122. The WPB **NOTED** that the first term of the current Vice-Chairperson, Daniela Rosa (EU) expired at the close of the WPM12 meeting and, as per the IOTC Rules of Procedure, participants are required to elected a new Vice-Chairperson of the WPM for the next biennium.

123. Ms. Rosa expressed her regret that she would not be able to continue as Vice-Chairperson of the WPM for the next biennium. **NOTING** the Rules of Procedure, the WPM **CALLED** for nominations for the position of Vice-Chairperson of the IOTC WPM for the next biennium. No nominations were received and therefore the position is currently vacant.

13.4Review of the draft, and adoption of the Report of the 12th Session of the WPM

124. The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM12, provided in Appendix VII.

125. The WPM **THANKED** the Chair for his excellent running of the meeting as well as his contributions to the intersessional work conducted to expedite the MSE of the Indian Ocean stocks.

126. The Chair **THANKED** all the participants for their dedicated discussion during the session. The Chair also expressed his appreciation to the rapporteurs and Secretariat for their hard work.

127. The report of the 12th Session of the Working Party on Methods (IOTC–2021–WPM12–R) was **ADOPTED** via correspondence.

APPENDIX I
LIST OF PARTICIPANTS

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APPENDIX II
MEETING AGENDA

Date: 18-20 October 2021
Location: Online
Venue: Microsoft Teams
Time: 12:00 – 16:00 (Seychelles time) daily
Chairperson: Dr. Hilario Murua; **Vice-Chairperson**: Daniela Rosa

1. **OPENING OF THE MEETING** (Chairperson)
2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chairperson)
3. **THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS**
   - 3.1 Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)
   - 3.2 Outcomes of the 4th Session of the Technical Committee on Management Procedures (IOTC Secretariat)
   - 3.3 Outcomes of the 25th Session of the Commission (IOTC Secretariat)
   - 3.4 Review of Conservation and Management Measures relevant to the WPM (IOTC Secretariat)
   - 3.5 Progress on the recommendations of WPM11 (IOTC Secretariat and Chairperson)
   - 3.6 Review of intersessional meetings related to the IOTC MSE process (Chairperson)
     - 2021 MSE Task Force Meeting
4. **ALBACORE MSE: UPDATE** (Developers)
   - 4.1 Review of the progress on development new Operating Models based on 2019 ALB stock assessment
   - 4.2 Feedback on MSE OM development
   - 4.3 Future steps and timeline
5. **SKIPJACK TUNA MSE: UPDATE** (Developers)
   - 5.1 Progress on the development of Skipjack MSE/MP
   - 5.2 Review of OM and MP development
   - 5.3 Discussion on MSE development
   - 5.4 Future steps and timeline
6. **BIGEYE TUNA TUNA MSE: UPDATE (Developers)**
   - 6.1 Review of Operating Models based on WPM, SC feedback, and latest stock assessment results
   - 6.2 Revision of Management Procedures and Performance Indicators
   - 6.3 Evaluation of new set of Management Procedures
7. **SWORDFISH MSE: UPDATE** (Developers)
   - 7.1 Progress on the development of Swordfish MSE/MP
   - 7.2 Review the conditioning of Operating Models based on 2020 Stock assessment
   - 7.3 Discussion on MSE development
8. **YELLOWFIN TUNA TUNA MSE: UPDATE** (Developers)
   - 8.1 Review of the progress on development new Operating Models based on 2021 YFT stock assessment
   - 8.2 Feedback on MSE OM development
   - 8.3 Future steps and timeline
9. **GENERAL MSE ISSUES** (Chairperson and Vice-chairperson)
   - 9.1 General discussion (e.g. catch uncertainty)
   - 9.2 Consideration of reconditioning OMs based on recent stock assessments
   - 9.3 Consideration of Exceptional Circumstances

9.4 MSE capacity building
9.5 Internal and External Peer review

10. JOINT CPUE STANDARDISATION (Chairperson and Consultant)
10.1 Update on the development of the joint CPUE indices for 2021 & 2020.
10.2 Future workplan

11. STOCK STATUS GUIDANCE (Chairperson and Vice-chairperson)
11.1 Review the approach used to provide stock status and management advice relative to reference points

12. WPM PROGRAM OF WORK (Chairperson and IOTC Secretariat)
12.1 Revision of the timeline of the MSE development
12.2 Revision of the WPM Program of Work (2022–2026) and research priorities

13. OTHER BUSINESS
13.1. Date and place of the 13th and 14th Sessions of the WPM (Chairperson and IOTC Secretariat)
13.2. Development of priorities for Invited Expert(s) at the next WPM meeting (Chairperson)
13.3. Election of a Chairperson and Vice-Chairperson for the next biennium (IOTC Secretariat)
13.4. Review of the draft, and adoption of the Report of the 12th Session of the WPM (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC–2021–WPM12–01a	Agenda of the 12th Working Party on Methods
IOTC–2021–WPM12–01b	Annotated agenda of the 12th Working Party on Methods
IOTC–2021–WPM12–02	List of documents of the 12th Working Party on Methods
IOTC–2021–WPM12–03	Outcomes of the 23rd Session of the Scientific Committee (IOTC Secretariat)
IOTC–2021–WPM12–04	Outcomes of the 25th Session of the Commission (IOTC Secretariat)
IOTC–2021–WPM12–05	Review of Conservation and Management Measures relating to methods (IOTC Secretariat)
IOTC–2021–WPM12–06	Progress made on the recommendations and requests of WPM11 and SC23 (IOTC Secretariat)
IOTC–2021–WPM12–07	Revision of the WPM Program of Work (2022–2026) (IOTC Secretariat & Chairpersons)
IOTC–2021–WPM12–08	A new simulation platform for Indian Ocean albacore and swordfish (Mosqueira I)
IOTC–2021–WPM12–09	Update of the Indian Ocean albacore Operating Model (Mosqueira I)
IOTC–2021–WPM12–10	Evaluation of empirical control rules for Indian Ocean Skipjack (Edwards C)
IOTC–2021–WPM12–11	Indian Ocean Bigeye Tuna Management Procedure Evaluation Update (Hillary R, Williams A, Preece A and Jumppanen)
IOTC–2021–WPM12–12	Update of the Indian Ocean swordfish operating model (Rosa D, Fu D, Coelho R and Mosqueira I)
IOTC–2021–WPM12–13	Indian Ocean yellowfin tuna management procedure evaluation update (Hillary R, Williams A, Preece A and Jumppanen P)
IOTC–2021–WPM12–14	Work plan for an Indian Ocean yellowfin tuna close-kin mark-recapture design study (Williams A, Hillary R and Preece A)
IOTC–2021–WPM12–15	Model-based estimates of Length composition time series for Indian Ocean yellowfin tuna fisheries (Fu D)
IOTC–2021–WPM12–16	Strategies for the conditioning of operating models for IOTC stocks (Edwards C, Hillary R, Mosqueira I, Preece A, Rosa D and Williams A)
IOTC–2021–WPM12–17	Consideration of Exceptional Circumstances processes in the IOTC (Preece A, Williams A, Hillary R)
IOTC–2021–WPM12–18	Updated report of trilateral collaborative study among Japan, Korea and Taiwan for producing joint abundance indices for the yellowfin tunas in the Indian Ocean using longline fisheries data up to 2020 (Kitakado T et al.)
IOTC–2021–WPM12–19	Rethinking a science-based management of FADs (Capello M et al.)
IOTC–2021–WPM12–20	Schedule of work for the development of management procedures for key species in the IOTC Area – UPDATE (Australia)
IOTC-2021-WPM12(MSE)-R	Report of the 12th Session of the IOTC Working Party on Methods Management Strategy Evaluation Task Force (Anon)
IOTC-2021-TCMP04-R	Report of the 4th Session of the Technical Committee on Management Procedures

APPENDIX IV

GUIDELINES FOR THE PROVISIONS OF EXCEPTIONAL CIRCUMSTANCES FOR IOTC SPECIES MPS

[*This is a living document with generic guidelines that could apply for any MP adopted and implemented by the IOTC.]*

When a Management Procedure (MP) is adopted, a set of checks are essential to ensure that unexpected events do not result in MP advice that is risky for the stock and fisheries. These checks are part of these guidelines that provide a structure for providing management advice when there are concerns about implementing an MP. The guidelines provide a scientific process for developing appropriate management responses to exceptional circumstances and, hence, provide transparency in TAC decision making by the Commission.

Exceptional circumstances are defined in the IOTC as "… circumstances (primarily related to future monitoring data falling outside the range covered by Management Strategy Evaluation (MSE) simulation testing) where overriding of the output from a Management Procedure should be considered…". Exceptional circumstance can include:

- New knowledge about the stock, population dynamics or biology
- Changes in fisheries or fishing operations
- Changes to input data to the MP, or missing data, or
- Inconsistent implementation of the MP advice (e.g. total catch is greater than the Total Allowable Catch (TAC)).

Management responses to exceptional circumstances can include review of additional information or new research, review of the performance of the MP (via reconditioned Operating Models), or management advice to precautionarily revise the TAC. These guidelines provide broad principles to govern the research or management actions to take in such an event.

The process has three stages: 1) determine whether any exceptional circumstances exist, 2) determine the severity and impact of the exceptional circumstances on achieving the objectives of the MP, and 3) if necessary, identify the research or management actions that could be taken by the IOTC.

Stage 1: When an MP is adopted, the IOTC Scientific Committee (SC) will annually review the following items for evidence of exceptional circumstances:

1. Information on the stock, fishing operations, population dynamics parameters, or biology that is outside the range (90% probability interval from MSE projections – or % to be decided by the SC) considered during MSE of the adopted MP.
2. Input data to the MP that are missing, have changed, or outside the range (90% – or % to be decided by the SC) simulated in the MSE.
3. Implementation of the MP that is inconsistent with the MP advice (e.g. total catch is greater than the TAC recommended by the MP).

Stage 2: If there is evidence for exceptional circumstances the SC will review the potential impact and severity on implementation and performance of the MP.

Stage 3: Depending on the impact of the exceptional circumstance, the SC will provide advice on the action required, such as a collection of ancillary data to be reviewed, review of the MP and, if necessary, provide updated management advice (e.g. TAC advice). As a guide, the SC could consider the following:

- If there is a very high potential impact the SC will consider TAC changes. TAC change can be determined by an x% change to the TAC, where the x% is based on an urgently updated assessment and projections and is consistent with meeting the objectives of the MP.

APPENDIX V

SCHEDULE OF WORK FOR THE DEVELOPMENT OF MANAGEMENT PROCEDURES FOR KEY SPECIES IN THE IOTC AREA

A more detailed explanation of the roles of the Working Parties (WPs), Scientific Committee (SC), Technical Committee on Management Procedures (TCMP) and the Commission are provided below

Year	Albacore	Skipjack	Yellowfin	Bigeye	Swordfish
2021	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to the Commission on outcomes from the application of the HCR. Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.
	Commission: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.
	WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.
2022	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs

	against Commission objectives.	against Commission objectives.	against Commission objectives.	against Commission objectives.	against Commission objectives.
	Commission: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission**: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.
	WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Process and application of the adopted MP.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.
2023	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	**TCMP**:	**TCMP**: Provide advice to the Commission on elements of candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.
	Commission: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission:** Consider work and advice from subsidiary bodies. Decision and adoption of an MP.	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.	**Commission**:	**Commission**: Consider work and advice from subsidiary bodies and provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.
	WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.	**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.		**WPs/SC**: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs,
2024	**TCMP**: Provide advice to Commission on elements of	**TCMP**: Provide advice to Commission on elements of	**TCMP**: Provide advice to Commission on elements of		**TCMP**: Provide advice to Commission on elements of

	candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.	candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.		candidate MPs, and any proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.
	Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.	**Commission:** Consider work and advice from subsidiary bodies. Decision and adoption of an MP.	**Commission**: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.		**Commission:** Consider work and advice from subsidiary bodies. Decision and adoption of an MP.

Explanation of roles in the development of candidate Management Procedures

Working Parties and Scientific Committee

The Scientific Committee (SC) and Working Parties (WPs) are responsible for undertaking the technical development of candidate management procedures (MPs), through formal Management Strategy Evaluation (MSE), and providing advice on candidate MPs to the Commission.
The Working Party on Methods (WPM) is the primary WP for the development of candidate MPs, but other WPs, such as the Working Party on Tropical Tuna (WPTT), Working Party on Temperate Tuna (WPTmT) and the Working Party on Billfish (WPB), may also contribute to MP development for relevant species.
'Undertake MSE'

- This involves developing operating models and evaluating the performance of candidate management procedures, which include harvest control rules and the pre-specification of data inputs and analyses, against the Commission's objectives.

'Provide advice on the performance of candidate MPs'

- This involves using the agreed performance statistics and standardised figures and tables to communicate results from MSE. Advice from the SC and WPs to the Commission also includes advice on the appropriateness of limit reference points (LRP) and target reference points (TRP), as required under Resolution 15/10.

Technical Committee on Management Procedures
Resolution 16/09 states that the objectives of the Technical Committee on Management Procedures (TCMP) include to '*Enhance the decision making response of the Commission in relation to management procedures, including recommendations made by the Scientific Committee*' and to '*Enhance communication and foster dialogue and mutual understanding between the Scientific Committee and the Commission on matters relating to management procedures*'.
'Provide advice to Commission'

- This involves assisting the Commission to consider the elements of MPs that require a decision by the Commission, including identifying and evaluating candidate MPs that aim to meet the Commission's objectives.

'On elements of candidate MPs that require a decision by the Commission'

- Elements of the MPs to be considered include the overaching management objectives, target and limit reference points, harvest control rules, and the performance of MPs against management objectives.

Commission
The Commission is ultimately responsible for guiding the MP process and making decisions on the adoption of MPs, drawing on the advice provided by subsidiary bodies.

'Decision and adoption of an MP'

- This involves considering a proposed MP, which may take the form of a conservation and management measure proposed by a Commission member, or endorsement of a candidate MP.

'Consider work and advice from subsidiary bodies'

- This involves the Commission considering advice from the WPs, SC and TCMP on the performance of MPs in achieving the Commission's objectives. In making decisions on adopting MPs, the Commission may also seek advice on compliance and implementation issues from the Compliance Committee.

'Provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs'

- This involves the Commission providing direction to the WPs and the SC on the need to further refine candidate MPs or develop new candidate MPs through formal MSE. This advice will in turn assist the Commission in its consideration and adoption of MPs.

APPENDIX VI
WORKING PARTY ON METHODS PROGRAM OF WORK (2022–2026)

The Program of Work consists of the following, noting that a timeline for implementation would be developed by the SC once it has agreed to the priority projects across all of its Working Parties:

Table 1. Priority topics for obtaining the information necessary to deliver the necessary advice to the Commission. Resolution 15/10 elements have been incorporated as required by the Commission.

Topic	Sub-topic and project	Timing				
		2022	2023	2024	2025	2026
1. Management Strategy Evaluation	Continuation of Management Strategy Evaluation for Albacore, Skipjack, Yellowfin, Bigeye tunas as well as Swordfish					
Future Research Requirements (not in order of priority)						
Management Strategy Evaluation	1.1 Albacore					
	1.1.1 Revision of Operating Models based on WPM and SC feedback, including possible robustness tests					
	1.1.2 Implementation of initial set of simulation runs and results					
	1.1.3 Revision of Management Procedures and Indicators after presentation of initial set to TCMP and Commission					
	1.1.4 External peer review (2022 or date TBD)					
	1.1.5 Evaluation of new set of Management Procedures (if required)					
1.2 Skipjack tuna						

1.2.1 Revision and adaptation of framework for simulation evaluations of MPs. Moving from HCR to fully specified MP.					
1.2.2 Develop revised production model for inclusion in simulation framework					
1.2.3 Condition OM on updated assessment model from 2020.					
1.2.4 Present revised MP results to TCMP with target adoption date of 2023					
1.2.5 Additional iterations if required					
1.3 Bigeye tuna					
1.3.1 Update OM & present preliminary MP results to TCMP, WPTT/WPM review of new OM					
1.3.2 External peer review (2021 or date TBC)					
1.3.3 Present revised MP results to TCMP with target adoption date of 2022					
1.3.4 Additional iterations if required					
1.4 Yellowfin tuna					
1.4.1 Update OM & present preliminary MP results to TCMP, WPTT/WPM review of new OM					
1.4.2 Present revised MP results to TCMP with target adoption date of 2024; iteratively update development if required)					
1.4.3 additional iterations if required					

	1.5 Swordfish					
	1.5.1 Initial OM					
	1.5.2 Conditioning and OM set up					
	1.5.3 Generic MP tests					
	1.5.4 Final Model with MPs					
	1.5.5 External peer review					
Multiple stock status derived from different model structures	3.1 Develop specific guidance for the most appropriate models to be used or how to synthesize the results when multiple stock assessment models are presented. (*see IOTC-2016-WPTT18-R, para.91*)					
Presentation of stock status advice for data limited stocks	2.1 Explore potential methods of presenting stock status advice to managers from a range of data limited scenarios, e.g. through the development of a 'Tier' approach for providing stock status advice, based on the type of indictors used to determine stock status (e.g. CPUE series, stock assessment model)					
Peer Review	External peer review based on Terms of Reference agreed to by the WPM and following the schedule recommended in Appendix V of the WPM12 report.					
Capacity Building	Ongoing development of tools, materials and courses to continue Capacity Building for increasing participation in the MSE process					

Table 2. Management Strategy Evaluation schedule for the IOTC Working Party on Methods (WPM) 2022-2026

Species	2022	2023	2024	2025	2026
Working Party On Methods					
Albacore	Technical Guidance on MSE development				
Skipjack tuna	Technical Guidance on MSE development				
Bigeye tuna	Technical Guidance on MSE development				
Yellowfin tuna	Technical Guidance on MSE development				
Swordfish	Technical Guidance on MSE development				

Note: the assessment schedule may be changed dependant on the annual review of fishery indicators, or SC and Commission requests. ALB: albacore; BET: bigeye tuna; YFT: yellowfin tuna; SKJ: skipjack tuna

APPENDIX VII
CONSOLIDATED RECOMMENDATIONS OF THE 12TH SESSION OF THE WORKING PARTY ON METHODS

Note: Appendix references refer to the Report of the 12th Session of the Working Party on Methods (IOTC–2021–WPM12–R)

Consideration of Exceptional Circumstances

WPM12.01: 82. The WPM **RECOMMENDED** that the SC should consider adopting these guidelines (Appendix IV) for dealing with exceptional circumstances while further **NOTING** that these guidelines are a living document and revisions may still be required in the future. The WPM **NOTED** these guidelines should provide a basis for the consideration of exceptional circumstances in future IOTC resolutions on the adoption of management procedures (Para. 82)

Revision of the WPM Program of work (2022–2026)

WPM12.02: The WPM **NOTED** that the schedule is still ambitious but that the technical work could, in principle, be completed within the proposed timeframes with minor adjustments. The MSE schedule is included are included in Appendix V. The WPM **RECOMMENDED** that the SC consider the revised timetable and endorse it for consideration by the Commission. (Para 109)

WPM12.03: The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2022–2026), as provided in Appendix IV (para. 114).

Date and place of the 13th and 14th sessions of the WPM

WPM12.04: The WPM **NOTED** that the global Covid-19 pandemic has complicated international travel and with no clear end to the pandemic in sight, it was not possible to finalise arrangements for the meeting in 2022. The Secretariat will continue to liaise with CPCs to determine their interest in hosting these meetings in the future when this becomes feasible. The WPM **RECOMMENDED** the SC consider mid October 2022 as a preferred time period to hold the WPM13. As usual it was also **AGREED** that this meeting should continue to be held back-to-back with the WPTT, with the WPM taking place before the WPTT (Para. 116)

Development of priorities for Invited Expert(s) at the next WPM meeting

WPM12.05: Given the importance of external peer review, the WPM **RECOMMENDED** that the Commission continues to allocate sufficient budget for a regular invited expert to be invited to meetings of the WPM (para. 118).

Review of the draft, and adoption of the Report of the 12th Session of the WPM

WPM12.06: The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM12, provided in Appendix VII (para. 124).