

Report of the 10th Session of the IOTC Working Party on Methods

Pasaia, Spain, 17-19 October 2019

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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.
F	Fishing mortality
FAD	Fish aggregating device
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})
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 underlying 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 an 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

1.	Opening of the Meeting.....	9
2.	Adoption of the Agenda and arrangements for the session	9
3.	The IOTC process: Outcomes, updates and progress.....	9
3.1	<i>Outcomes of the 21st Session of the Scientific Committee.....</i>	<i>9</i>
3.2	<i>Outcomes of the 23rd Session of the Commission.....</i>	<i>9</i>
3.3	<i>Review of Conservation and Management Measures relevant to the WPM</i>	<i>10</i>
3.4	<i>Progress on the recommendations of WPM09</i>	<i>11</i>
3.5	<i>Review of intersessional meetings related to the IOTC MSE process.....</i>	<i>11</i>
4.	Albacore MSE: Update	11
5.	Skipjack tuna MSE: Update.....	12
6.	Bigeye tuna and yellowfin tuna MSE: update	12
6.1	<i>Review of Operating Models based on WPM and SC feedback, including possible robustness tests</i>	<i>12</i>
6.2	<i>Revision of Management Procedures and Indicators</i>	<i>14</i>
6.3	<i>Evaluation of new set of Management Procedures</i>	<i>15</i>
7.	Swordfish MSE: update.....	15
7.1	<i>Generic Management Procedures.....</i>	<i>15</i>
8.	General MSE Issues	16
9.	Joint CPUE Standardisation	16
9.1	<i>Update on the status of the joint CPUE indices (yellowfin tuna, albacore).</i>	<i>16</i>
10.	Stock Status Guidance	18
10.1	<i>Guidance on most appropriate models – different structures</i>	<i>18</i>
10.2	<i>Review the approach used to provide management advice – relative to reference points</i>	<i>20</i>
10.3	<i>Presentation of stock status advice for data limited stocks.....</i>	<i>20</i>
11.	WPM Program of Work	21
11.1	<i>Revision of the WPM Program of work (2020–2024).....</i>	<i>21</i>
12.	Other business	22
12.1	<i>Date and place of the 11th and 12th sessions of the WPM.....</i>	<i>23</i>
12.2	<i>Development of priorities for Invited Expert(s) at the next WPM meeting.....</i>	<i>23</i>
12.3	<i>Election of a Chairperson and Vice-Chairperson for the next biennium.....</i>	<i>23</i>
12.4	<i>Review of the draft, and adoption of the Report of the 10th Session of the WPM</i>	<i>23</i>
Appendix I List of participants.....		25
Appendix II Meeting Agenda		27
Appendix III List of documents.....		29
Appendix IV Working Party on Methods Program of Work (2020–2024)		31
Appendix V Proposed schedule of work for the development of management procedures for key species in the IOTC Area.....		34
Appendix VI Consolidated recommendations of the 9th Session of the Working Party on Methods		36

EXECUTIVE SUMMARY

The 10th Session of the Indian Ocean Tuna Commission’s (IOTC) Working Party on Methods (WPM) was held at AZTI Tecnalia, Spain 17–19 October 2019. A total of 37 participants (23 in 2018, 28 in 2017 and 29 in 2016) attended the Session. The list of participants is provided in Appendix I. The meeting was opened by the Chairperson, Dr Toshihide Kitakado (Japan) who welcomed participants to Spain.

The following are the recommendations from the WPM10 to the Scientific Committee, which are provided in Appendix VI.

Update on the status of the joint CPUE indices (yellowfin tuna, albacore).

WPM10.01: The WPM **RECOMMENDED** exploring options for regular joint-tRFMO workshops on Joint CPUE Standardization to initially take place in 2020. The options include requesting a workshop through the Kobe Steering Committee, to consider formats such as a CAPAM workshop coordinated by the IATTC, or to directly approach other RFMOs such as ICCAT and the IATTC. (para.72).

Revision of the WPM Program of work (2020–2024)

WPM10.02: The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2019–2023), as provided in Appendix IV (para. 125).

WPM10.03: 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 **RECOMMENDED** additional work to address the reviewed comments made (para. 126).

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

WPM10.04: 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. 137).

Review of the draft, and adoption of the Report of the 8th Session of the WPM

WPM10.05: The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM10, provided in Appendix V (para. 144).

1. OPENING OF THE MEETING

1. The 10th Session of the Indian Ocean Tuna Commission’s (IOTC) Working Party on Methods (WPM) was held at AZTI Tecnalia, Spain 17–19 October 2019. A total of 37 participants (23 in 2018, 28 in 2017 and 29 in 2016) attended the Session. The list of participants is provided in [Appendix I](#). The meeting was opened by the Chairperson, Dr Toshihide Kitakado (Japan) who welcomed participants to Spain.

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 WPM10 are listed in [Appendix III](#).

3. THE IOTC PROCESS: OUTCOMES, UPDATES AND PROGRESS

3.1 Outcomes of the 21st Session of the Scientific Committee

3. The WPM **NOTED** paper IOTC–2019–WPM10–03 which outlined the main outcomes of the 21st Session of the Scientific Committee (SC21), specifically related to the work of the WPM.
4. The WPM **NOTED** that in 2018, the SC made a number of endorsements and recommendations in relation to the WPM08 report. These are provided below for reference

- **Albacore MSE**

- *Acknowledging that there may be circumstances in which understanding of the productivity of stocks changes markedly, or where management or fleet changes result in large changes to the fishery, the SC REQUESTED that the WPM and MSE working groups discuss the issue of exceptional circumstances in the context of how these influence the validity of operating models, and produce a guideline or protocol and a series of recommendations for the SC’s consideration. The WPM Chairperson agreed to progress this work during 2019.*

- **Skipjack tuna MSE**

- *Noting that the skipjack tuna harvest control rule is not a fully specified management procedure, the SC RECOMMENDED that a workplan and budget should be developed to undertake review and possible revision of the skipjack tuna harvest control rule under Resolution 16/02.*

- **Review of IOTC MSE Process and Methods Meetings**

- *The SC noted the issue of budget/resourcing in terms of the schedule of MSE development but that so far, the budgetary commitment from the Commission has been limited. The SC therefore RECOMMENDED that the Commission allocate additional resources to the MSE work.*

- **Presentation of stock status advice for data limited stocks**

- *The SC noted that funding has been received through an EU grant to conduct work for improving the data-limited methods for WPNT species and that this is due to commence in 2019. The SC welcomed this information and REQUESTED that the WPEB and WPB also be included in the planning and review.*
- *The SC AGREED that work on the presentation of stock status advice for data limited stocks will need to be carried out inter-sessionally, and that this will require some level of preparation and planning. The SC REQUESTED the WPM Chairperson liaise with the Chairs of the WPNT, WPEB and WPB in order to draft a study proposal on this issue*

- **Update on the status of the joint CPUE indices (yellowfin tuna, albacore)**

- *Noting that yellowfin tuna assessment results are sensitive to the target variable in the standardisation, the SC REQUESTED that further joint CPUE analysis should continue to explore and test alternative methods for identifying and accounting for targeting.*

3.2 Outcomes of the 23rd Session of the Commission

5. The WPM **NOTED** paper IOTC–2019–WPM10–04 which outlined the main outcomes of the 23rd Session of the Commission, specifically related to the work of 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.

6. The WPM **NOTED** the 7 Conservation and Management Measures (CMMs) adopted at the 23rd Session of the Commission (consisting of 7 Resolutions and 0 Recommendations) as listed below:

IOTC Resolutions

- Resolution 19/01 *On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC Area of competence.*
 - Resolution 19/02 *Procedures on a fish aggregating devices (FADs) management plan, including a limitation on the number of fads, more detailed specifications of catch reporting from fad sets, and the development of improved fad designs to reduce the incidence of entanglement of non-target species.*
 - Resolution 19/03 *On the conservation of mobulid species caught in association with fisheries in the IOTC Area of Competence.*
 - Resolution 19/04 *Concerning the IOTC Record of Vessels Authorised to operate in the IOTC Area of Competence.*
 - Resolution 19/05 *On a ban on discards of bigeye tuna, skipjack tuna, yellowfin tuna, and non-targeted species caught by purse seine vessels in the IOTC Area of Competence.*
 - Resolution 19/06 *On establishing a programme for transhipment by large-scale fishing vessels.*
 - Resolution 19/07 *On vessel chartering in the IOTC Area of Competence.*
7. The WPM **NOTED** that these Conservation and Management Measures shall become binding 120 days after their distribution to all CPCs. The final versions of the newly agreed CMMs will be made available here in due course: <http://iotc.org/cmms>.
8. The WPM **NOTED** that the Commission also made a number of general comments and requests regarding the recommendations made by the Scientific Committee in 2018, which have relevance for the WPM (details as follows: paragraph numbers refer to the report of the Commission IOTC–2019–S23–R).
- ***Report of the 3rd Session of the Technical Committee on Management Procedures (TCMP03)***
 - *(Para. 66): The Commission NOTED that further work is required on understanding the determination of stock status relative to Reference Points, and endorsed the TCMP request to form an ad-hoc working group to continue to work on this matter intersessionally in preparation for the TCMP in 2020.*
 - *(Para. 67): The Commission NOTED that a range of tuning criteria have been specified by the TCMP for the management procedures of key IOTC stocks (refer to Appendix V of the TCMP03 report). The Commission NOTED the success of the TCMP in engaging discussions on Management Procedures through the use of interactive tools.*
 - *(Para. 68): The Commission AGREED that the TCMP should continue to meet in order to progress its work on management procedure matters and advise the Commission on management procedure-related issues, including MSE. The Commission also AGREED that while the TCMP should continue to educate participants on MSE processes, it should concentrate on advancing the development of Management Procedures for presentation to the Commission. To this end, capacity building should also continue intersessionally, and the Commission REQUESTED the Secretariat to explore possible external sources of funding to undertake this.*
 - *(Para. 69): The Commission NOTED that the management advice arising from the Yellowfin tuna management strategy evaluation was of concern, and if implemented would require major catch reductions to recover the stock. The Commission AGREED that more information on the options to reduce catches was required and REQUESTED the Scientific Committee and the TCMP to investigate the possibility of including an additional parameter, namely the reduction of juvenile catch, in future tunings of the management procedure in order to determine plausible ranges of juvenile catch reduction. If this parameter proves to be difficult to be included as a tuning criteria, it should be presented as a summary performance statistic. The Commission REQUESTED that the TCMP provide further advice on this issue in 2020.*

3.3 Review of Conservation and Management Measures relevant to the WPM

9. The WPM **NOTED** paper IOTC–2019–WPM10–05 which aimed to encourage participants at the WPM10 to review some of the existing Conservation and Management Measures (CMM) relevant to the WPM, noting the CMMs referred to in document IOTC–2019–WPM10–04, 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.

3.4 Progress on the recommendations of WPM09

10. The WPM **NOTED** paper IOTC-2019-WPM10-06 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 WPM10 as appropriate given any progress.

3.5 Review of intersessional meetings related to the IOTC MSE process

11. The WPM **NOTED** the presentation of the report of the 8th MSE workshop of IOTC WPM scientists that took place in Ispra, Italy from 19-22 March 2019 (IOTC-2019-WPM10-INF01).
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.
13. The WPM **NOTED** that Instituto Português do Mar e da Atmosfera (IPMA) had offered to host the next meeting of the MSE workshop of the IOTC WPM in Olhao, Portugal in March 2020.

4. ALBACORE MSE: UPDATE

14. The WPM **NOTED** a presentation on the update of the albacore MSE work. This work was based on a document presented to the TCMP03 in June 2019 (IOTC-2019-TCMP03-09) and included the following abstract provided by the author

“An evaluation of Management Procedures (MPs) for Indian Ocean albacore tuna is being carried out. The analysis attempts to simulation-test a full MP, consisting on data collection, an specified mechanism to evaluate stock status and/or trends, and a decision rule.

 - *The base case Operating Model (OM) for albacore is being developed by the Working Party on Methods (WPM) with input from the Working Party on Temperate Tuna (WPTmT). The current base case is likely to be updated following the new stock assessment for this stock to be carried out by WPTmT in July 2019. This will update the OM to the start of 2018 without the current extension from the 2014 stock status estimates.*
 - *Two types of MPs are being evaluated and presented here. They mainly differ in the method used to assess stock status: trends in the main CPUE series, or a surplus production stock assessment. Both depend on the availability of an index of abundance generated in a similar manner to what is currently being used by WPTmT for the albacore stock assessment. One of them also requires good estimates of total catches from all fleets.*
 - *Further work on this MSE exercise will require financial resources to be made available. Development has so far been funded in kind by the European Commission’s DG MARE and DG JRC, but this is unlikely to continue due to staff changes from July 2019.”*
15. The WPM **NOTED** that the lead modeller was not available to attend the meeting and so the presentation was provided by the WPM chair. The WPM further **NOTED** that the lead modeller is not currently available to continue the development of the Albacore MSE, but were informed that the secretariat is seeking solutions to contract him to continue the work,
16. The WPM chair then provided a summary of the results from the recent albacore stock assessment as described in document IOTC-2019-WPTmT07(AS)-R. The WPM **NOTED** that the assessment differs in both input data, assumptions and results from the last albacore assessment, which has significant implications for the albacore MSE.
17. The WPM **NOTED** that the assessment was sensitive to the weighting of the size information. Although this data was generally given a very low weighting in the model, different weightings were investigated during the assessment process to attempt to address a wide range of uncertainty. The WPM discussed that previous investigations suggest that increasing the weighting of the size data increases the process error in the model and reduces the predictive power. The WPM **ACKNOWLEDGED** that this data provides little information on scaling and perhaps additional analyses such as analysing age-structure data could provide additional insight into the stock status.

18. The WPM **NOTED** that several key assumptions in the 2019 assessment have been changed from the previous assessment. In addition to the weighting of the size data, other changes are the inclusion of a new growth curve as well as a revised joint LL CPUE index and the treatment of this index. The WPM **ACKNOWLEDGED** that these changes may require a reconditioning of the albacore Operating Model.
19. The WPM **DISCUSSED** that a two-step MSE process has been suggested at the TCMP for Yellowfin tuna. The first step is to reverse or at least halt the continuous downward trend (one-way downhill trip) in the stock's biomass to provide sufficient contrast for reducing uncertainty about the current stock status in the short term and the second step is to manage the stock given a set of longer term performance criteria. The WPM **NOTED** that a similar approach may be needed for the albacore stock in light of the new assessment results which indicate the albacore stock has moved from the green quadrant of the Kobe plot to the orange quadrant.
20. The WPM **AGREED** that the 2019 albacore stock assessment results fall outside the range of uncertainty captured by the current OM and therefore reconditioning of the OM is required based on the 2019 assessment. The WPM **NOTED** that should the results of the 2019 albacore assessment not be endorsed by the SC, the new OMs may be conditioned in 2020 on an updated assessment.
21. The WPM also **DISCUSSED** the utility of presenting of time varying (dynamic) MSY. It was agreed that this is a generic issue applicable to all species and so will be covered under section 10 below. Another issue common to all species is the lag between when the catch data is received and the MP is implemented (TAC put into effect). This time lag needs to be discussed and resolved for each species.

5. SKIPJACK TUNA MSE: UPDATE

22. The WPM **REVIEWED** the current status of the Skipjack MSE and subsequent Harvest Control Rule (HCR) adopted by the Commission (Res 16/02). The WPM **NOTED** that the first iteration of the HCR was implemented in 2018 subsequent to the 2017 Skipjack Stock Assessment and a Catch Limit was established for 2018-2020. WPM further **NOTED** that Res 16/02 required review and, if necessary, revisions to the HCR by 2021.
23. The WPM **RECALLED** that the SC had endorsed the WPM09 request for the SKJ HCR be developed into a full Management Procedure. The WPM **NOTED** that the Secretariat is in the advanced stages of contracting an expert to develop the SKJ MP using funds from and EU Grant.

6. BIGEYE TUNA AND YELLOWFIN TUNA MSE: UPDATE

6.1 Review of Operating Models based on WPM and SC feedback, including possible robustness tests

24. The WP **NOTED** that the MSE for both species is being pursued in the strict sense of MP in which the MP consists of simulation-tested combination of data collection, analysis methods and HCR (which makes this work different to the SKJ assessment, where no specification on data and analyses methods was made

Yellowfin tuna

25. The WPM **NOTED** paper IOTC–2019–WPM10–09 which provided an update on the IOTC Yellowfin Tuna Operating Model Development. The following abstract was provided by the authors:

“This paper summarizes progress on the development of Operating Models (OMs) for IOTC yellowfin (YFT) tuna, highlighting priorities for technical feedback. A short stand-alone summary document describing the most recent reference set Operating Model (OM) is included at attachment 1. This paper focuses on OM developments since the IOTC MSE Task Force meeting in March 2019 (Kolody and Jumppanen 2019a,b). MP evaluation updates for yellowfin and bigeye tunas are described in Kolody and Jumppanen (2019c). The latest version of the MSE software and technical documentation is publicly available from github <https://github.com/pjumppanen/niMSEIO-BET-YFT/>. (See paper for full abstract)”

26. The WPM **NOTED** that the OM is based on the 2018 yellowfin assessment, modified to remove the environmental indices links and adding random noise to the initial population age structure.
27. The WPM **NOTED** that the OM reference set grid was extended to include 11 uncertainty dimensions. Fractional factorial design was used to reduce the full grid of 4608 models to 1152 models, designed to estimate main effects and all 2 way interactions. All models were subject to a small jitter analysis. The grid was filtered to remove marginal convergence, large catch penalties, and a small number of outlier models with an (annualized aggregate) CPUE RMSE > 0.3. Inspection of fit were applied to retain 420 models in the final reference set. The rejection of models was disproportionate among some of the factor levels.
28. The WPM **NOTED** that the starting parameter values can substantially affect estimates from individual models, but the MP evaluations from the reference set OM ensemble were very similar regardless if the best or worst of the

(converged) models from the jitter analysis were selected. The WPM further noted that an OM derived from filtered main effects fractional factorial design with 49 models yielded very similar MP evaluation results to the larger grid of 420 models.

29. The WPM **NOTED** that the new reference set OM ensemble is more pessimistic than the 2018 model grid.
30. The WPM **NOTED** the additional exploratory analysis to consider alternative model uncertainties including hyperstability/hyperdepletion assumptions in the CPUE indices, and incorporation of PSFS indices, and alternative stock-recruitment assumption. The WPM did not recommend adopting any of these results.
31. The WPM **NOTED** that a new class of model-based MP was developed as part of the MSE, which uses internal projections to achieve the rebuilding target as an asymptote. The new MP appears to be able to resolve the biomass overshooting problem as identified in the TCMP 2019. The WPM **NOTED** some further development on the original Pella-Tomlinson-based MP which resulted in a more robust minimization and also avoids the biomass overshoot problem.
32. The WPM **NOTED** that the TCMP 2019 MP evaluation results mistakenly included a 3-year MP data to implementation lag. The current results were corrected to include the requested 2 year lag, though it was further noted that the draft YFT MP proposal (IOTC-2019-WPM10-10) is currently assuming a 3-year lag.
33. The WPM **NOTED** that MP evaluations were undertaken to identify the minimum possible rebuilding time frames that could be achieved under a range of different TAC change constraints, as requested by TCMP 2013.
34. The WPM **NOTED** the request made by the TCMP regarding the use of non-equilibrium production model MPs requires further clarification.
35. The WPM **NOTED** the request from the Commission to investigate the possibility of including an additional parameter, namely the reduction of juvenile catch, in future tunings of the management procedure in order to determine plausible ranges of juvenile catch reduction. The WPM **NOTED** that it is difficult to incorporate a reduction of fish as a tuning criterion and it is perhaps more appropriate to consider alternative catch allocations in the projections. However, this represents a political decision rather than a scientific problem. the WPM **AGREED** to seek more guidance from the TCMP on to how to proceed on this request
36. The WPM **NOTED** the following points for the next iteration of the YFT MSE:
 - The WPM did not request any modifications to the reference set OM or robustness tests, but noted that the reference set OM will have to be evaluated in relation to the 2019 assessment at the WPTT to see if reconditioning is required. The WPM **REQUESTED** that specific criteria for deciding whether or not reconditioning is required should be developed at the next session of the WPM.
 - Main effects fractional factorial design appears to be adequate for producing consistent MP evaluation results, with a target of 50-150 models in the reference set OM.
 - A standard jitter analysis for every model is probably not necessary, but is likely to reduce the frequency of extreme outliers.
 - Retain the 2 year MP implementation data lag unless advised otherwise by the TCMP.

Bigeye tuna

37. The WPM then **NOTED** paper IOTC-2018-WPM10-08 which provided an update on the IOTC Bigeye Tuna MSE Operating Model Development. The following abstract was provided by the authors:

“IOTC bigeye (BET) Management Strategy Evaluation (MSE) development requests since the 2018 WPTT and WPM were mostly addressed for the IOTC MSE Task Force meeting in Mar 2019 and are documented in a separate information paper (Kolody and Jumppanen 2019a). This paper highlights key changes in the BET reference set OM requested by the IOTC 2019 MSE Task Force meeting and outlines issues to be addressed to progress the bigeye OMs to the next iteration. Issues related to selecting OM ensembles that are relevant to both bigeye and yellowfin are documented in the yellowfin companion paper (Kolody and Jumppanen 2019g). A stand-alone document (attachment 1) summarizes the current state of the bigeye reference set OM as used for MP evaluation in Kolody and Jumppanen (2019c). (See paper for full abstract).”
38. The WPM **NOTED** that the OM for bigeye tuna is based on the reference model of the 2016 assessment model, with key differences in the treatment of CPUE series from the temperate region and assumptions on the initial population structure.
39. The WPM **NOTED** that the reference grid incorporated eight dimensions of structural and parameter uncertainties. The WPM also **NOTED** that the reference grid adopted a fractional factorial design aiming to include only the main effects terms. The fractional factorial design is effective in reducing the size of the grid with a large number

of dimensions while being able to capture most of the uncertainty of the full grid. Previous work on BET, and parallel testing with YFT, indicated that MP evaluations based on the main effects experimental design of 50-100 models were very similar to OMs with an order of magnitude more models. The grid was further reduced on the basis of numerical problems including 1) insufficient convergence (despite repeated attempts in a small jitter analysis), and 2) catch penalties that suggest the models have trouble removing the catch for some age/quarter/region strata. Other diagnostics examined include aggregated indices of fit to the data, recruitment deviation RMSE and trends, none of which identified unacceptable outlier behavior. The WPM suggested the fractional factorial design can be considered for stock assessment grid runs which are often constrained by time.

40. The WPM **NOTED** that the final reference set OM included 500 realizations sampled from the uniformly weighted grid of 94 retained models. The retained models were not balanced with respect to the reference set factors.
41. The WPM **NOTED** that the reference set OM is similar to the previous iteration and is generally optimistic about current stock status and future stock status at current catch levels.
42. The WPM **NOTED** that the distribution of the stock status characteristics (MSY and depletion) across the final reference grid exhibited two modes. These could be smoothed out by adding intermediate grid factor levels, but results from the previous iteration of MP testing suggested that this was probably not going to have a significant effect on MP evaluation performance statistics.
43. The WPM **NOTED** that the attempt to develop an alternative growth curve for the MSE has been unsuccessful as the available otolith ageing data from the eastern Indian Ocean suggested a much faster growth rates for the juveniles than those estimated from the tagging data. The WPM **NOTED** that it is possible that differences may reflect some spatial heterogeneity in growth rates of bigeye tuna in the Indian Ocean, or size-based selectivity from different fisheries.
44. The WPM **NOTED** that the MPs always use the same historical CPUE series, while the OM is conditioned to 8 different series, to represent CPUE standardization uncertainty. Consequently, model predicted CPUE for the projection period may not be consistent with the historical observed CPUE indices. The WPM discussed possible ways to alleviate this discontinuity. To date, the q was re-scaled such that the historical vulnerable biomass and historical CPUE means were equal over the whole time series, which sometimes causes a large discontinuity in the first projection year. An alternative option was proposed in which the rescaling is conducted over the terminal period only. This removes the discontinuity, but may have other consequences. The WPM **AGREED** that the effect of different options for linking the historical CPUE observations used by the MP with the simulated projection CPUE requires further investigation.
45. The WPM **DISCUSSED** whether evaluating the predictive capabilities of models would provide useful criteria for differentially weighting models for inclusion in the OM. The WPM discussed that the hindcasting approach might be one of candidate procedures to address this critical issue, however no decision was reached.
46. The WPM **NOTED** that MP evaluation results were provided that addressed the 2019 TCMP tuning objective requests, and the robustness testing requested by the WPTT/WPM 2018.
47. The WPM **NOTED** that Resources have been identified to support the ongoing bigeye MSE until at least Dec 2020
48. The WPM **NOTED** the following points for the next iteration of the BET MSE:
 - The WPM did not request any modifications to the reference set OM or robustness tests, but noted that the reference set OM will have to be evaluated in relation to the 2019 assessment at the WPTT to see if reconditioning is required. The WPM **REQUESTED** that specific criteria for deciding whether or not reconditioning is required should be developed at the next session of the WPM
 - Main effects fractional factorial design appears to be adequate for producing consistent MP evaluation results, with a target of 50-150 models in the reference set OM.
 - A standard jitter analysis for every model is probably not necessary, but is likely to reduce the frequency of extreme outliers.
 - Retain the 2 year MP implementation data lag unless advised otherwise by the TCMP

6.2 Revision of Management Procedures and Indicators

49. The WPM **NOTED** paper IOTC–2019–WPM10–11 which provided an update on the IOTC Bigeye and Yellowfin Management Procedure Evaluation. The following abstract was provided by the authors:

“This document presents an update of Management Procedure (MP) evaluation results for bigeye and yellowfin tunas since the 2019 IOTC Technical Committee on Management Procedures (TCMP) and Commission meetings, from which we highlight the following points. (See paper for full abstract)”

50. The WPM **NOTED** this paper was presented together with paper IOTC-2019-WPM10-08 and IOTC-2019-WPM10-09 and so the discussions on this paper are captured in the section above.
51. The WPM **THANKED** the authors for the excellent work to-date on the bigeye and yellowfin tuna MSE which has addressed the requests from WPM/WPTT2018 and the 2019 MSE Task Force for the calculations of a reference set OM ensemble.

6.3 Evaluation of new set of Management Procedures

52. The WPM **NOTED** paper IOTC–2019–WPM10–10 which outlined a proposal on a management procedure for yellowfin tuna in the IOTC Area of Competence, including the following abstract provided by the authors:
“This paper summarizes progress on the development of Operating Models (OMs) for IOTC yellowfin (YFT) tuna, highlighting priorities for technical feedback. A short stand-alone summary document describing the most recent reference set Operating Model (OM) is included at attachment 1. This paper focuses on OM developments since the IOTC MSE Task Force meeting in March 2019.”
53. The WPM **ENCOURAGED** the participants to provide further comments to improve the wording of the proposal.

7. SWORDFISH MSE: UPDATE

7.1 Generic Management Procedures

54. The WPM **NOTED** paper IOTC–2019–WPM10–12 which provided updates on the Indian Ocean swordfish management strategy evaluation: initial testing of candidate management procedures. 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 and initial management procedure evaluation. It explores the role of the structural uncertainty in the current stock assessment by means of a grid of SS3 model fits. The current grid results in 2592 alternative population trajectories and productivity estimates. A preliminary analysis was performed to identify clusters from which model runs can be sampled to reduce the number of runs in the OM, five clusters have been proposed. The full OM and a sample of 100 runs from each cluster were explored regarding the effects on several indicators and residual analysis of CPUE indices and stock-recruitment relationship. Projections have been carried out for the subsetted OM, composed of 500 runs. Two candidate MPs are being tested so far, a CPUE-based MP and a model-based MP.”*
55. The WPM **NOTED** that there was uncertainty about the catch included in the operating model. This is similar to the situation for the YFT, BET and ALB operating models.
56. The WPM **NOTED** that in some model runs there are slight departures in the estimated catch from the observed catch, and that this should be investigated by inspecting the catch likelihood from the models to identify any conflicts in obtaining the observed catch.
57. The WPM **NOTED** that it would be useful to apply regional scaling methods to estimate relative biomasses in the four regions.
58. The WPM **NOTED** very high variability in tuning projections outcomes, affecting both estimates of fishing mortality and spawning biomass.
59. The WPM **NOTED** that the operating model includes 4 separate regions with no movement between them. The observed CPUE trends differ among regions, but for the projections a one area model is used (due to a limitation of the FLR modelling tool), and only one CPUE can be used; which assumes for the projections that all areas have the same trend. The WPM **REQUESTED** that the WPB consider how this may affect the results and suggested that it may be useful to focus on one region at a time, such as the southwest where there was more depletion.
60. The WPM **NOTED** that the MSE would benefit from applying joint CPUE standardization methods to swordfish data. This would provide consistent CPUE standardization approaches across all datasets and would also provide better data coverage in all regions.
61. The WPM **NOTED** that the WPB has a swordfish assessment planned for 2020.
62. The WPM **ACKNOWLEDGED** the progress done so far and was informed by the Secretariat that there is funding for continuing this work in 2020.

8. GENERAL MSE ISSUES

63. The WPM **ACKNOWLEDGED** the need to conduct reviews of the MSEs that are currently being undertaken. It was noted that this should take place both internally and externally.
64. The WPM **RECALLED** its discussion on the topic from the 2018 meeting and **NOTED** that some elements of Internal Review have been conducted during the year through collaboration between developers and through the process of review at WPM, WPTT and SC as well as the reviews conducted by the MSE task force meeting. It was suggested that as part of an internal review, a member of the MSE task force Group could install the software used to develop the MSE and conduct some basic checks to ensure there are no fatal errors in the code that would prevent it from running. Thereafter, some basic checks could be carried out, such as changing some of the scenarios and rerunning to ensure no unexpected outcomes are achieved and that the graphic outputs make sense. This would not be a full line by line review of the code, but rather basic checks to make sure there are no obvious errors and that the software does what it is intended to do.
65. The WPM further **NOTED** that External Independent Review has not yet been fully specified or conducted for any of the MSE projects underway.
66. To facilitate both the internal and external reviews the WPM **AGREED** that the development of ToRs for both reviews should be elaborated by the group. A draft document has been created in the MSE Task Force meeting regarding the guidelines for review of Management Strategy Evaluation Simulations (IOTC-2019-WPM10-INF01, Annex: E). The document contained elements relevant for both an internal and external review. The Working Group will continue to discuss how the reviews will proceed once the MSE work is near completion.
67. The WPM **REQUESTED** that the MSE Task Force with the assistance of the WPDCS explore alternative catch history assumptions for both OM conditioning and catch reporting biases in the MSE projections.

9. JOINT CPUE STANDARDISATION

9.1 Update on the status of the joint CPUE indices (yellowfin tuna, albacore).

68. The WPM **NOTED** paper IOTC-2019-WPM10-16 which reported on a collaborative study of bigeye and yellowfin tuna CPUE from multiple Indian Ocean longline fleets in 2019, with consideration of discarding. The following abstract was provided by the authors:
- “In April and May 2019 a collaborative study was conducted between national scientists with expertise in Japanese, Korean, Seychelles, and Taiwanese longline fleets, an independent scientist, and an IOTC scientist. The meetings addressed Terms of Reference covering several important issues related to yellowfin and albacore tuna CPUE indices in the Indian Ocean. The study was funded by the Indian Ocean Tuna Commission (IOTC) and the International Seafood Sustainability Foundation. (See paper for full abstract)”*
69. The WPM **NOTED** that there is limited effect of including discards in the standardized CPUE and that discarding would only be problematic if discarding practices have systematically changed over time. The WPM also **NOTED** discards are only considered for the Taiwanese CPUE, so that effect could be disguised in the joint-standardization model that is fitted across fleets. The WPM **REQUESTED** that the secretariat facilitate further analyses to isolate the discard effect. The WPM further **NOTED** that logbook reported discard rates were lower than might be expected perhaps indicating that clarification is needed regarding the nature of what is defined in the discards and the need for comparison with observer data.
70. The WPM **NOTED** that indicative changes in size composition within an area are not explicitly accounted for within Joint-CPUE standardization. The WPM **NOTED** that a detailed review of the quality and trends in size composition data should first be completed to identify whether specific consideration of temporal long-term changes in size is warranted
71. The WPM **NOTED** the importance of supporting and strengthening the current collaborations, and to continue the development of methods for joint-CPUE standardization.
72. The WPM **RECOMMENDED** exploring options for regular joint-tRFMO workshops on Joint CPUE Standardization to initially take place in 2020. The options include requesting a workshop through the Kobe Steering Committee, to consider formats such as a CAPAM workshop coordinated by the IATTC, or to directly approach other RFMOs such as ICCAT and the IATTC.
73. The WPM **NOTED** that the lack of access to the operational level longline CPUE, except during the limited time available for joint meetings between authors, greatly reduces the efficiency of the process, limits the degree of capacity building for participating scientists, and reduces the ability to check results and ensure quality. In the

interest of normalizing the process for producing joint longline CPUE for future assessments, the WPM **REQUESTED** that the Secretariat continue discussions with the affected CPCs to develop a confidential data repository. This repository would be managed either by the IOTC or by some other group acceptable to the interested parties, so as to permit more detailed evaluation of these data as well as assuring the confidentiality of the information.

74. The WPM **SUGGESTED** that it may be useful to remove data from the early period (eg. Prior to 1972) in the CPUE analysis to avoid unduly influencing results with the early hyperdepletion data that remains unexplained, unless the extent of the hyperdepletion is estimated.
75. The WPM **NOTED** paper IOTC–2019–WPM10–14 which provided a study to account for Fishing Days Without Set, Fishing Concentration and Piracy in the CPUE Standardisation of Yellowfin Tuna in Free Schools for the EU Purse Seine Fleet Operating in the Indian Ocean During the 1991-2017 Period. The following abstract was provided by the authors:

“The time series of EU purse seine fleet catches per unit effort (CPUE) of yellowfin tuna (YFT) from the Indian Ocean were standardized using an extension of the Delta-lognormal GLMM to three components. The aim was to depict the trend in abundance for adult YFT observed in free schools (FSC). The originality of this work relied on the inclusion of i) null sets, considered as presence of YFT FSC, ii) fishing days without set, considered as absence of FSC, iii) EU fishing agreement in the exclusive economic zones driving EU purse seine fleet presence in these areas, iv) time spent by centroid cell by boat by day to constrain detectability, v) the Gulland’s index of fishing effort concentration to measure the extent to which a fleet has concentrated its fishing effort in areas with higher than average catch rates and, vi) piracy as a presence absence variable. Standardized CPUE for FSC was thus defined as the product of the number of set (positive and null) by spatio-temporal strata, the proportion of sets with large YFT (>10 kg) and the catch per large YFT set. To detect strata without sets, all activities recorded in captain logbooks were used for the period 1991-2017. This new standardization approach, therefore, represents a significant advance over previous efforts, though there are a number of avenues for future progress.”

76. The WPM **NOTED** that it is important to evaluate the effects of individual covariates on the standardized abundance index. To address this, the WPM **REQUESTED** that the authors include influence plots of covariates should be included as part of the analysis.
77. The WPM **NOTED** that it is important to better understand the implications of including the age of vessels (year of fishing minus the start of service) as a main effect..
78. The WPM **NOTED** that the inclusion of the Gulland index as a predictor variable in the standardization model is not common practice. The WPM **SUGGESTED** further exploring the underlying mechanisms of incorporating the Gulland index as predictor using simulations to ensure that it has the desired properties in estimating the ‘true’ abundance trend.
79. The WPM **NOTED** that spatial covariates are presently not considered in the standardization and **SUGGESTED** to possibly including those in future developments of the standardization approach. The WPM **NOTED** the potential for hyperstability in purse seine free school CPUE given the nature of the search process, whereby vessels may tend to search in areas with higher catch rates.
80. The WPM **NOTED** that the results of the binomial are sensitive to the scaling of the probabilities. The WPM therefore **SUGGESTED** that the authors clarify in the text that they averaged over the fixed values of continuous covariates and factorial levels of categorical variables when making predictions and that the authors should conduct a sensitivity analysis to this methodological choice.
81. The WPM **NOTED** paper IOTC–2019–WPM10–15 which provided a comparative study on CPUE standardization of bigeye tuna in the Indian Ocean using multi-scale fisheries data and environment data. The following abstract was provided by the authors:

*“Environmental, spatial, and temporal variability could impact the relative abundance of highly migratory species. It becomes especially problematic when the variability affect the standardization of CPUE (catch-per-unit-effort) used to assess the status of fish stocks. This paper presents CPUE standardization and model comparison procedures for bigeye tuna (*Thunnus obesus*) in the Indian Ocean based on multi-scale fisheries data and environment data from 2008 to 2015. We used the fisheries datasets from two sources for comparison: (1) the statistical longline datasets published by IOTC Secretariat with monthly catch-and-effort of the 5° or 1° grid; and (2) the survey datasets from the Chinese longline fishery with set by set catch-and-effort data. We calculated multiple marine environmental factors for CPUE standardization models (See paper for full abstract).”*

82. The WPM **AGREED** that the presenter’s proposal to use cell area in the area statistical weighting is preferable to the currently implemented approach of multiplying cell area by the CPUE response. The WPM **NOTED** that this approach is planned for the joint CPUE standardization.
83. The WPM **SUGGESTED** extending the presented analysis by applying Generalized Additive Modelling framework to incorporate non-linear longitude and latitude interactions, which may more efficiently account for confounding effects of environmental predictors with space and time.

10. STOCK STATUS GUIDANCE

10.1 Guidance on most appropriate models – different structures

84. The WPM **NOTED** paper IOTC–2019–WPM10–17 which reported on the application of a multivariate lognormal approach to estimate uncertainty about the stock status and future projections for Indian Ocean Yellowfin tuna. The following abstract was provided by the authors:
- “This paper presents a multivariate lognormal (MVLN) Monte-Carlo approach to produce Kobe phase plots and Kobe II projection matrices for range of fixed catch scenarios from the 2018 Indian Ocean yellowfin tuna reference grid of Stock Synthesis models. First, we present Kobe-phase plots for the current stock status that compare within-model uncertainty estimates for a single reference case model to the structural uncertainty estimates from a reference grid of 24 models. The Kobe phase plot results portrait a more pessimistic stock status for the reference case model (94.3% overfished) compared to the uncertainty grid of 24 Stock Synthesis model configurations (83.9% overfished), which captures a wider range of plausible outcomes along SSB/SSBMSY axis. (See paper for full abstract)”*
85. The WPM **NOTED** that this method will be applied for the YFT and BET assessments in 2019. The author, however asked the WPM for help to assemble a small group of statistically minded scientists to evaluate the set penalty rules that are currently that are intended prevent implausible variance estimates during the projection phase; and to provide feedback on how these can be improved.
86. The WPM **WELCOMED** the approach described, and generally agreed that it looked reasonable and was useful in dealing with many of the challenges related to incorporating the uncertainty around projections from multiple assessment models.
87. The WPM **NOTED** that this approach may be particular useful to apply to small- to medium-sized grids of models, but that it should converge to the same results if larger model grids be utilised, which would make it redundant. The WPM further **NOTED** that although the code had been made generic for producing the Kobe phase plot, it was not generic for the projections that are required to construct the Kobe II Strategy Matrix. Further discussion at the WPTT would be needed to address the specific issues relevant to the BET and YFT assessments.
88. The WPM **NOTED** that this approach has been applied for other species and for tropical tunas in the Atlantic Ocean, which also involved validation against more computational intense MCMC and bootstraps approaches. In this way, it is being scrutinised by different experts and is therefore being validated to some degree.
89. The WPM **NOTED** paper IOTC–2019–WPM10–18 which provided information on recent studies on the population delineation of yellowfin tuna in the Indian Ocean – consideration for stock assessment. The following abstract was provided by the authors:
- “The Indian Ocean yellowfin tuna (YFT) stock assessment by Indian Ocean Tuna Commission (IOTC) is undertaken based on the assumption of a single stock for the entire Indian Ocean. However, molecular studies by Kunal et al. (2013), based on the Mitochondrial DNA D-loop analysis identified three discrete populations of yellowfin tuna in the Indian waters (Northern Arabian Sea, Lakshadweep Islands and rest of Indian Seas). A larger study with samples from all the oceans using whole-genome sequencing in concert with a draft genome assembly also indicated possibility of a distinct yellowfin tuna population in the Arabian Sea in addition to Atlantic and Indo-Pacific populations (Barth et al., 2017). The probable existence of distinct yellowfin populations in the Indian Ocean raises important management considerations for this species, which need to be addressed at the earliest for ensuring sustainability of the species. (See paper for full abstract)”*
90. The WPM **THANKED** the authors for summarising studies on yellowfin tuna stock structure that have been conducted in the Indian Ocean. The WPM **ENCOURAGED** the authors to present this work to future meetings of the WPTT.
91. The WPM **NOTED** that a stock structure project for a variety of IOTC species is currently being finalised although the results from that study were not ready to be presented at the current meeting.

92. The WPM **NOTED** the need to integrate several sources of information such as otolith microchemistry and genetic analysis to obtain a clearer picture of stock structure for yellowfin tuna in the Indian Ocean.
93. The WPM **NOTED** paper IOTC–2019–WPM10–25 which discussed whether Close-Kin Mark Recapture is Feasible for IOTC yellowfin tuna stock assessment. The following abstract was provided by the authors:
- “This paper provides (i) brief consideration of options to collect data for improving the IOTC yellowfin stock assessment, (ii) an introduction to the general concept of Close-Kin Mark Recapture (CKMR) - a reasonably new, but proven fisheries assessment tool (e.g. it has been successfully applied to southern bluefin tuna), and (iii) a rough evaluation of the logistical and economic feasibility of applying this tool to the IOTC yellowfin tuna (YFT) population. (See paper for full abstract)”*
94. The WPM **THANKED** the authors for this interesting study and **AGREED** that this is a novel technique that potentially could avoid several of the problems inherent in the other types of data currently available for stock assessments and the RTTP-IO data. The approach provides information about absolute spawner abundance, total mortality. (which can be partitioned into M and F when coupled with catch at age data), and reproductive success by age/size.
95. The WPM **NOTED** that the methodology has its limitations, and these would need to be addressed through careful sampling design. This technique requires a sufficient number of samples to be collected with a sufficient distribution of sampling throughout the range of the target species. If this sampling is sufficient, it will not only provide information on spawning stock size, but also stock structure information. However, if the sampling is insufficient, key components of the population may not be identified, creating biases in the estimates.
96. The WPM **NOTED** that the sampling would need to be conducted over multiple years. Each sampling event provides information about multiple historical spawning events but the additional of multiple years provides more information on the spawning abundance time series.. The WPM **ACKNOWLEDGED**, however that although the sampling may provide a single (or limited number) of data points, this is crucial in a stock assessment context as it provides a clear scaling factor for an assessment model.
97. The WPM **NOTED** that there could be potential unforeseen biases in the technique due to the link between the genotype and the phenotype. If a genotype is expressed as a phenotype that is more likely to be selected by a fishery (increased catchability), the study could violate assumptions that would be very difficult to identify.
98. The WPM **REQUESTED** that existing methodological studies on CKMR be presented to the WPM so that the technique can be thoroughly reviewed for use in IOTC stocks. Feasibility of the technique for tropical tuna species should be discussed by the WPTT. The WPM was informed that feasibility studies for CKMR have been developed for North Atlantic Bluefin tuna and another in underway for sharks species in the Indian Ocean. These studies may prove useful for guiding the discussions of the WPM.
99. The WPM **NOTED** that the current feasibility study indicates that CKMR could be economically viable (eg. Similar cost to the current IO stock structure project). However, a full design study evaluating all costs and logistical feasibility needs to be undertaken before beginning such an application.
100. The WPM **NOTED** paper IOTC–2019–WPM10–20 which provided a summary of activities of the Indian Ocean yellowfin workplan towards a new stock assessment. The following abstract was provided by the authors:
- “In 2018, a new stock assessment was carried out for Indian Ocean yellowfin using Stock Synthesis III, a fully integrated model that is used for the three tropical tuna stocks in the IOTC (bigeye, yellowfin and skipjack). However, the lack of understanding of stock dynamics due to various uncertainties led the IOTC’s Scientific Committee (SC) to develop a workplan to address these uncertainties in 2019 before providing management advice. The adopted workplan has two main components: uncertainty on data and uncertainty on models, each one of them with a series of specific items. In this document we describe how the tasks of the workplan have been organized and undertaken. The assessments of the three tropical tuna stocks face common problems and complexities in the IOTC and therefore, parts of this workplan could contribute to the harmonization of stock assessment strategies across stocks. In this document we identify areas for improvement that are common to all stocks in the IOTC.”*
101. The WPM **THANKED** the author for his leadership in driving a demanding intersessional programme, including disseminating the information to the interested/cooperating parties and coordinating the responses and feedback. The WPM **NOTED** that this is a good example for future work that needs to be conducted intersessionally in IOTC Scientific working parties.
102. The WPM **NOTED** that one limitation of the process was that information was generally disseminated using email, which was simple initially, but as email threads grew longer it became more complicated to follow the group developments.

103. The WPM **REQUESTED** that the secretariat investigate potential project management solutions to be able to manage initiatives such as that conducted for the YFT assessment but also general document management, file sharing and code/model warehousing.
104. The WPM **NOTED** paper IOTC–2019–WPTT21–50 which provided information on a preliminary assessment of yellowfin tuna in the Indian Ocean using SS3. The following abstract was provided by the authors:
- “This paper presents a preliminary reference model for the assessment of yellowfin tuna (*Thunnus albacares*) using the age and length structured integrated assessment model Stock Synthesis (SS) version 3.30.09. In this document we review the reference model that was used for the 2018 assessment as part of the 2019 workplan for yellowfin. The main features of the new model are a proposal for reducing or removing the influence of tagging data and for a reduced number of areas. The analyses that led to this proposal are explained throughout the document. In brief, the analyses and diagnostics of the model suggest that tagging data and environmental data do not contain enough information to estimate the movement between the 4 areas defined within the model: western-tropical, western-temperate, eastern-tropical and western tropical, and that these data make the model unstable. Therefore, we analyzed and compared three spatial configuration options: two area model defining East and West regions, three area model aggregating regions 3 and 4 of the 2018 model, and a four-area model comparable to the last year reference model but with a different version of (v3.30).” – see document for full abstract.*
105. The WPM **NOTED** that this paper will be discussed in detail during the WPTT21 meeting, but agreed to provide comments on the technical aspects of the models and their evaluation procedures including diagnostics.
106. The WPM **NOTED** that a diagnostic toolbox is being developed to apply to IOTC assessments. This would provide a suite of standard diagnostics that would be very informative to assess model outputs and function. The WPM **AGREED** that this would be a useful tool.
107. The WPM **NOTED** that although not all the proposed diagnostics had been applied to the current YFT assessment, several had been or are in the process of being implemented, such as hindcasting cross validation procedures to evaluate the predictive skill of the model. In addition, one of the collaborators in the modelling activity provided details on additional diagnostics using the toolbox. The WPM **AGREED** that this diagnostic information should be provided as an information document to the WPTT.
108. The WPM **NOTED** that the updated YFT assessment will be very useful in informing the future development of the YFT MSE.

10.2 Review the approach used to provide management advice – relative to reference points

109. The WPM **ENCOURAGED** all Working Parties undertaking assessments to present time varying (dynamic) MSY as this can be very informative especially with regards to capturing changes in fleet dynamics and selectivity.
110. The WPM **DISCUSSED** how best to present this information. One suggestion was to present dynamic MSY in the F and B ratios on the Kobe plots. The WPM **NOTED** that generating this information can be time consuming and not particularly suitable during the restricted time available in stock assessment meetings.
111. Alternatively, the WPM **NOTED** that ICCAT had been presenting a time series of MSY, and this could be a standard figure for IOTC assessments as well. The estimation of the time series would be simpler than including it in the Kobe plots and so this could be a good alternative.
112. The WPM also **ACKNOWLEDGED** that some tuna RFMOs provide fishery impact analyses to show the effect each fleet has on stock status. This could be a useful figure for IOTC stocks as well.

10.3 Presentation of stock status advice for data limited stocks

113. The WPM **NOTED** the request from the SC to investigate alternative stock assessment methods to be used in data-limited situations and for an evaluation of alternative methods of presenting advice from data-limited assessments to managers:

*“The SC **NOTED** the importance of exploring alternative data poor stock assessment methods and **RECOMMENDED** that the Commission allocates funding for work to explore methods based on different data sources, such as catch curve estimation of mortality from length-frequency data. A range of data sources should be explored, including data from observer programmes, the sport fisheries project, and non-state actor (e.g. WWF) projects for suitability”. (SC19, Para. 32)*

*“The SC **RECALLED** the recommendation of the WPNT05 for the SC to request the Working Party on Methods evaluate a proposed alternative methodology for presenting management advice for data poor methods in 2016.*

*The SC **REQUESTED** that the WPM evaluate the possibility of using different colours to distinguish between stocks which have not been assessed (e.g., white) and stocks which have been assessed but the status is considered to be uncertain (e.g., grey)”. (SC19, Para. 33)*

114. The WPM **NOTED** that funding was received to conduct this work, particularly for the WPNT, from an EU grant and that it was completed in early 2019.

11. WPM PROGRAM OF WORK

115. The WPM **NOTED** paper IOTC–2019–WPM10–19 which provided a schedule of work for the development of management procedures for key species in the IOTC Area, including the following abstract 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). The Schedule ran from 2017 to 2020 and during that time 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 23rd Session in 2019, 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 2019. 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 2020 sessions. This updated Schedule outlines the process that will need to be followed and the decisions that need to be made to develop management procedures for key IOTC species (at the stock or fishery level) in the IOTC area of competence. It provides a guide for the IOTC committees and sub-committees, as well as the Commission, to understand their roles and responsibilities in the process of developing and adopting management procedures. It also provides indicative timeframes for this work, which may be subject to change. The schedule of work is intended to continue to be a ‘living’ document that the Commission owns and uses (including updating as required) to catalyse, track and confirm its ongoing commitment to the development of management procedures.”

116. The WPM **NOTED** that this document is a living document providing a proposed plan to guide the work on MPs. The timelines for each species do not preclude an MP being adopted prior to the dates indicated and it acknowledges that unforeseen circumstances can cause delays in the MP development.
117. The WPM **NOTED** that MP adoption would be 2021 for YFT, 2022 for BET, 2023 for ALB and SKJ and no specified date for SWO. (The Proposed timetable is included as Appendix V)
118. The WPM **RECALLED** that Res 16/02 required review and, if necessary, revisions to the HCR by 2021. Due to delays in contracting an expert to conduct the revision of the SKJ HCR, the WPM **AGREED** that 2023 would be a more realistic target to complete this work.
119. The WPM **NOTED** that for YFT, this timeline will need to be reviewed in light of the assessment results in 2019. As with ALB there is a possibility that the new assessment will imply a reconditioning of the operating model, which could delay the proposed dates.
120. The WPM **ACKNOWLEDGED** that for BET, the 2019 assessment may indicate a change in stock status from the last assessment which would also imply reconditioning of the OM also potential changes to the tuning criteria. This will need to be evaluated during the WPTT21 meeting.
121. The WPM **AGREED** that the OMs should not be continuously reconditioned after each updated assessment. The WPM **NOTED** that the assessment process in IOTC is evolving quickly and so in some cases, the existing OMs have not captured the full range of uncertainty or the revised assumptions in the latest assessment models necessitating reconditioning. These developments should continue to be monitored and addressed by the different working parties.

11.1 Revision of the WPM Program of work (2020–2024)

122. The WPM **NOTED** paper IOTC–2019–WPM10–07 presenting the draft WPM Programme of Work (2020–2024).
123. 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)

124. 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 (2020–2024) that are yet to be funded, for circulation to potential funding bodies.
125. The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2020–2024), as provided in [Appendix IV](#).
126. 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 **RECOMMENDED** additional work to address the reviewed comments made.

12. OTHER BUSINESS

127. The WPM **NOTED** paper IOTC–2019–WPM10–21 which provided an update marine fisheries data collection methods in India. The following abstract was provided by the authors:

“The marine fishery data collection in India is accomplished by two methods a). land-based sampling (by Fisheries Departments of State Governments/Union Territories (UT) and the Central Marine Fisheries Research Institute, CMFRI) and b) sea-based exploratory surveys (by Fishery Survey of India, FSI). The CMFRI along with the Fisheries Departments of the coastal States/UTs undertakes regular sampling and estimation of the fish landings from designated landing points throughout the coastline. Besides estimating the fishery landings, studies on biological and socio-economic attributes of fisheries are also carried out by the institute on a regular basis. The Fishery Survey of India (FSI) operates eleven research/survey vessels for collecting the sea truth data on the fish abundance, biology, oceanographic parameters etc. Time series data on landings and effort are used to arrive at estimates on Maximum Sustainable Yield (MSY). For potential yield estimations of highly migratory large pelagics, a proxy of the MSY estimations by Indian Ocean Tuna Commission (IOTC), after incorporating correction factors including productivity and results of fishery independent surveys are used. The methodologies adopted by these different agencies for data collection and reporting are detailed in the present paper.”

128. The WPM **NOTED** that India collects fishery independent longline data through government research cruises that are undertaken on a monthly basis. The WPM noted that these data could be useful in CPUE standardisation, the presenter agreed to explore the possibility of sharing these data with the Scientific Committee.
129. The WPM **NOTED** paper IOTC–2019–WPM10–23 which presented a comparison of Tuna Harvest methods in Iran. The following abstract was provided by the authors:

“Different harvest methods applied to catch tuna species in Iran. These methods are respectively ranked as below: - Gill-net - Long-line - Purse-seine - Trolling Gill-net has a long history in tuna fisheries and has been used since local fishermen exploited dhows. Despite all extension measures applied to modify fishing methods, about 93% of tuna is currently harvested by gillnet fisheries. Long-line fisheries practically has been started about three years ago and has been gradually expanded with steady gillnet decline. Purse-seine fisheries have been also established from almost 30 years ago and each recent year 5 vessels are active in this type of fisheries. Trolling has also used as a tuna fishing method by vessels with less than 3 Mt. during some seasons of year. In current article, catch composition and Catch per unit effort (CPUE) of each method has been compared and with analyzing each method, technical and social considerations are assessed to predict development trends of every single tuna harvest method in Iran.”

130. The WPM **NOTED** the importance of the Iran gillnet data and the CPUEs currently being developed. The WPM encouraged Iran to continue to develop these indices by species for use by the Scientific Committee.
131. The WPM **SUGGESTED** that a more detailed comparative analysis of species composition, bycatch rates and size frequency in gillnet and the emerging longline fishery would be valuable
132. The WPM **NOTED** paper IOTC–2019–WPM10–24 which provided a study on Maximum Sustainable Yield Assessment in Thailand. The following abstract was provided by the authors:

“Since 2015, fisheries management scheme in Thailand has been shifted from open access fishery to limited access fishery aiming to reorganize fisheries in and outside Thai waters with the views to prevent IUU fishing and to preserve aquatic animal resources as a sustainable source of food for humanity. Based on the Royal Ordinance on Fisheries B.E. 2558 (2019), fishing license is issued based on reference point. Currently, maximum sustainable yield (MSY) is used as the reference point for fishing license issuance. The MSY assessment is conducted every year with three groups of species, i.e. demersal fish, pelagic fish, and anchovy,

due to the complexity of tropical multi-species fishery. Then, the total allowable catch (TAC) is determined based on the MSY assessment results. The TAC will be allocated to every single vessel both artisanal and commercial fishing vessels and an amount of TAC is specified in commercial fishing licenses (See paper for full abstract).”

133. The WPM **THANKED** the authors for their interesting presentation and **ENCOURAGED** them to continue to provide information to the IOTC Scientific Committee.

12.1 Date and place of the 11th and 12th sessions of the WPM

134. The WPM **REQUESTED** that the IOTC Secretariat liaise with CPCs intersessionally to determine if they would be willing to host the 11th and 12th sessions of the WPM in conjunction with the WPTT (Table 1.).

Table 1. Draft meeting schedule for the WPM (2020 and 2021)

Meeting	2020			2021		
	No.	Date	Location	No.	Date	Location
Working Party on Methods (WPM)	11 th	Third week in October (3 d) (with WPTT)	Maldives	12 th	Third week in October (3 d) (with WPTT)	TBD

135. The WPM also **NOTED** the informal MSE task force meeting to be held at the Instituto Português do Mar e da Atmosfera (IPMA) in, Faro, Portugal in 2020 (para. 12).

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

136. The WPM **NOTED** that unfortunately no invited expert could attend the WPM10.

137. 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.

138. 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 2020, by an Invited Expert(s):

- **Expertise:** Management Strategy Evaluation.

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

Chairperson

139. The WPM **NOTED** that the second term of the current Chairperson, Dr Toshihide Kitakado, is due to expire at the end of the current WPM meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Chairperson for the next biennium.

140. The WPM **THANKED** Dr Kitakado for his Chairmanship over the past four years and looked forward to his continued engagement in the activities of the WPM in the future.

141. **NOTING** the Rules of Procedure (2014), the WPM **CALLED** for nominations for the newly vacated position of Chairperson of the IOTC WPM. Dr Hilario Murua (ISSF) was nominated, seconded and elected as Chairperson of the WPM for the next biennium.

Vice-Chairperson

142. The WPM **NOTED** that the second term of the current Vice-Chairperson, Dr Iago Mosqueira, is due to expire at the closing of the current WPM meeting and, as per the IOTC Rules of Procedure (2014), participants are required to elect a new Vice-Chairperson for the next biennium.

143. **NOTING** the Rules of Procedure (2014), the WPM **CALLED** for nominations for the position of the Vice Chairperson of the IOTC WPM. Daniela Rosa (EU) was nominated, seconded and elected as Vice-Chairperson of the WPM for the next biennium.

12.4 Review of the draft, and adoption of the Report of the 10th Session of the WPM

144. The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM10, provided in [Appendix VI](#).

145. 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.

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

147. The report of the 10th Session of the Working Party on Methods (IOTC-2019-WPM10-R) was **ADOPTED** on 19th October 2019.

APPENDIX I
LIST OF PARTICIPANTS

Chairperson

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Vice Chairperson

Absent

Other Participants

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APPENDIX II MEETING AGENDA

Date: 17-19 October 2019

Location: San Sebastian, Spain

Venue: AZTI Tecnalia

Time: 09:00 – 17:00 daily

Chairperson: Dr. Toshihide Kitakado; **Vice-Chairperson:** Dr. Iago Mosqueira

- 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 21st Session of the Scientific Committee (IOTC Secretariat)
 - 3.2 Outcomes of the 23rd Session of the Commission (IOTC Secretariat)
 - 3.3 Review of Conservation and Management Measures relevant to the WPM (IOTC Secretariat)
 - 3.4 Progress on the recommendations of WPM09 (IOTC Secretariat and Chairperson)
 - 3.5 Review of intersessional meetings related to the IOTC MSE process (Chairperson)
- 4. ALBACORE MSE: UPDATE** (Vice-Chairperson)
 - 4.1 Review of Operating Models based on WPM and SC feedback, including possible robustness tests
 - 4.2 Review of set of simulation runs and results
 - 4.3 Revision of Management Procedures and Indicators
 - 4.4 Evaluation of new set of Management Procedures
- 5. SKIPJACK TUNA MSE: UPDATE** (Chairperson)
 - 5.1 Review of model implementation and participation in MSE process
- 6. BIGEYE TUNA AND YELLOWFIN TUNA MSE: UPDATE** (Chairperson and Developers)
 - 6.1 Review of Operating Models based on WPM and SC feedback, including possible robustness tests
 - 6.2 Review of set of simulation runs and results
 - 6.3 Revision of Management Procedures and Indicators
 - 6.4 Evaluation of new set of Management Procedures
- 7. SWORDFISH MSE: UPDATE** (Vice-Chairperson and Developers)
 - 7.1 Conditioning of operating models
 - 7.2 Generic Management Procedures
- 8. GENERAL MSE ISSUES** (Chairperson and Vice-chairperson)
 - 8.1 Consideration of Exceptional Circumstances
 - 8.2 Internal and External Peer review
- 9. JOINT CPUE STANDARDISATION** (Chairperson and Consultant)
 - 9.1 Update on the status of the joint CPUE indices (yellowfin tuna, albacore).
- 10. STOCK STATUS GUIDANCE** (Chairperson and Vice-chairperson)
 - 10.1 Guidance on most appropriate models – different structures
 - 10.2 Synthesis of results from multiple model outputs
 - 10.3 Review the approach used to provide management advice – relative to reference points
 - 10.4 Presentation of stock status advice for data limited stocks
- 11. WPM PROGRAM OF WORK** (Chairperson and IOTC Secretariat)
 - 11.1 Revision of the WPM Program of Work (2020–2024)

12. OTHER BUSINESS

- 12.1 Date and place of the 11th and 12th Sessions of the WPM (Chairperson and IOTC Secretariat)
- 12.2 Development of priorities for Invited Expert(s) at the next WPM meeting (Chairperson)
- 12.3 Election of a Chairperson and Vice-Chairperson for the next biennium (IOTC Secretariat)
- 12.4 Review of the draft, and adoption of the Report of the 10th Session of the WPM (Chairperson)

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC-2019-WPM10-01a	Agenda of the 10th Working Party on Methods
IOTC-2019-WPM10-01b	Annotated agenda of the 10th Working Party on Methods
IOTC-2019-WPM10-02	List of documents of the 10th Working Party on Methods
IOTC-2019-WPM10-03	Outcomes of the 21 st Session of the Scientific Committee (IOTC Secretariat)
IOTC-2019-WPM10-04	Outcomes of the 23 rd Session of the Commission (IOTC Secretariat)
IOTC-2019-WPM10-05	Review of Conservation and Management Measures relating to methods (IOTC Secretariat)
IOTC-2019-WPM10-06	Progress made on the recommendations and requests of WPM09 and SC21 (IOTC Secretariat)
IOTC-2019-WPM10-07	Revision of the WPM Program of Work (2020-2024) (IOTC Secretariat & Chairpersons)
IOTC-2019-WPM10-08	Update on IOTC bigeye tuna MSE Operating Model Development October 2019 (Kolody D and Jumppanen)
IOTC-2019-WPM10-09	Update on IOTC yellowfin tuna MSE Operating Model Development October 2019 (Kolody D and Jumppanen)
IOTC-2019-WPM10-10	Proposal on a management procedure for yellowfin tuna in the IOTC Area of Competence (Various)
IOTC-2019-WPM10-11	IOTC Bigeye and Yellowfin Management Procedure Evaluation update Oct2019 (Kolody D and Jumppanen)
IOTC-2019-WPM10-12	Updates on the Indian Ocean swordfish management strategy evaluation: initial testing of candidate management procedures (Rosa D, Mosqueira I, Fu D and Coelho R)
IOTC-2019-WPM10-13	A global review of conceptual and management advice framework in RFMOs (Murua H, Adam S, Merino G, Kitikado T, Williams A and Scott J).
IOTC-2019-WPM10-14	Accounting for Fishing Days Without Set, Fishing Concentration and Piracy in the CPUE Standardisation of Yellowfin Tuna in Free Schools for the EU Purse Seine Fleet Operating in the Indian Ocean During the 1991-2017 Period (Guéry L, Kaplan D, Marsac F, Floch L, Deslias C, Abascal F, Baez J-C and Gaertner D)
IOTC-2019-WPM10-15	A comparative study on CPUE standardization of bigeye tuna in the Indian Ocean using multi-scale fisheries data and environment data (Zhang T, Song L, Yuan H)
IOTC-2019-WPM10-16	Collaborative study of bigeye and yellowfin tuna CPUE from multiple Indian Ocean longline fleets in 2019, with consideration of discarding (Hoyle S et al.)
IOTC-2019-WPM10-17	Application of a multivariate lognormal approach to estimate uncertainty about the stock status and future projections for Indian Ocean Yellowfin tuna (Winker H, Walter J, Cardinale M and Fu D)
IOTC-2019-WPM10-18	Recent studies on the population delineation of yellowfin tuna in the Indian Ocean – consideration for stock assessment (Varghese SP, Mukesh, Pandey S, and Ramalingam L).
IOTC-2019-WPM10-19	Schedule of work for the development of management procedures for key species in the IOTC Area – UPDATE (Australia)
IOTC-2019-WPM10-20	Summary of activities of the Indian Ocean yellowfin workplan towards a new stock assessment (Merino G, Adam S, Kitakado T and Murua H)
IOTC-2019-WPM10-21	Marine fisheries data collection methods in India – an update (Mukesh, Varghese SP, Pandey S, and Ramalingam L).
IOTC-2019-WPM10-22	Problems and issues of conversion of gillnetting fleet of Pakistan to longlining with the aim to reduce bycatch (M Moazzam)
IOTC-2019-WPM10-23	Comparison of Tuna Harvest methods in Iran (Moradi G)
IOTC-2019-WPM10-24	Maximum Sustainable Yield Assessment in Thailand: A Case of Pelagic Fish in the Andaman Sea (Noranarttragoon P).
IOTC-2019-WPM10-25	Is Close-Kin Mark Recapture Feasible for IOTC yellowfin tuna stock assessment? (Kolody D and Bravington M)

Document	Title
IOTC-2019-WPM10-INF01	Report of the 8th Workshop on Management Strategy Evaluation in Working Party on Methods of Indian Ocean Tuna Commission (Anon)
IOTC-2019-WPM10-INF02	Indian Ocean Bigeye Tuna MSE Update March 2019 (Kolody D and Jumppanen)
IOTC-2019-WPM10-INF03	Indian Ocean Yellowfin Tuna MSE Update March 2019 (Kolody D and Jumppanen)

APPENDIX IV
WORKING PARTY ON METHODS PROGRAM OF WORK (2020–2024)

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	Research Priority	Funding Priority	Lead	Timing				
					2020	2021	2022	2023	2024
1. Management Strategy Evaluation	1.1 Albacore	High	2	Consultant					
	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	High	3	Consultant					
	1.2.1 Review of model implementation and participation in MSE process								

<p>1.3 Bigeye tuna</p> <p>1.3.1 Update OM & present preliminary MP results to TCMP, WPTT/WPM review of new OM</p> <p>1.3.2 External peer review (2021 or date TBC)</p> <p>1.3.3 Present revised MP results to TCMP with target adoption date of 2022</p> <p>1.3.4 Additional iterations if required</p>	High	5	Australia (CSIRO)	<table border="1"> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>■</td><td></td><td></td><td></td><td></td></tr> <tr><td>■</td><td>■</td><td>■</td><td></td><td></td></tr> <tr><td></td><td>■</td><td>■</td><td></td><td></td></tr> <tr><td></td><td>■</td><td>■</td><td></td><td></td></tr> </table>						■					■	■	■				■	■				■	■							
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<p>1.4 Yellowfin tuna</p> <p>1.4.1 Update OM & present preliminary MP results to TCMP, WPTT/WPM review of new OM</p> <p>1.4.2 External peer review (2020 or date TBD)</p> <p>1.4.3 Present revised MP results to TCMP with target adoption date of 2021; iteratively update development if required)</p> <p>1.4.4 additional iterations if required</p>	High	4	Australia (CSIRO)	<table border="1"> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>■</td><td></td><td></td><td></td><td></td></tr> <tr><td>■</td><td>■</td><td></td><td></td><td></td></tr> <tr><td></td><td>■</td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td>■</td><td>■</td><td></td></tr> </table>						■					■	■					■						■	■						
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<p>1.5 Swordfish</p> <p>1.5.1 Initial OM</p> <p>1.5.2 Conditioning and OM set up</p> <p>1.5.3 Generic MP tests</p> <p>1.5.4 Final Model with MPs</p> <p>1.5.5 External peer review</p>	High	1	EU/IPMA	<table border="1"> <tr><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td></tr> <tr><td>■</td><td>■</td><td>■</td><td>■</td><td>■</td></tr> <tr><td></td><td>■</td><td>■</td><td>■</td><td>■</td></tr> </table>						■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■
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2. 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 indicators used to determine stock status (e.g. CPUE series, stock assessment model)	Medium	7	Consultant					
3. 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)	Medium	6	Consultant					

APPENDIX V

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

Year	Albacore	Skipjack	Yellowfin	Bigeye	Swordfish
2020	<p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>WPs/SC: Apply harvest control rule (HCR) using results from 2020 stock assessment to calculate total annual catch limit. (Secretariat to advise CPCs of catch limit.)</p> <p>Extend the HCR to develop full candidate MPs and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>
2021	<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>TCMP: Provide advice to the Commission on outcomes from the application of the HCR.</p> <p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.</p>	<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>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.</p> <p>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.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>
2022	<p>TCMP: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an</p>	<p>TCMP: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an</p>		<p>TCMP: Provide advice to Commission on elements of candidate MPs, and any proposed Resolutions for an</p>	<p>TCMP: Provide advice to Commission on elements of candidate MPs, and any</p>

	<p>an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>	<p>MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>		<p>MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.</p>	<p>proposed Resolutions for an MP, that require a decision by the Commission, including the performance of candidate MPs against Commission objectives.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need to undertake further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>
2023	<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.</p>	<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP.</p>			<p>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.</p> <p>Commission: Consider work and advice from subsidiary bodies. Decision and adoption of an MP <u>or</u> provide direction to the WPs/SC on the need for further MSE of candidate or alternative MPs.</p> <p>WPs/SC: Consider recommendations from the Commission and undertake MSE to provide advice on the performance of candidate MPs.</p>

APPENDIX VI
CONSOLIDATED RECOMMENDATIONS OF THE 9TH SESSION OF THE WORKING PARTY ON
METHODS

Note: Appendix references refer to the Report of the 10th Session of the Working Party on Methods (IOTC–2019–WPM10–R)

Update on the status of the joint CPUE indices (yellowfin tuna, albacore).

WPM10.01: The WPM **RECOMMENDED** exploring options for regular joint-tRFMO workshops on Joint CPUE Standardization to initially take place in 2020. The options include requesting a workshop through the Kobe Steering Committee, to consider formats such as a CAPAM workshop coordinated by the IATTC, or to directly approach other RFMOs such as ICCAT and the IATTC. (para.72).

Revision of the WPM Program of work (2020–2024)

WPM10.02: The WPM **RECOMMENDED** that the Scientific Committee consider and endorse the WPM Programme of Work (2019–2023), as provided in Appendix IV (para. 125).

WPM10.03: 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 **RECOMMENDED** additional work to address the reviewed comments made (para. 126).

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

WPM10.04: 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. 137).

Review of the draft, and adoption of the Report of the 8th Session of the WPM

WPM10.05: The WPM **RECOMMENDED** that the Scientific Committee consider the consolidated set of recommendations arising from WPM10, provided in Appendix V (para. 144).