

Report of the 15th Session of the IOTC Working Party on Methods (Management Strategy Evaluation Task Force)

Online, 10 - 13 April 2024

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

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EXECUTIVE SUMMARY

The 15th Session of the Indian Ocean Tuna Commission’s (IOTC) Working Party on Methods Management Strategy Evaluation Task Force (WPM(MSE)) was held online using Zoom from 10 - 13 April 2024. A total of 18 participants attended the Session. The list of participants is provided in [Appendix I](#). The meeting was opened by the Chairperson, Dr Hilario Murua (ISSF) who welcomed participants.

The following are the recommendations from the WPM15 to the Scientific Committee, and key outcomes of the WPM, which are provided in [Appendix VI](#)

WPM(MSE) 15.01: The WPM(MSE) **NOTED** that the BET MP (as per Resolution 22/03) is scheduled to be run in 2024. The WPM **RECOMMENDED** that the secretariat and CSIRO collaborate to run the BET MP and produce a report to the WPM on the recommended TAC for 2026 to 2028. The collaboration in 2024 will facilitate transition of running the BET MP, and transfer of code, to the secretariat (Para 32).

1. OPENING AND ADOPTION OF AGENDA

1. The 15th Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Methods Management Strategy Evaluation Task Force (WPM(MSE)) was held online using Zoom from 10-13 April 2024. A total of 18 participants attended the Session. The list of participants is provided in [Appendix I](#). The meeting was opened by the Chairperson, Dr Hilario Murua (ISSF) who welcomed participants.
2. The WPM(MSE) **ADOPTED** the Agenda provided at [Appendix II](#). The documents presented to the WPM(MSE) are listed in [Appendix III](#).

2. REVIEW OF MP PROCESS IN IOTC

2.1 Review outcomes of COM (S27) in 2023 and TCMP07 in 2024

3. The WPM **NOTED** a presentation by the Chair regarding the updates from the 2023 Session of the Commission (S27) as well as a recap of the deliberations during the 2024 TCMP07. The presentation summarised the information related to MSE found in documents [IOTC-2024-TCMP07-R](#) and [IOTC-2023-S27-R](#).
4. The WPM(MSE) were **INFORMED** that in the Commission report ([IOTC-2023-S27-R](#)):
 - (Para. 76) The Commission **NOTED** the report of the 6th meeting of the Technical Committee on Management Procedures (TCMP) (IOTC-2023-TCMP06-R) and **ENDORSED** the following TCMP recommendation:
 - The TCMP **NOTED** the recommendation by the SC that it is advisable to have focused dialogue with managers on those MSEs which are more advanced such as that for SKJ and SWO. The TCMP therefore **RECOMMENDED** that a virtual TCMP is convened early in 2024 with a special focus on the MSEs for SKJ and SWO, and that it be held back-to-back with the WPM(MSE) meeting.
 - (Para. 77) The Commission **SUPPORTED** the work conducted by the TCMP and its role in providing science-based advice for management. However, the Commission **AGREED** that the dialogue in the TCMP has become too technical and has limited the involvement of managers in recent years, as most of the discussions take place among the technical experts.
 - (Para. 78) The Commission **URGED** the TCMP to continue with capacity building initiatives to facilitate understanding of the process and increase participation by all parties with the aim of managers being better able to contribute to the implementation of the MSE process. The Commission **ACKNOWLEDGED** that an MSE capacity building workshop is planned to be held in September 2023.
 - (Para. 79) The Commission **REQUESTED** the MSE developers to communicate the results of their analyses in a less technical manner and **ENDORSED** the creation of a small working group to discuss and agree on ways to improve communication between the scientists and the managers. This could include modifying the existing templates for presentation of MSE outputs to increase understanding and better meet the needs of the managers.
5. TCMP **NOTED** that important issues were discussed in the TCMP report ([IOTC-2024-TCMP07-R](#)):
 - (Para. 30) TCMP **NOTED** the instability in catches associated with more aggressive tuning targets. It was proposed to exclude the 50% tuning, **NOTING** that a similar decision had been made for the MSE for bigeye tuna and swordfish. However, TCMP **NOTED** that MPs need still be evaluated using the full assessment model grid (currently only half models are included in the OM) and the MP performance may also change if TAC stabilizers are introduced. TCMP **AGREED** to postpone the decision to the TCMP08 meeting in May, pending full results, to allow MP options to be further narrowing down. Furthermore, the TCMP **NOTED** that the MP tuned for 50% of probability of reaching the target was preliminarily evaluated to have achieved a probability of being in the green Kobe quadrant ($B > BMSY$ and $F < FMSY$) of 83% and 85% for Type A MP and Type B MP, respectively.
 - The TCMP found that the qualitative comparisons of multiple MPs against different management objectives (e.g., Type-A, 60% tuning is preferred against the maximum average catch; Type-B, 50% tuning is preferred against the maximum possible catch) in the skipjack MSE are very informative, and **REQUESTED** that the developers produce such qualitative comparisons (with an emphasis on whether the difference is significant)

to summarize MP performance in order to assist managers in making MP selection decisions.

- (Para. 37) The TCMP **NOTED** that the estimator in the Model-based MP is based on a standard Schaefer surplus production model, which assumes MSY occurs at 50% SBO. The TCMP further **NOTED** that this assumption does not align with the underlying 40-10 Hockey stick harvest control rule, as management actions may not be triggered when the stock falls below BMSY. It was pointed out that the discrepancy might not be important since the estimator serves to provide inputs to the HCR and it is subject to testing. Nevertheless, the TCMP suggested examining the effects of an estimator more in tune with the HCR, one that corresponds to an MSY occurring at 40% SBO, to determine its influence on MP performance. The TCMP **AGREED** that this warrants a technical discussion at the upcoming MSE April task force meeting.
- (Para. 38) Based on the observed performance of MPs, the TCMP discussed options to refine MP selections for further consideration at the TCMP meeting in May. The TCMP **NOTED** that the performance was quite similar among various TAC stabilizers and **AGREED** to eliminate both the 15-15 and 10-10 options while retaining the 15-10 option. Additionally, the TCMP **AGREED** to maintaining all types of MPs (although model-based MPs typically yield lower catches they offer greater stability)
- (Para. 40) The TCMP **RECALLED** that the deadline for submission of full documents for the TCMP in May falls on 10 April (30 days prior to the start of the TCMP meeting). The TCMP **NOTED** that this deadline falls before the completion of the MSE Task Force meeting, which takes place from the 10 – 13 April. As such, any discussions that take place during that meeting would not be able to be incorporated into the documents submitted for the TCMP. As such, the TCMP **AGREED** that the deadline for submission of documents for the TCMP should be extended until the 19th of April on an exceptional basis in 2024.

3. STATUS OF WORK ON ALBACORE OMS AND MPs

3.1 Review progress and difficulties

6. The WPM(MSE) **NOTED** the presentation of paper [IOTC-2024-WPM15\(MSE\)-04rev1](#) which provides an update on the Approximate Bayesian Computation approach for conditioning the operating models for Indian Ocean albacore tuna, including the following summary provided by the authors.

”In this paper we condition the Indian Ocean Albacore tuna OM that mirrors (biologically and structurally) the most recent stock assessment, utilises length composition and longline CPUE data, and is able to explore a wide range of stock status prior hypotheses, many of them built on information from the results of the stock assessment. The aim of this work was to cover the same range of factors/hypotheses covered in the previous suite of OMs”

7. The WPM(MSE) **NOTED** that there were likely spatial patterns in various fishery and/or stock related processes but **AGREED** not to include these in the current MSE, as they have not been included in any assessments and would require a substantial amount of work to implement.

3.2 Future Work

8. The WPM(MSE) **NOTED** the selectivity for the ‘other fleets’ fishery (as defined in the analyses) was assumed to be the same as the purse seine fleet, which catches mostly large fish. The WPM(MSE) **REQUESTED** that the developers identify the gears and locations for the ‘other fleets’ to evaluate if the purse seine selectivity is the most appropriate for this fleet.
9. The WPM(MSE) **NOTED** that the conditioning OMs being developed with the ABC approach retain the seasonality and sex structure of the stock assessment model, but that the previous MSE framework used for projections was an annual model with no sex structure. The WPM(MSE) **REQUESTED** that the developers integrate the seasonal and sex structure into the projection models for consistency between the OM and projections.
10. The WPM(MSE) **NOTED** that there were some Bayesian approaches that could be used to validate some of the different model scenarios in the OM, but that these approaches could not be used to validate the models that use different data sets (e.g. CPUE data from regions 1 and 3). The WPM(MSE) **REQUESTED** Secretariat to contact

that experts from the WPTmT to ask them to attend the next WPM meeting to provide advice on the most appropriate CPUE series to use in the OM.

4. STATUS OF WORK ON SKIPJACK OMs AND MPs

4.1 Review progress and difficulties

11. The WPM(MSE) **NOTED** the presentation of paper [IOTC-2024-WPM15\(MSE\)-03rev1](#) which provides an update on further MP simulation testing for Indian Ocean skipjack tuna, including the following summary provided by the authors.

“Work on an updated Management Procedure for Indian Ocean skipjack tuna has been ongoing since 2019. The current phase of the work is from October 2023 to June 2024. The current report provides a review of work to date for discussion by the WPM (MSETF) and in preparation for the 8th TCMP in May 2024” – see the paper for the full abstract.
12. The WPM(MSE) **NOTED** that different combinations of MP configurations were assessed: three tuning criteria (50%, 60%, or 70% in the target quadrant), two alternative tuning parameter values ('Stable': $a_x = 8\%$ and $a_T = 32\%$, or 'Target': $a_x = 10\%$ and $a_T = 40\%$), and two TAC buffer options ('B': a 15% symmetric TAC buffer, or no buffer). In total, 12 MPs were evaluated.
13. The WPM(MSE) **NOTED** that the asymmetric TAC buffer (10% down, 15% up) was not investigated due to time constraints but will be done prior to the next TCMP meeting in May. All management procedures were assessed against the full grid of 36 assessment models as the OM. The reference case assumed a two-year lag, comprising one year of data lag and one year of implementation lag, and assumed no overcatch. The robustness tests conducted thus far encompassed scenarios with 20% or 30% overcatch.
14. The WPM(MSE) **NOTED** that the 'target' MP aligns the two HCR control parameters to 10% and 40% depletion, in accordance with TCMP07's request. It was pointed out by the modeler that a minor shift of the HCR control parameters to the left (i.e. lower) could enhance the stability of the catch. This is due to the observation errors in the catch rates, which are indicators of stock abundance. The size of the shift depends on the magnitude of these errors. Consequently, a 'stable' MP has been developed to demonstrate this effect. The WPM(MSE) further **NOTED** that these HCRs replaced the Type A and B (control parameter values) HCR assessed during TCMP07, which had only been tested against half of the operational models.
15. The WPM(MSE) **NOTED** that the modeler had investigated an alternative tuning parameter setting for TCMP07, which had a steeper HCR slope. These simulations demonstrated a trade-off between the maximum possible catch and the catch stability.
16. The WPM(MSE) **NOTED** that a comparison of the catch variability between the 'stable' and 'target' MP options also depends on the TAC buffer option. For the 'target' option, variability in catch decreases when the TAC buffer is applied, whereas for the 'stable' option, variability increases under the buffer option as a result of more frequent TAC changes. The WPM(MSE) **REQUESTED** that the developer includes a diagnostics that records when the TAC buffer is triggered (both minimum and maximum) when evaluating the performance of the 'stable' and 'target' MP options with respect to catch variability.
17. The WPM(MSE) **NOTED** that in robustness testing of overcatch, the HCR will consistently be triggered on the slope. Consequently, the 'target' MP typically outperforms the 'stable' MP by reaching the slope sooner. However, the TAC becomes more unstable.
18. The WPM(MSE) **NOTED** the question regarding why the overcatch scenario is considered only in robustness testing, considering that the TAC has been consistently exceeded in the past. The WPM(MSE) **RECALLED** that in previous iterations, MPs were developed assuming overcatch. However, this assumption would implicitly suggest that the TAC cannot be managed, thus potentially encouraging overcatch against the TAC. A more suitable approach involves developing MPs under the assumption of no implementation error but evaluating the consequences or impact should overcatch of the TAC occur. The WPM(MSE) **NOTED** the importance of

establishing measures to ensure the recommended catch limits are not exceeded and, thus, to ensure that MP is implemented effectively.

19. The WPM(MSE) **NOTED** that the HCRs are based on empirical catch rates instead of estimated depletion, and output a TAC rather than an exploitation rate. An exploitation rate-based MP generally requires biomass estimates from a biomass dynamic model to convert the exploitation rate into a TAC. However, these models have proven ineffective for skipjack because the stock is predominantly driven by recruitment.
20. The WPM (MSE) **NOTED** that the HCRs are bounded by a minimum catch (C_{min}); consequently, fishing mortality will not decrease to zero, even when stock status is very low. The WPM(MSE) **RECALLED** that the minimum catch was established to account for artisanal and small-scale catches, which are challenging to regulate.

4.2 Preparation of the 8th session of TCMP

21. The WPM(MSE) **REQUESTED** that a qualitative table, similar to that in [IOTC-2019-TCMP03-INF03](#), be used to compare the MP performance qualitatively. The qualitative table, derived from quantitative values and enhanced with a colour gradient corresponding to the performance metrics values, could effectively illustrate the qualitative performance of the MPs.
22. The WPM(MSE) **REQUESTED** that following additional runs be conducted, and the results made available for discussion in TCMP08:
 - Evaluate symmetric (15%) and asymmetric (10% down, 15% up) TAC-change buffers as requested by TCMP07; remove the no buffer option to avoid big interannual changes in TAC (in the reference set);
 - Three robustness tests being:
 - Include a sustained drop in recruitment for 5 – 10 years at the lowest historic recruitment level with the incorporation of autocorrelation in the recruitment deviates comparable to the observed recruitment trends.
 - Explore the consequence of three-year total lags when setting the TAC;
 - Test the overcatch scenario (20% and 30%) with the symmetric constrained on TAC and also with asymmetric constraints.

5. STATUS OF WORK ON SWORDFISH OMs AND MPs

5.1 Review progress and difficulties

23. The WPM(MSE) **NOTED** the presentation of the work currently being carried out on MSE for swordfish, contained in document [IOTC-2024-WPM15\(MSE\)-05](#), and summarized by the authors as follows:

“The reference operating model for the Indian Ocean swordfish stock has been developed over the last four years and has been endorsed by the IOTC scientific committee. The OM was developed based on the 2020 WPB SS3 assessment, and covered the dynamics of the swordfish until the year 2018. This OM was updated to the year 2023 by projecting the stock forward based on the reported catches for the period 2019 to 2022 and assuming a fishing mortality in 2023 at the 2022 level. A comparison of the OM with the output of the new 2023 stock assessment shows that the OM remains appropriate to describe the dynamics of the Indian Ocean swordfish stock, as well as its current status.” see the paper for the full abstract

24. The WPM(MSE) **DISCUSSED** progress on the technical MSE work to test the range of candidate management procedures recommended for further evaluation by the TCMP in February 2024. The key issues discussed included fishing mortality estimates, initial catch differences, Implementation lag, and a modified HCR for model-based MPs.
25. The WPM(MSE) **NOTED** differences in the trend and end estimates of F over time for the 2023 assessment relative to the median and range of uncertainty in F estimated by the updated OM. Such differences led to discussion as to whether the OM needed to be updated for the recent assessment. However, concerns over apparent differences were resolved when it was determined that the difference was due to different age ranges being

used for the F estimation. Once these were standardised between the OM and assessment, the assessment estimates of F and associated uncertainty fell well within the OM estimated uncertainty for fishing mortality over time and the trends over time were more correlated. The WPM(MSE) **AGREED** that use of the current OM for evaluation of MPs remained appropriate and it was not necessary to update the OM to reflect the recent assessment.

26. The WPM(MSE) **NOTED** an apparent difference in the starting catches of the retuned empirical MPs versus those of the model-based MPs which had not been retuned. The Swordfish development team **NOTED** this difference and would check that the starting catches are the same when the model-based MPs are retuned for the TCMP.
27. The WPM(MSE) **NOTED** that the reference set of MPs were tested under the assumption of a two-year lag between the last year of data used to run an MP and the year of actual TAC implementation. However, the WPM(MSE) **NOTED** that it would more likely be a three year lag if the Commission needed an additional year to agree short term allocation of the TAC (for the period of the TAC). The WPM(MSE) **AGREED** that a three-year lag would be tested as a robustness test to check that the candidate MPs would be robust to a three year lag.
28. The WPM(MSE) **NOTED** that there are a number of ways that catch variability over projection periods can be summarised and represented as a performance metric for candidate MPs. For Swordfish, The WPM(MSE) **AGREED** that it would be the average change per TAC cycle rather than annual average change, in recognition that TACs may be set for three year periods so the relevant measure is the average change across years where a TAC change was scheduled (not all years, which would include years when the TAC is held constant). So a period of 15 years may have 5 TAC periods meaning the average variability is the average of those five potential changes in TAC. The WPM(MSE) **NOTED** this would both reflect how this statistic has been calculated in previous MSE work within the IOTC and would be consistent with the maximum and minimum TAC change limits i.e. the maximum value of this statistic would be whatever the maximum percentage TAC change was applicable.
29. The WPM(MSE) **NOTED** that the model-based MPs had the best performance in terms of catch stability (holding TACs very stable) but at the sacrifice of the opportunity to achieve higher TACs when the biomass was at higher levels. Some preliminary exploration of an alternate form of model-based MP harvest control rule allowing higher TACs at higher stock sizes was undertaken during the meeting, however the work was not completed because some issues were identified, The WPM(MSE) **NOTED** that the existing set of 6 candidate MPs provide suitable options of appropriately performing MPs for Commission consideration.

6. STATUS OF WORK ON YELLOWFIN OMs AND MPs

6.1 Review progress and difficulties

30. The WPM(MSE) **NOTED** that the yellowfin tuna MSE has not made any further progress and that the modelers are considering alternative methods of conditioning the OM for this species including the Approximate Bayesian Computation (ABC) paradigm.

6.2 Future Work

31. The WPM(MSE) **NOTED** that the yellowfin stock assessment underwent an external review in February 2023 and that the review report was discussed at the WPTT and the SC in 2023. The review offers some recommendations for how to improve the yellowfin stock assessment, which can also be considered and accommodated for the ongoing development of the yellowfin MSE.

7. STATUS OF BIGEYE MP

7.1 Work in support of Res 22/03

32. The WPM(MSE) **NOTED** that the BET MP (as per Resolution 22/03) is scheduled to be run in 2024. The WPM **RECOMMENDED** that the secretariat and CSIRO collaborate to run the BET MP and produce a report to the WPM on the recommended TAC for 2026 to 2028. The collaboration in 2024 will facilitate transition of running the BET MP, and transfer of code, to the secretariat.

33. The WPM(MSE) **NOTED** that two specified data inputs, catch and standardised CPUE, are required to run the BET MP. The WPM(MSE) was advised that the joint CPUE working group from Japan, Korea and Taiwan,China would meet in May 2024 to conduct the joint CPUE analysis using operational data. The focus of the joint work is the YFT CPUE for the 2024 stock assessment, but the group will also attempt to complete the BET CPUE standardisation for running the BET MP. If the work cannot be completed in May, it will be completed by early September to allow sufficient time to run the MP prior to the WPM meeting in October.
34. The WPM(MSE) **NOTED** that the WPM will review the run of the BET MP, the MP TAC advice and annual review of exceptional circumstances at WPM/WPTT in October 2024 to provide recommendations and advice to the SC.

7.2 Future Work

35. The WPM (MSE) **DISCUSSED** the external review work of the bigeye tuna MP and results of the discussions are provided in Section 8.4.

8. GENERAL DISCUSSION ON OMs AND MPs

8.1 Alternative OM conditioning approaches

36. The WPM(MSE) **NOTED** that the ABC approach that is being investigated for albacore tuna has shown some encouraging results to address the ‘running out of fish’ problem. This problem arises when the model is not able to make projections using the reported catches from most recent years because the biomass is very low. This was partly achieved by imposing penalty functions on potentially unrealistic exploitation rates. Such an approach could help mitigate several known problems with the yellowfin assessment/OM, where certain models seem unrealistically pessimistic.

8.2 Consideration of multi-species OMs/MPs

8.3 Exceptional circumstances

37. The WPM(MSE) discussed the exceptional circumstances guidelines adopted in 2021 and **NOTED** that any changes or updates are scheduled to be considered at the WPM in 2024. The WPM **NOTED** that the annual review of exceptional circumstances, in 2022 and 2023, in relation to operation of the BET MP and implementation of TAC advice, had worked well as a review process.
38. The WPM(MSE) **NOTED** that the exceptional circumstances guidelines are generic, not species specific, and provide a process for review and action on issues that may arise in implementation of an adopted MP for SKJ and SWO. The WPM(MSE) further **NOTED** that exceptional circumstances will be triggered if the recommended TAC is exceeded, and the WPM and SC will make recommendations for actions that may be considered by the Commission in response.

8.4 BET external peer-review

39. The WPM(MSE) **NOTED** that the Terms of Reference for an external peer review of the bigeye tuna MP are reported in the 2021 SC report and funding had been secured and a suitable consultant identified in 2023. However, the review of the BET MSE and MP had not commenced because there had been administrative difficulties in contracting and changes in circumstances of the consultant. There have also been concerns that the agreed budget will not cover the scope of the review as outlined in the Terms of Reference.
40. Therefore, the WPM(MSE) proposed revisions to the Terms of Reference and suggested candidate reviewers. The agreed Terms of Reference for the review is provided in [Appendix V](#). The WPM(MSE) **REQUESTED** the Secretariat to contact identified candidate reviewers to ascertain their availability and interest in conducting the review. The WPM(MSE) **AGREED** that the deadline for reporting the results of the review will be determined upon identification of the reviewer(s).

8.5 Workplan and roadmap 2024-2026

41. The WPM(MSE) **NOTED** that the potential adoption of MPs for Swordfish and Skipjack Tuna in 2024 has implications for the IOTCs Science budget and that any agreement of budget at SCAF might need to be reviewed and modified by the Commission pending outcomes relating to proposals to adopt MPs for both species. Clearly further MSE testing of candidate MPs will not be required if MPs are adopted in 2024. As such finalisation of the budget should be undertaken by the Commission after decisions are agreed on the MP proposals.

8.6 Other issues

9. PREPARATION OF TCMP08 AND COMMISSION (S29)

9.1 Agenda for TCMP08

42. The WPM **DISCUSSED** the agenda for the TCMP08 and **AGREED** to the version provided in [Appendix IV](#) of this report. The TCMP Chair will allow brief presentations on proposals for adoption of MP to aid discussions at the Commission meeting.

9.2 Organization, tasks and responsibilities

43. The WPM(MSE) **DISCUSSED** the organization of TCMP08 meeting with associated tasks and responsibilities prior to and during the meeting and **AGREED** that the Skipjack and Swordfish updates would again take priority in 2024.

9.3 Format and guidelines for presenting MSE/MP results

44. The WPM **AGREED** to focus on the qualitative summary of the key performance measures for the candidate MPs in the presentations to the TCMP and the main body of the documentation. The summary will be linked to the figures and tables, with technical details in appendices. The format will be similar to the BET MP final documentation ([IOTC-2022-TCMP05_07](#)).
45. A shorter and simpler introductory description of MSE and MPs will be presented to TCMP08. The WPM **REQUESTED** further guidance from Commissioners and the small working group on improving communication on MSE and MPs.

9.4 Capacity building on MSE at IOTC

46. The WPM(MSE) **NOTED** the following discussions held during the Commission in 2022 (IOTC-2022-S26-R):
- “(Para 49) The Commission ACKNOWLEDGED an offer by the PEW Charitable Trusts to support capacity building workshops and activities for MSE. The Commission REQUESTED the Secretariat to liaise with PEW to coordinate these activities.”*
- (Para 83) The Commission ACKNOWLEDGED further offers to support capacity building workshops and activities for MSE from WWF and ISSF (Refer also to paragraph 49).”*
47. The WPM(MSE) **AGREED** that MSE/MP general framework be presented as capacity building exercise at the TCMP08 focusing on how to interpret the results of the different figures and tables provided in the MP papers. The WPM(MSE) **CONSIDERED** that using Bigeye MP document could facilitate the communication.
48. The WPM(MSE) **NOTED** the capacity building workshop for coastal states originally planned for late September 2023 did not take place due to logistical reasons, and the Secretariat had been in contact with PEW and coastal states to discuss alternatives dates and location.
49. The WPM(MSE) **NOTED** that MSE educational tools (<https://iotc.org/educational-tools>) developed as part of the ABNJ project (phase II) would benefit IOTC members and **SUGGESTED** that the tools being included as an information paper of the TCMP08.

10. OTHER BUSINESS

11. ADOPTION OF REPORT

50. The WPM(MSE) **NOTED** that the report would be adopted via correspondence.

APPENDIX I
LIST OF PARTICIPANTS

Chairperson

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APPENDIX II MEETING AGENDA

Date: 10-13 April 2024

Location: Online

Platform: MS Teams

Time: 10:00 – 11:00 daily (Seychelles time)

Chair: Hilario Murua (ISSF); **Vice-chair:** Ann Preece

DRAFT AGENDA

- 1. Opening and adoption of agenda**
- 2. Review of MP process in IOTC**
 - 2.1. Review outcomes of TCMP07 in 2024 and S27 in 2023
 - 2.2. Process of MSE development, discussion and adoption at IOTC
- 3. Status of work on Albacore OMs and MPs**
 - 3.1. Review progress and difficulties
 - 3.2. Future work
- 4. Status of work on Swordfish OMs and MPs**
 - 4.1. Review progress and difficulties
 - 4.2. Future work
 - 4.3. Preparation of the 8th session of TCMP
- 5. Status of work on Skipjack OMs and MPs**
 - 5.1. Review progress and difficulties
 - 5.2. Future work
 - 5.3. Preparation of the 8th session of TCMP
- 6. Status of work on Yellowfin OMs and MPs**
 - 6.1. Review progress and difficulties
 - 6.2. Future work
- 7. Status of Bigeye MP**
 - 7.1. Work in support of Res 22/03
 - 7.2. Future work
- 8. General discussion on OMs and MPs**
 - 8.1. Alternative OM conditioning approaches
 - 8.2. Consideration of multi-species OMs/MPs
 - 8.3. Exceptional circumstances
 - 8.4. BET external peer-review
 - 8.5. Workplan and roadmap 2024-2026
 - 8.6. Other issues
- 9. Preparation of TCMP08 and Commission (S28)**
 - 9.1. Agenda for TCMP08
 - 9.2. Organization, tasks and responsibilities
 - 9.3. Format and guidelines for presenting MSE/MP results
 - 9.4. Capacity building on MSE at IOTC
- 10. Other business**
- 11. Adoption of Report**

APPENDIX III
LIST OF DOCUMENTS

Document	Title
IOTC–2024–WPM15(MSE)–01a	Agenda of the 15th Working Party on Methods Management Strategy Evaluation Task Force
IOTC–2024–WPM15(MSE)–03rev1	Further MP simulation testing for Indian Ocean skipjack tuna (Edward C)
IOTC–2024–WPM15(MSE)–04 rev1	Conditioning IOTC Albacore OMs using the ABC approach (Hillary R, Mosqueira I)
IOTC–2024–WPM15(MSE)–05	IOTC Swordfish Management Strategy Evaluation Update (Brunel T, Mosqueira I)

APPENDIX IV**PROPOSED AGENDA FOR THE TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES (TCMP)****Date:** 10-11 May 2024**Location:** InterContinental Mauritius Resort Balaclava, Mauritius (Hybrid)**Co-Chairs:** Ms. Riley Kim Jung-re (Commission Chair) and Dr. Toshihide Kitakado (SC Chair)

- 1. OPENING OF THE SESSION AND ARRANGEMENTS** (Co-Chairs)
- 2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Co-Chairs)
- 3. ADMISSION OF OBSERVERS** (Co-Chairs)
- 4. DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES** (IOTC Secretariat)
 - 4.1 Outcomes of the 7th Session of TCMP
- 5. INTRODUCTION TO MSE AND PRESENTATION OF MSE RESULTS**
- 6 STATUS OF THE MANAGEMENT STRATEGY EVALUATION/OPERATING MODELS AND ACTIONS NEEDED FOR ADOPTION** (Developers)
 - 6.1 Skipjack tuna (Charlie Edwards)
 - 6.2 Swordfish (Thomas Brunel/Iago Mosqueira)
 - 6.3 General Issues
 - 6.3.1 MP implementation, actions and regular implementation review
- 7 FUTURE DIRECTION OF THE TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES** (Co-Chairs)
 - 7.1 Workplan
 - 7.1.1 New timelines
 - 7.1.2 Budget and resources needed for technical developments
 - 7.1.3 External review
 - 7.2 Priorities
 - 7.3 Process and future meetings of TCMP
- 8 ADOPTION OF REPORT** (Co-chairs)

APPENDIX V**DRAFT TERMS OF REFERENCE FOR AN INDEPENDENT PEER REVIEW OF THE IOTC BIGEYE TUNA
MANAGEMENT STRATEGY EVALUATION (BIGEYE)*****Introduction***

IOTC Resolution 15/10 requested the IOTC Scientific Committee to develop and assess, through the management strategy evaluation (MSE) process, the performance of Management Procedures (MP) and Harvest Control Rules (HCRs), to achieve Target Reference Points (TRPs) on average and avoid the Limit Reference Points (LRPs) with a high probability taking into account the levels of uncertainty in the stock assessments for the priority species listed as Skipjack, Bigeye tuna (BET), Yellowfin tuna, Albacore tuna, and swordfish.

The Working Party on Methods (WPM), in conjunction with other Working Parties, has been developing the MSE for different IOTC species and has identified the need for external peer-review of the MSE process. As such, the 2021 MSE task force of the WPM meeting discussed the merits of external peer-review and agreed that external review at both the technical (e.g. code inspection) and process can greatly benefit the MSE. The MSE task force of the WPM suggested that the external review could be conducted independently and in parallel to the TCMP process, preferably to species for which the MP evaluation is close to completion (such as BET), and when resources and expertise are available.

Moreover, the 2021 WP on Methods identified as a **priority** in its workplan the need of an external peer review based on Terms of Reference agreed to by the WPM and the Scientific Committee and following the schedule recommended in its workplan (Appendix VI of the [IOTC–2021–WPM12–R\[E\]](#)). The WPM also identified as a research priority in its workplan the external peer-review for Bigeye MSE to be completed by 2023. The WPM also noted that clear instructions and terms of references should be provided for the external review given the complexity of the MSE process. Moreover, the WPM highlighted that arranging an external peer review will not be trivial due to the complexity of the process, the limited number of experts able to conduct the work as well as the cost and, thus, the WPM suggested that the scope should be agreed and terms of references developed. The absence of an independent review should not preclude the Commission from the initial adoption of a Resolution for an MP. As part of the MP resolution, the review of the performance of the MP (e.g. after 6-9 years of implementation) by the SC and TCMP should also be specified.

The SC24 will review and finalize these ToRs for the external Bigeye MSE peer review. The starting dates of the peer review will be agreed with the experts but ideally will be mid-2022 after IOTC Commission approves Scientific Committee workplan.

Objectives

The objective of the Terms of References is to contract a qualified individual, and/or group of individuals, to conduct the review of the bigeye MSE operating model (OM) and the MPs evaluated through MSE.

Based on the review work provide recommendations for improving the bigeye MSE, including the operating model, harvest control rules and management procedures.

Terms of Reference

The key areas for consideration by the peer review of the Indian Ocean Bigeye Tuna Management Strategy Evaluation ([IOTC-2021-WPM12\(MSE\)-04](#)) are listed below:

- Review the operating model conditioning and the range of uncertainties included in reference and robustness sets

- Review the evaluation of the adopted Management Procedure
- Review the robustness scenarios tested through the MSE
- Review the exceptional circumstances guidelines endorsed by the Commission
- Advise on adequacy of communication in the reports of MSE results, the trade-offs between various management procedures, and the ranking of management procedures.
- Provide recommendations for future developments to improve the bigeye MSE and MP, if applicable.

Workplan

It is envisaged that the external expert will review the bigeye MSE documentation . and be able to replicate the results from the BET MP code. To carry out the peer-review the external expert will:

- work with the developer of the bigeye MSE, the WPTT, the SC Chair, IOTC Secretariat and IOTC Stock Assessment expert, to review the OM and performance of candidate MPs. The contractor will also suggest ways to improve the current MSE framework.
- review the process followed to adopt a MP, by reviewing relevant documents, including SC documents, reports from SC or Commission meetings, IOTC Recommendations, etc. and to provide comments on the appropriateness of the selection (or omission) of OMs and MPs considered, as well as on the involvement of scientists and/or stakeholders in the process.
- document the quality control procedures followed by the reviewer to test the code, the outcomes of the review process, and the comments on the MSE process, with suggestions for the future work of the SC.
- participate in the WPM meeting as well as other relevant IOTC MSE meetings and discussions.

Deliverables

- An inception draft report documenting the initial review process, preliminary outcomes, initial recommendations and next steps to be discussed with bigeye MSE developers, IOTC WPM Chair, IOTC WPTT Chair and Vicechair, and SC Chair and Vicechair.
- A comprehensive report documenting all the review process conducted, the outcomes of the review and responses to initial recommendations as well recommendations to improve future next MSE iteration, that will be presented as an IOTC document during the IOTC WPM and SC.

Duration of the work and potential funding

- The consultant is expected to take no more than 40 working days to execute the assignment with a potential cost of \$20,000.

Contractor minimum qualifications

- At least a PhD or equivalent experience in the relevant sciences, e.g. Mathematics, Statistics, Engineering, Fisheries Science, Marine Biology, Natural Sciences, Biological Sciences, Environmental Sciences or a closely related field.
- A minimum of 10 years of experience in advanced fishery modelling, including experience in Management Strategy Evaluation and the provision of stock assessment and management advice, preferably for highly migratory species.
- Experience in participating in interdisciplinary and international working group and/or projects.
- Demonstrated experience in quantitative methods, system modelling and software design.
- Demonstrated experience in design and implementation of management strategy evaluation and stock assessment models, preferably for highly migratory species.
- Strong working knowledge of and ability to program in major software used in fisheries stock assessment and MSE, in particular, R, ADMB and C++. Experience with FLR library is desired.
- Strong working knowledge and ability to develop and maintain contemporary program documentation systems.

- Good communication skills with scientists, managers, and stakeholders with an ability to explain the essences of the complex technical objectives, results and implications of OMs and Management Procedures (MP) to a non-technical audience is desirable.
- Excellent working knowledge of one of the two official languages of IOTC (English and French). A high level of knowledge of English is highly desirable.
- Strong teamwork and project management skills.

References

Kolody, D, Jumppanen, P. 2021. Indian Ocean Bigeye Tuna Management Procedure Evaluation Update March 2021. Working Paper prepared for the Management Strategy Evaluation Task Force of the Indian Ocean Tuna Commission Working Party on Methods Meeting, March 2021. IOTC-2021-WPM12(MSE)-04.

APPENDIX VI**CONSOLIDATED RECOMMENDATIONS OF THE 15TH SESSION OF THE WORKING PARTY ON METHODS
(MANAGEMENT STRATEGY EVALUATION TASK FORCE)**

NOTE: APPENDIX REFERENCES REFER TO THE REPORT OF THE 15TH SESSION OF THE WORKING PARTY ON METHODS (MANAGEMENT STRATEGY EVALUATION TASK FORCE) (IOTC–2024–WPM15(MSE)–R)

WPM(MSE)15.01: The WPM(MSE) **NOTED** that the BET MP (as per Resolution 22/03) is scheduled to be run in 2024. The WPM **RECOMMENDED** that the secretariat and CSIRO collaborate to run the BET MP and produce a report to the WPM on the recommended TAC for 2026 to 2028. The collaboration in 2024 will facilitate transition of running the BET MP, and transfer of code, to the secretariat (Para 32).