

REPORT OF THE 8th WORKSHOP on MSE of the IOTC WORKING PARTY on METHODS

PREPARED BY: WPM CHAIR, 04 APRIL 2019

1. Introductory items

The 8th workshop on Management Strategy Evaluation (MSE) of the Working Party on Methods (WPM) of IOTC was held at Joint Research Centre (JRC) in Ispra, Italy. The list of participants is given in Annex A. The Group is composed of members of the IOTC WPM actively involved on the development of MSE simulations for IOTC stocks

1.1 Opening remarks

The meeting was chaired by Dr Toshi Kitakado, the chair of the IOTC Working Party on Methods. Dr Kitakado welcomed the participants to the workshop. He noted that the main objectives of the meeting were:

1. To review recent progress and the current status of the development of MSE (OMs, MPs and simulations) for ALB, SKJ, YFT, BET and SWO
2. To agree on how best to present MSE results to IOTC Scientific Committee (SC), Technical Committee on Management Procedures (TCMP), and Commission (COM)
3. To review the plan for the upcoming TCMP03
4. To develop a possible roadmap for the next 4 years of MSE work to guide MP developers

The agreed agenda was adopted as is provided in Annex B

1.2 Appointment of chair and rapporteurs

Item	Rapporteur(s)
1. Introductory items	Kitakado
2. Review of current state of affairs	Kitakado
3. Review of status of work on Albacore OMs and MPs	de Bruyn
4. Review of status of work on Skipjack OMs and MPs	Murua
5. Review of status of work on Yellowfin and Bigeye OMs and MPs	Merino
6. Work on Swordfish OMs	Coelho, Scott
7. Presentation of MSE	Williams
8. Training and capacity building on MSE at IOTC	Scott
9. Other ISSUES for WPM10	Coelho, de Bruyn

10. Peer review process for WPM MSE	de Bruyn
11. 2019-2022 ROADMAP	de Bruyn
12. Other business	Murua, Merino
13. Adoption of report	Kitakado

1.3 REVIEW of available documents

The Group noted that the available documents related to the progress on MSE for each species and these are covered individually in items 3 – 6 below.

2. REVIEW of current state of affairs

2.1 UPDATE on WPM09 and SC21 in 2018

The group recalled that the 9th Session of the WPM was held in Victoria Seychelles, 25-17 October 2018. The consolidated list of recommendations to the SC21 is shown in the appendix to the WPM09 report.

2.2 UPDATE on TCMP02 and COM(S22) in 2018

The group recalled the 2nd Session of the Technical Committee on Management Procedures (TCMP02) was held in Bangkok, Thailand, from 18th to 19th May 2018. The TCMP is mandated under IOTC Resolution 16/09 [*on establishing a technical committee on management procedures*], which supersedes Resolution 14/03 [*On enhancing the dialogue between fisheries scientists and managers*]. The main objectives of the TCMP are as follows:

- a) Enhance the decision making response of the Commission in relation to management procedures, including recommendations made by the Scientific Committee;
- b) Enhance communication and foster dialogue and mutual understanding between the Scientific Committee and the Commission on matters relating to management procedures;
- c) Assist the Commission to obtain and promote the effective use of scientific resources and information.

The Commission meeting was held on 21-25 May 2018. A total of 10 Conservation and Management Measures (CMMs) were adopted at the 22nd Session of the Commission

Active IOTC Resolutions relevant to MSE works are as follows:

- Resolution 18/01 On an interim plan for rebuilding the Indian Ocean yellowfin tuna stock in the IOTC Area of Competence (which supersedes IOTC Resolution 17/01 On an interim plan for rebuilding the Indian ocean yellowfin tuna stock in the IOTC area of competence).
- Resolution 16/02 On harvest control rules for skipjack tuna in the IOTC area of competence
- Resolution 16/09 On establishing a technical committee on management procedures dialogue
- Resolution 15/10 On target and limit reference points and a decision framework
- Resolution 12/01 On the implementation of the precautionary approach

2.3 PROCESS of MSE development, discussion and adoption at IOTC

The Group noted that the SC concluded that the Workplan for MSE identified in Res 15/10 is unlikely to be achieved since adequate and timely resources for conducting the required work have not been made available. The TCMP01 provided an updated workplan for the MSE in its meeting report.

3. REVIEW of status of work on Albacore OMs and MPs

3.1 REVIEW status and issues

The developer of the Albacore MSE provided an update on the work related to this species to date. The developer noted that not much progress had been made on albacore since the 2018 Scientific Committee as time had been dedicated to advancing the swordfish MSE. The developed platform contains a fully set OM and the code to run and tune the proposed MPs. An initial set of MP tuning runs have been carried out

3.2 DISCUSSION of problems and solutions

Operating model (OM)

The developer noted that the operating model is conditioned with data up to 2014, and a request was made for it to be extended to 2018. A large number of model runs were struggling to account for the reported catches for the 2015 – 2017 period. It was therefore agreed that the model would need to be updated with at least the latest catches and associated CPUEs to try and resolve this problem. It was acknowledged however, that the ALB assessment to take place in July 2019 would also assume a newly developed growth curve. The effect of this new growth curve on the assessment is currently unknown and therefore this may necessitate the reconditioning of the current OM.

Based on work conducted for other IOTC species, it was noted that there appeared to be no clear relationship between likelihood values and convergence criteria. It was suggested that obtaining good likelihood values may be a priority over restricting the convergence criteria. Jittering of the initial values was generally considered to be a good idea to further ensure convergence.

The Group further noted that at some stage, the OM should no longer be modified otherwise it can become an infinite process of adjusting the OM in response to changes in future assessments. However, the Group generally agreed that it may be premature to freeze the OM at this stage, as the growth factor has been substantially revised using data from the Indian Ocean and therefore should be taken into consideration should the assessment in July demonstrate that this has a profound effect on the assessment results.

Management Procedure (MP)

The developer noted that some improvements have been made to the MP code when this code was applied to the SWO MSE. These will now be applied to the albacore analysis as well.

The group discussed the effect of the performance computation period. The group noted that the TCMP had agreed that for BET, the tuning criteria were only computed over the projection Years 2030 to 2034.

It was discussed that this may be appropriate for the ALB MSE as well. Simulations show that this would result in greater probability of the stock remaining in the required state throughout the projection period. It was agreed that this change in the tuning criteria would need to be discussed with the TCMP, although as it had already been agreed for BET, this would probably not be problematic.

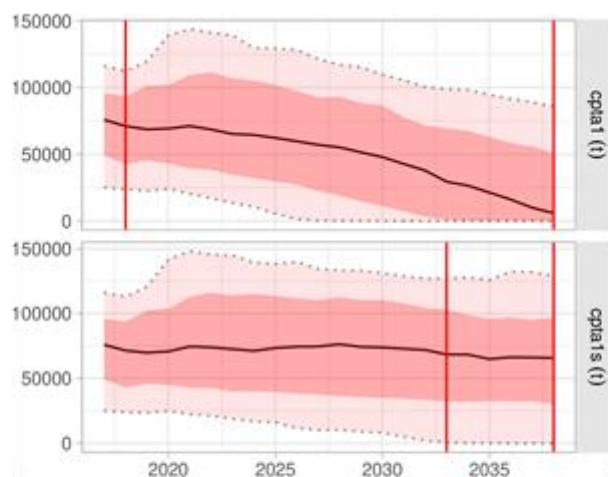


Figure 1: Example MP run showing the difference in SSB trajectories when the whole projection period (top panel) or the last 10 years (bottom panel) are used to compute the tuning performance indicators. In the future this will be done for projection period 2030 - 2034

The Group further discussed some ongoing technical issues. It was pointed out that the CPUEs drive the MPs but the limitations of the currently available CPUEs are recognized pertaining to changes in time and effort in targeting and fleet operation. It may be sufficient to have a good set of robustness tests to check the MP performance to defend more robustly against this problem, but it is clearly essential to look at the impact of having less precision in the CPUE series in the future (eg. due to less LL observations). The group suggested that this could be discussed with Simon Hoyle, the contractor working on the joint CPUE index, as he had intimate knowledge of the operational CPUE data. It was generally agreed that this could be first considered under the robustness tests, but also considered in the definition of Exceptional Circumstances. An increase in CV on future CPUE could easily be assumed.

The Group discussed the potential confusion surrounding the terminology used in the MSE and how this may not be fully understood. For example the seemingly inconsistent use of B/B0 instead of B/BMSY in the HCR. It was pointed out that there should be a separation between reference points in the operating model (which are usually MSY based) and the parameters to evaluate performance of the HCR (which are usually depletion based). However, it was acknowledged that this could cause confusion when management options are usually based on MSY reference points. Despite the fact that B/B0 may be more precisely estimated than B/BMSY it was acknowledged that it was difficult to explain why BMSY cannot be measured with precision, but FMSY generally can. The group agreed that it may be more convenient at this stage to show the performance statistics and not the parameterization of the HCR which is causing the confusion.

3.3 PLAN toward TCMP03, COM(S23), WPM10 and SC22 (Timelines, responsibilities)

The group agreed that the tuning criteria was a priority to be discussed during the TCMP. To this end,

the figure demonstrating the selection of the period of performance statistic averaging may be useful for illustrating this point.

The group acknowledged that there is a problem affecting many scenarios in which the catch cannot be extracted from the available biomass which may necessitate a reconditioning of the OM in relation to the new assessment. The implications of the SS catch penalty require further investigation. For these reasons, it may be advisable to place less emphasis on the ALB MSE at the 2019 TCMP meeting.

The group also noted the importance of starting work on defining the criteria for exceptional circumstances. This can be guided by the progress made in other fora (such as the IWC, RSA OMP process) The group agreed that this would likely be common across the different species and so should be discussed at a general level. It would be preferable to identify the 3 or 4 main issues to be included and not overcomplicate the presentation of this issue to the TCMP.

4. REVIEW of status of work on Skipjack OMs and MPs

No progress for SKJ was presented. The group noted that Resolution 16/02 calls for a revision of the SKJ MSE/MP by 2021. The group also noted that the SKJ MSE revision was identified as a high research priority by the WPTT/SC in 2018. The IOTC Secretariat informed the group that funds have been secured to hire a modeller to progress the MSE of SKJ. However, the IOTC Secretariat informed the group that it appears that Nokome Bentley, the former developer of the SKJ MSE, will not be available to carry out the work. The group discussed whether the modeller should recreate the work done previously from scratch in another platform, or whether they should build on the existing platform. The group expressed that there was a preference to migrate the platform to something with which the group is more familiar (such as flr) in order to facilitate the long-term maintenance of the code. The IOTC Secretariat requested the nomination of candidates who can do the work. The following candidates were suggested:

- Adam Langley (independent consultant)
- Charles Edwards (CSIRO)
- David Die (University of Miami)
- Graham Pilling (SPC)

It was also noted that the available funding is for 2019 which created some logistical constraints as to what can be done. The Group requested that the IOTC Secretariat organize the work as soon as possible to meet the 2021 deadline for the SKJ MSE revision.

5. REVIEW of status of work on Yellowfin and Bigeye OMs and MPs

Two presentations were made in this section.

1) IOTC 2019 IOTC MSE Task Force Bigeye Progress Update

- Fractional factorial design was explored as a method for describing the uncertainty of a full factorial grid with a reduced number of models. In the test case, a 288 model full grid was compared with a 144 model fractional (in which main effects and all 2 way interactions would be estimable in an experimental design context) and 72 model fractional (in which only main effects would be estimable). The stock status inferences from the 3 grids were very similar, and the MP evaluation graphics were almost identical.

- All models in the grid were repeatedly fit from jittered initial parameter values to test minimization reliability. There was considerable variability in the likelihood attained due to this initial value sensitivity. However the CV of the variability in stock status (depletion and MSY) due to convergence variability was only about 10% of the CV among model configurations. Furthermore, there was no indication of a relationship between a lower maximum gradient and a better objective function value (as long as the gradient is <0.01). This appears to justify the 0.01 convergence criterion in this case.
- Three new dimensions were explored for the reference case OM: alternate growth function, alternate regional scaling factors and dome-shaped LL selectivity. There was moderate sensitivity to the alternate growth curve, but it was dropped because it was an ad hoc combination of growth curves derived from incompatible data. There was also moderate sensitivity to the LL selectivity function, but the double normal option was removed from the candidate reference case because there was not time to resolve bounds issues (and there was no specific request to include it).
- The interim reference case for the MP evaluations was a fractional design of 144 models with 7 factors (steepness, natural mortality, weighting of tagging data, catchability trend, cpue standardization method, CPUE regional scaling factor and CL assumed sample size). All models converged.
- It was observed that the Stock Synthesis catch likelihoods (type 3 hybrid F configuration) formed a bimodal distribution (among models). The larger catch penalties tended to be associated with the more pessimistic models (and possibly yellowfin models that failed to converge after multiple attempts). This suggests that the catch penalty might provide a means of identifying models that are implausible, i.e. the fishing mortality must be questionably high to invoke the penalty, and this might be expected to happen in cases where the retrospective pattern suggests that the model is persistently pessimistic (e.g. the yellowfin assessment). If the reference OM was filtered on the basis of catch penalty $<1e-5$, 84 of the models would be retained (this was not applied for the results presented).
- Preliminary evaluations of empirical (CPUE) and model based (Pella and Tomlinson) MPs was presented using the tuning objectives (pG[0.5,0.6,0.7] 2030-2034) defined by the 2019 TCMP. It was noted that the MPs contain a 15% TAC change limit.
- The group noted that the BET catches tended to be stable with all tuning levels, and MP adoption might be easier if stricter TAC change constraints were imposed in the early years, so that industry would not have any risk of immediate quota cuts.
- A series of Robustness tests were conducted and behaved as expected (i.e. MPs were less likely to meet management objectives), though catastrophic failure was avoided (except in the 20+ year timeframe for the 3% per year increasing LL catchability trend).
- It was suggested that the time series plots for the TCMP should be truncated at the 20 year period used for the standard TCMP summary statistics.
- The proposed reference case OM for the 2019 TCMP comprises 72-144 models with 8 factors in a fractional factorial design:
 - 3 X steepness: $h = 0.7, 0.8, 0.9$
 - 3 X M

- 2 X tag weight $\lambda = 0.001, 1.0$
 - 2 X LL CPUE catchability trend 0, 1% per year
 - 2 X tropical CPUE standardization method: HBF, cluster analysis
 - 2 X regional scaling factors
 - 2 X CL assumed sample sizes: ESS=10, 1 iteration of post-fit reweighting
 - 2 X LL selectivity function: logistic, double normal
- It was noted that the double normal selectivity function was not a specific request for BET, but was added to be consistent with ALB and SWO (provided that results are plausible).
 - The group discussed whether the catch penalty should be used as a plausibility criterion for OMs and stock assessments and agreed that further clarification of its implementation was required.
 - It was considered that the current tuning levels appear to cover a sufficient performance range for the next TCMP.
 - It was noted that the budget for the bigeye MSE ends in December 2019 and the future funding of this project will need to be discussed.

2) IOTC 2019 IOTC MSE Task Force Yellowfin Progress Update

- The YFT OM was updated from the 2018 assessment, in recognition that a number of assumptions had changed, data had been revised, and this might prove helpful for the yellowfin assessment review.
- The initial Reference Grid OM included 144 models with 11 factors using a fractional grid (that would allow main effects estimation in an experimental design context, but all interaction terms would be confounded). Factors: steepness, natural mortality, size composition weighting, tag weighting, catchability trend, CPUE standardization method, CV of the LL CPUE, growth curves, regional scaling factor, longline selectivity function and tag mixing period. 121 models converged (the others failed 10+ times).
- If the catch penalty was used to filter plausible models, 63 of the 121 models would be retained. As with BET, this was flagged for further investigation.
- The current version of OMs shows more stable estimates of stock status and productivity across scenarios than in previous versions. The cause is not known, but could relate to i) the revised base assessment, ii) the phasing of the base assessment (which might have been adjusted in 2018 to avoid a known false minimum), or iii) the repeated convergence might have reduced the outliers. This new parameter space removes the need for "grid-sampling" as was applied in the previous two iterations (i.e. where the full grid was sampled to attain central tendency MSY and depletion estimates consistent with the stock assessment, but with inflated variance assumptions).
- The group noted that a number of inferences were most sensitive to the CL sample size assumptions and the iterative re-weighting caused a substantial decrease to the quality of fit to the CPUE data. The group recommended dropping the CLRW option (mean ESS ~53), while retaining the CL75 option

(mean ESS ~23).

- Preliminary evaluations of empirical (CPUE), constant catch and model based (Pella and Tomlinson) MPs was presented using a range of tuning objectives:
 - $p(B(2024) > BMSY) = 0.5$
 - $p(B(2029) > BMSY) = 0.5$
 - $p(B(2034) > BMSY) = 0.5$
- The TAC change constraints needed to be >15% to meet these tuning objectives and >25% for tuning objective 1.
- It was noted that the current tuning levels appear to span a reasonable range of the MP trade-off space.
- It was hoped that subsetting the MP evaluation results to illustrate only the most optimistic scenarios ($B_{current} > BMSY$) would be useful for demonstrating to industry that the MPs could deliver stable catches even if the assessment and OM were biased to be too pessimistic. However, the results indicated that most of the surplus biomass above the biomass target went into further increasing biomass, rather than being retained as catch. This suggests that there might be scope for improving MP performance, or the data are simply not informative enough to reliably distinguish among productivity levels in the short-medium term.
- The proposal for the reference case OM for the 2019 TCMP is aiming for between 72 and 144 models (depending on the fractional design adopted)
 - 3 X steepness: $h = 0.7, 0.8, 0.9$
 - 3 X M
 - 2 X tag weight $\lambda = 0.001, 1.0$
 - 2 X growth options (original and Dortel et al 2015)
 - 2 X LL CPUE catchability trend 0, 1% per year
 - 2 X tropical CPUE standardization method: HBF, cluster analysis
 - 2 X LL CPUE CV: 0.1, 0.3
 - 2 X regional scaling factors
 - 2 X CL assumed sample sizes: $ESS=10, (1 \text{ iteration of post-fit reweighting})^{0.75}$
 - 2 X LL selectivity function: logistic, double normal
 - 2 X tag mixing period: 4, 8 quarters
- It was noted that the double normal selectivity function was requested as a robustness test for YFT, but was proposed for the reference set here to be consistent with ALB and SWO (if results are plausible).

- It was suggested that catchability trend estimations were done after the piracy period. This estimated trend will be used for the projections.
- It was noted that the budget for the yellowfin MSE ends in December 2019 and the future funding of this project will need to be discussed.

6. Work on Swordfish OMs

The current development state of Indian Ocean SWO MSE was presented. The group noted the good progress that has been made since the last SC meeting.

The group discussed the cluster analysis that was used. The authors explained that this was mostly an exploratory analysis to try to reduce the number of models where projections are carried out. With this method there is still the need to run the entire grid of models, and then the cluster analysis is carried out to reduce the number of models, assuming that within each cluster there are models providing similar information, i.e., redundant models. Within each cluster a certain number of models, in this case 100, are randomly selected.

One detail discussed is that the sampling right now is equally weighed within each cluster (100 models per cluster; 5 clusters), and it was suggested that the sampling could be weighted by the number of models in each cluster. The Group also discussed it would be useful to run projections on the full grid to compare with the subsets made.

Another suggestion was to also consider R_0 in the calculation of distances for the clustering in the multivariate analysis.

The Group noted and discussed the autocorrelation patterns in the S-R residuals that have a strong pattern, and that the current projections already incorporate an AR1 process. It could be worth exploring if incorporating more time lags in the autocorrelation would make a significant difference.

The Group discussed possible robustness tests for the future, and noted that alternative catches series could be explored this way. In the case of SWO, there have been issues in the catches, mostly due to the estimation methods used to reconstruct catches from coastal fisheries, based on proxies from industrial fisheries. In the last assessment the most plausible catch series was used, but the previously used alternative series could also be tested in a robustness test. Additionally, observation error in catches could be considered for the projections.

The utility of making use of a combined CPUE for projections in the MSE was briefly discussed. The group noted that for Tropicals and Albacore, joint analysis of operational level longline data has improved the capability for assessing stock status and for conditioning of MSE. It was suggested that similar benefit could be accrued to the SWO assessment and the SWO MSE, if such a joint analysis could be conducted. The group recommended that the Secretariat pursue this project.

With regards to the period for the tuning optimization, the Group agreed to use a similar approach as in BET, i.e., tuning for the entire period of time (e.g., 2020 - 2034) but then also only for the last years (e.g., 2030 - 2034).

7. PRESENTATION of MSE

Agenda

The Group reviewed the agenda from TCMP02 and discussed how it should be revised for TCMP03 (Annex C). It was agreed that the first 5 agenda items would remain the same as for TCMP02, but some minor revisions should be made to subsequent agenda items.

The group discussed the option of introducing live polling at agenda item 6.5 where participants use their mobile phones or computers to respond anonymously to questions designed to determine participant's understanding of management objectives and the MSE/MP process. The Group agreed that live polling could also be used during the discussion of the species-specific MP progress (agenda item 7) to obtain participant's feedback on tuning objectives for each species. The SC Chair will coordinate the development of suitable questions for the live polling, and will seek feedback from the Group.

The Group agreed that the order of the species-specific presentations under agenda item 7 would be BET, YFT, ALB, and SWO. A specific presentation for SKJ was not considered necessary, given that there has been no MSE work for the species since the HCR (Res 16/02) was adopted. However, the Group agreed that it was important to provide an update to the TCMP03 on the requirements under Res 16/02 for further MSE work for SKJ by 2021. The discussion of species-specific MPs at agenda item 8 was incorporated into Agenda item 7, after progress for each species is presented.

The Group agreed that it would be useful to utilise the shiny app that was introduced at TCMP02 (<https://puntapps.shinyapps.io/tunafijimse/>) to reinforce the concepts of MSE. However, the Group agreed that in addition to the exercise at TCMP02 that explored the trade-offs among different management objectives, the task(s) given to participants at TCMP03 should be modified, if possible, to highlight additional aspects of MSE (e.g. explore the impact on stock status from increasing the CV of the cpue time series and also contrast in rebuilding (e.g. YFT) or lightly exploited condition (e.g. BET)). The Chair of the Group will follow up with Graham Pilling (SPC) in April to confirm whether there have been any updates to the shiny app, and what additional aspects could be explored with the shiny app for TCMP03. Similar to TCMP02, the Group suggested that the shiny app exercise should be run in a less formal format, with assistance of scientists being offered to small groups of participants to promote better understanding of the examples developed.

It was agreed that the draft presentations, papers, and the shiny app (with instructions) be circulated to the Group for the first round of comments and review by 30 April and for a second round of comments and review by 21 May, after which the materials should be posted to the IOTC TCMP Meeting website on 31 May to provide CPCs with opportunity to examine the material in advance of the meeting (14-15 June). In addition, the Group agreed that the example graphics, summary tables and glossary of terms should be provided to the TCMP participants, also in advance of the meeting, as well as in hard copy form at the meeting.

TCMP presentations

The Group discussed each of the species-specific MP presentations for TCMP03 and agreed that the general format of the presentations should be the same across all species. The Group suggested that some generic slides (e.g. difference between a HCR and an MP, difference between MP types, importance of data availability (e.g. operational cpue)) be moved into the general introductory presentation, as they apply to all species. The Group also made some suggestions to improve the clarity

of the figures (trade-off plots and Kobe plots), such as including using different shaped symbols to indicate the alternative MP classes, different colours to represent tuning objectives, and refining the legend labels to clearly identify each MP. The group discussed the difficulty in representing the uncertainty for each MP in the Kobe plots, as the 2 dimensional Confidence Intervals (CIs) are not indicative of the true 'banana shape' of the uncertainty. The Group made some suggestions for alternative ways to represent the uncertainty, such as rotating the CIs 45 degrees.

The Group discussed the general observation from all the MSEs that the tuning objective is more influential on MPs than the MP type i.e. there is very little distinction in performance of MPs between MP types. The Group agreed that this result needs to be explained very clearly at TCMP03, and discussed options for providing additional information to the TCMP to assist managers to distinguish between alternative MPs of similar performance. One suggestion from the Group was to plot the cumulative catch over the projection period for each MP to allow a comparison of cumulative catch among MPs at a future time period of interest.

The Group agreed that the ALB presentation should include 2 sets of analyses (for two different tuning criteria) so that the TCMP can advise which is preferred. The Group also agreed that the SWO presentation should include the preliminary results from the OM development, and should inform the TCMP03 of the intent of using objectives and MPs and seek feedback from TCMP03 on using the same tuning objectives as BET.

It was agreed that for the TCMP, with regards to SWO, the highlight should be to briefly show that progress is being made, and then to request input in the tuning criteria objectives. It would be good to provide some initial options/examples, for example based on what has been agreed for ALB or BET, and then adapt based on specificities for the species biology.

Guidelines (Meta-rules)

The Group discussed the need to introduce the concept of meta-rules, including exceptional circumstances and periodic MP reviews to the TCMP. It was agreed that the presentation made to the TCMP should not be too detailed but rather include the key concepts that need to be considered. Key areas in which exceptional circumstances may arise include:

1. Data (eg. If observed CPUEs fall outside the ranges considered by the current models or if there are major changes in biological parameters)
2. Assessments (eg. Inconsistencies between the OM grid and assessment results such as when the assessment is outside a pre-agreed range of either B or F ratios from the OM grid)
3. Implementation (eg. If actual catches are outside the TACs set by the MP)

It was generally agreed that the details of exceptional circumstances should be discussed by the Scientific Committee before providing more definitive options to the TCMP.

Glossary of Terms

The Group discussed the need to revise the glossary of terms for the TCMP in light of the recommendation from the 2018 Joint tRFMO MSE meeting to harmonise the use of terms associated with MSE and MP processes. Where the same terms appear in the IOTC TCMP glossary, the Group agreed to use the definitions in the glossary of terms developed by the Joint tRFMO. The revised glossary of terms for TCMP03 is provided in Annex D.

Timeline until TCMP03

April 30: Circulate 1st draft ppt, paper, shiny application (including instruction)

May 7: Comments

May 21: Circulate 2nd draft ppt, paper, shiny application (including instruction)

May 25: Comments

May 28: Info paper to be submitted to SCAF
May 31: Submission due for papers (and shiny)

June 13: 1030am, informal pre-meeting

June 14-15: IOTC-TCMP03

June 17-21: IOTC-Commission (S23)

8. TRAINING and capacity building on MSE at IOTC

The group recalled that a main source of capacity building for understanding MSE and Management Procedures at the IOTC has been the Common Oceans Areas Beyond National Jurisdiction Tuna project. The project has supported several capacity building workshops in the region as well as having provided direct support for conduct of MSE activities, including scientist-manager dialogue meetings, related to IOTC fisheries. It was also noted that the first phase of the Tuna project will come to closure this year and that capacity building opportunities making use of the Tuna project funding will also come to a close. While there may be some limited opportunity to conduct additional capacity building with remaining Tuna project support, no specific plans have been made to date. The second phase of the Tuna project is only now being scoped and it is too early to know how much emphasis will be placed upon this component in phase II, which might not come into effect for a year or more after the end of phase I.

One opportunity for additional MSE capacity building at the Commissioner level will occur during the June TCMP3 meeting. The group agreed that the exercises used at TCMP2, with modification, should again be used at TCMP3 to assist in capacity building and understanding.

The group noted the ongoing need for capacity building for MSE and recommended that the Commission fund continuing capacity building efforts in the region. The group considered that an annual budget of \$50,000 would be needed to support this continuing need.

9. Other ISSUES for WPM10

There were no other issues discussed during the meeting

10. PEER REVIEW for WPM MSE

The Group 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.

10.1 Internal

The group recalled its discussion on the topic from the 2018 meeting and noted that some elements of Internal Review has 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 this group. It was suggested that as part of an internal review, a member of the working 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.

The creation and maintenance of a trial specification document for each species MSE was suggested. This document would enable anyone to quickly see the detailed specifications of the models used in the MSE process. This document could be updated as the models are modified, with a short paragraph explaining the changes made between each version.

10.2 External

The group further noted that External Independent Review has not yet been fully specified or conducted for any of the MSE projects underway. The group noted the work recently conducted by ICCAT to review the MSE conducted for albacore. This work has terms of reference to conduct the review which may be of use for guiding an external review for IOTC MSE processes. It was noted that the ICCAT review was not particularly detailed, and that it may be useful for the group to develop a list of specific checks and diagnostics that could be run to test the functioning of the code. In addition, an external expert could also review the outcomes of the simulations as well as the decisions and taken to parameterize the models. The decisions incorporated in the models have been based on external expert input during the Working Groups and so some measure of external review on this issue has been undertaken already.

The group noted the importance of presenting the review process to the TCMP but that the presentation should not be too detailed. To facilitate both the internal and external reviews the group agreed that the development of ToRs for both reviews should be elaborated by the group. This would be particularly useful for the contracting of an external reviewer. To this end, a draft document was created regarding the guidelines for review of Management Strategy Evaluation Simulations (Annex: E). The document contained elements relevant for both an internal and external review. The group also discussed potential experts to conduct an external review, and there was some agreement that Dr Tom Carruthers from the University of British Columbia, Canada would be a suitable candidate.

The group recommended that in support of conducting External Review, adequate funding be provided by the Commission. In this regard, a proposal for funding and associated work plan for such review of the MSE projects nearing completion, need be prepared and considered at this year's SCAF meeting (June 2019), which will occur just in advance of the TCMP meeting. The group further recommended that the Chairs of WPM and SC develop a specific 2 year plan and funding proposal for consideration at SCAF.

11. 2019-2022 ROADMAP

Species	Source	2019	2020	2021	2022
Yellowfin	Requested	Funding ABNJ/CSIRO \$75,000	Requires \$75,000	TBD	TBD

	In kind				
Bigeye	Requested	Funding ABNJ/CSIRO \$75,000	Requires \$75,000	TBD	TBD
	In kind				
Skipjack	Requested	Funding EU Grant TBD	If extension granted, 2019 funding can extend into 2020. Requires \$60,000	TBD	TBD
	In kind				
Albacore	Requested	Funding EC/JRC In kind?	Requires \$75,000	TBD	TBD
	In kind				
Swordfish	Requested	Funding EU Grant \$10,000 (travelling)	Requires \$45,000 (travelling + partial salary for 1 developer)	TBD	TBD
	In kind	Salaries (developers): \$12,000	Salaries (other developers): \$8,100		
Capacity Building	Requested	\$0 committed	Requires \$50,000	TBD	TBD
	In kind				
Review	Internal				
	External				

12. OTHER BUSINESS

12.1 SC Strategic plan

A draft IOTC Strategic Science Plan 2020–2024 was presented during 2018 IOTC Scientific Committee. This draft IOTC Strategic Science Plan 2020–2024 was distributed to IOTC CPCs through Circular 19-04 for comments and revision to be received by 15th April 2019. The IOTC Secretariat and Scientific Committee Chair will compile all comments received and present a consolidate SRP to the IOTC Commission in June for endorsement. The group noted that some terminology in relation to Harvest Control Rules and Management Procedures may be confusing and may not follow the agreed terminology. It was agreed that scientists from the group would send their comments through their respective CPCs to ensure the terminology in relation to MSE/MP is

correctly used in the SRP. Moreover, the IOTC Secretariat and SC Chair will also ensure that the terminology is correctly and consistently used.

12.2 *Tropical tunas stock assessment work plan*

- First, the Group discussed the details of the workplan adopted by the last SC (Appendix 38 of the Scientific Committee report). In brief, this workplan aims mostly at reducing the current uncertainties in data and the model specification and parameters estimations used to estimate YFT in 2018. These issues affect also the assessments of the other tropical tunas. For this, a series of small working groups will be created and their expected outcomes will be improvements on different components of the stock assessment. In particular, the work will be divided in two main components: Uncertainty on data and uncertainty on model. Progress made in the different sections will be reported to the 2019 WPTT and it is aimed that a new stock assessment proposal will be allow providing sound projections than the 2018 model. The workplan foresees reviews and improvements in model structure, key parameters, sources of data, diagnostics and supporting models.
- This workplan might be funded by the EC-EU through a Specific Contract which will be carried out in close cooperation with the IOTC Secretariat and scientific community. The Specific Contract foresees tasks for EU scientists and small contracts for non-EU experts (travels, accommodations, etc.) with a relevant role in the WPTT.
- The workplan foresees the creation of a A Steering Committee with experts from the EU, IOTC Secretariat and other relevant experts will be established.
- The Group discussed the stock assessment responsibilities for 2019. In this regard, IOTC Secretariat (Dan Fu) will carry out the assessment of bigeye, Adam Langley (contractor) will be responsible of the assessment of albacore and therefore, the yellowfin stock assessment should be the expected outcome of the 2019 workplan for this stock.
- It was noted that the fishing industry is funding some additional work to improve the last stock assessment. However, it was not completely clear if the industry will fund a revision of the 2018 model or a new stock assessment proposal for 2019.
- The Workplan is aimed at addressing concerns that under the current working party formulation, there is inadequate time available to fully address issues and uncertainties related conduct of assessments making use of complex and highly parameterized models for developing management advice.

13. ADOPTION of report

The meeting closed on 22 March 2019 after reviewing the draft report and adopting the text. Dr. Kitakado thanked the participants for their cooperative and constructive discussion. He also thanked the rapporteurs. The meeting thanked the Chair, and it also thanked Dr Mosqueira for arranging an efficient working environment.

Annex A. LIST OF PARTICIPANTS

M Shiham Adam	Ministry of Fisheries, Marine Resources and Agriculture, Maldives
Franco Biagi	Directorate-General for Maritime Affairs and Fisheries, EU
Rui Coelho	Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Portugal
Paul de Bruyn	IOTC secretariat
Toshihide Kitakado	Tokyo University of Marine Science and Technology, Japan
Dale Kolody	CSIRO, Australia
Gorka Merino	AZTI, Spain
Iago Mosqueira	Joint Research Centre, European Commission
Hilario Murua	AZTI, Spain
Daniela Rosa	Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Portugal
Gerald Scott	International Seafood Sustainability Foundation, USA
Ashley Williams	Department of Agriculture, Australia

Annex B. AGENDA

1. Introductory items Opening remarks

- 1.1 Appointment of chair and rapporteurs
- 1.2 REVIEW of available documents

2. REVIEW of current state of affairs

- 2.1 UPDATE on WPM09 and SC21 in 2018
- 2.2 UPDATE on TCMP02 and COM(S22) in 2018
- 2.3 PROCESS of MSE development, discussion and adoption at IOTC

3. REVIEW of status of work on Albacore OMs and MPs

- 3.1 REVIEW status and issues
- 3.2 DISCUSSION of problems and solutions
- 3.3 PLAN toward TCMP03, COM(S23), WPM10 and SC22 (Timelines, responsibilities)

4. REVIEW of status of work on Skipjack OMs and MPs

- 4.1 REVIEW status and issues
- 4.2 DISCUSSION of problems and solutions
- 4.3 PLAN toward TCMP03, COM(S23), WPM10 and SC22 (Timelines, responsibilities)

5. REVIEW of status of work on Yellowfin and Bigeye OMs and MPs

- 5.1 REVIEW status and issues
- 5.2 DISCUSSION of problems and solutions
- 5.3 PLAN toward TCMP03, COM(S23), WPM10 and SC22 (Timelines, responsibilities)
- 5.4 CONSIDER multispecies issues

6. Work on Swordfish OMs

- 6.1 Review stock assessment results
- 6.2 PLAN toward TCMP03, COM(S23), WPM10 and SC22 (Timelines, responsibilities)
- 6.3 Others

7. PRESENTATION of MSE

8. TRAINING and capacity building on MSE at IOTC

- 8.1 CALENDAR of activities
- 8.2 Others

9. Other ISSUES for WPM10

- 9.1 Tier approach
- 9.2 Stock assessment methods for data limited stocks
- 9.3 Averaging/selection from different stock assessment models/scenarios

10. PEER REVIEW process for WPM MSE

- 10.1 Internal
- 10.2 External

11. 2019-2022 ROADMAP

12. OTHER BUSINESS

12.1 SC Strategic plan

12.2 YFT stock assessment work plan

13. ADOPTION of report

Annex C. Proposed agenda for TCMP03

**AGENDA FOR THE 3RD TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES
MEETING**

Date: 14-15 June, 2019

Location: Hyderabad, Indian

Time: 0900–1700 daily

Co-Chairs: Susan Imende Ugandi (Commission Chair); Hilario Murua (SC Chair)

Facilitator: Graham Piling

18 of May Morning

1. OPENING OF THE SESSION AND ARRANGEMENTS (Co-Chairs)

2. ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION (Chairpersons)

3. ADMISSION OF OBSERVERS (Chairpersons)

**4. DECISIONS OF THE COMMISSION RELATED TO THE WORK OF THE TECHNICAL COMMITTEE
ON MANAGEMENT PROCEDURES (IOTC Secretariat)**

- 4.1 Resolution 16/09 – Terms of Reference
- 4.2 Outcomes of the 2nd Session of TCMP
- 4.3 Outcomes of the 22nd Session of the Commission meeting
- 4.4 Outcomes of the 21st Session of the Scientific Committee

5. OVERVIEW OF THE EVALUATION OF MANAGEMENT PROCEDURES IN THE IOTC (SC Chairperson)

- 5.1 The IOTC Process on adoption of management procedures (Including the Resolution 15/10 of the Management Framework) (SC Chair).
- 5.2 Management Procedures and MSE:
 - 5.2.1 Basic principles
 - 5.2.2 Roles and responsibilities, dialogue tools and feedback mechanism
- 5.3 SC proposal for the standard presentation of MSE results

6 HANDS-ON WORKSHOP – DEMONSTRATION OF MSE TOOL (Facilitator) -

- 6.1 Demonstration of MSE tool
- 6.2 How to test different options on key inputs
- 6.3 HCR – MP creation
- 6.4 Discussion on trade-offs
- 6.5 Questionnaire

18 of May Afternoon

7 STATUS OF THE MANAGEMENT PROCEDURE EVALUATION/OPERATING MODELS (Facilitators)

- 7.1 Albacore tuna (Iago Mosqueira, Vice-Chairperson of the WPM)
- 7.2 Bigeye tuna (Dale Kolody)

- 7.3 Yellowfin tunas (Dale Kolody)
- 7.4 Skipjack tuna (Hilario Murua, Chairperson of the SC)
- 7.5 Swordfish (Iago Mosqueira, Vice-Chairperson of the WPM)

19 of May Morning

**8 DISCUSSION ON THE ACTIONS NEEDED FOR THE ADOPTION OF MANAGEMENT PROCEDURES,
INCLUDING BUDGET (Facilitator)**

- 8.1 Albacore tuna
- 8.2 Yellowfin tuna
- 8.3 Skipjack tuna
- 8.4 Bigeye tuna
- 8.5 Swordfish

**9 FUTURE DIRECTION OF THE TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES
(Chairpersons)**

- 9.1 Workplan (Including new timelines/budget and resources needed)
- 9.2 Priorities
- 9.3 Process and future meetings of TCMP

19 of May Afternoon

10 ADOPTION OF REPORT (Chairpersons)

APPENDIX I
TABLE OF PERFORMANCE INDICATORS ENDORSED BY SC18

Candidate performance statistics	Performance measure/s	Summary statistic
Measures: Sustainability		
Objective: probability of maintaining stock in the Kobe green zone		
Mean spawner biomass relative to unfished	SB/SB ₀	Geometric mean over years
Minimum spawner biomass relative to unfished	SB/SB ₀	Minimum over years
Mean spawner biomass relative to B _{MSY}	SB/SB _{MSY}	Geometric mean over years
Mean fishing mortality relative to target	F/F _{targ}	Geometric mean over years
Mean fishing mortality relative to F _{MSY}	F/F _{MSY}	Geometric mean over years
Probability of being in Kobe green quadrant	SB, F	Proportion of years that SB ≥ SB _{targ} & F ≤ F _{targ}
Probability of being in Kobe red quadrant	SB, F	Proportion of years that SB < SB _{targ} & F > F _{targ}
Measures: Safety		
Objective: maximize the probability of the stock remaining above the biomass limit		
Probability that spawner biomass is above 20% of SB ₀	SB	Proportion of years that SB > 0.2SB ₀
Measures: Yield		
Objective: maximize catches across regions and gears		
Mean catch	C	Mean over years
Mean catch by region and/or gear	C	Mean over years
Mean proportion of MSY	C/MSY	Mean over years
Abundance: maximize catch rates to enhance fishery profitability		
Mean catch rates by region and gear	A	Geometric mean over years
Measures: Stability in catches		
Objective: maximise stability in catches to reduce commercial uncertainty (i.e. minimise year-to-year fluctuations in catches)		
Mean absolute proportional change in catch	C	Mean over years of absolute (C _t /C _{t-1})
Variance in catch	C	Variance over years
Variance in fishing mortality	F	Variance over years
Probability of fishery shutdown	C	Proportion of years that C = 0

Note: All the candidate performance statistics are summarised using the XXth percentiles (e.g. XX=5/10/50) of their distributions over multiple stochastic realisations. The summary will include short and long-term time windows (e.g. 1, 3, 5, 10 and 20 years).

Annex D. A GLOSSARY OF SOME TERMS REFERRED TO IN PRESENTATIONS AND DISCUSSION AT THE TCMP03

	IOTC
B	Stock biomass, which may refer to various components of the stock. Often spawning stock biomass (SB) of females is used, as the greatest conservation concern is to maintain the reproductive component of the resource.
B_{LIMIT}	Biomass Limit Reference Point. A biomass level below which is considered to be undesirable and which management action should avoid (Can also be expressed as SB _{LIMIT})
B_{TARGET}	Target biomass. A biomass level that is desirable and which management action should aim for (Can also be expressed as SB _{TARGET})
B_{THRESHOLD}	Threshold biomass. A biomass level above B _{LIMIT} and below B _{TARGET} (Can also be expressed as SB _{THRESHOLD})
B_{CURRENT}	Biomass in the last year(s) of the stock assessment (Can also be expressed as SB _{CURRENT}).
B₀	Initial biomass prior to fishing as estimated from a stock assessment (Can also be expressed as SB ₀)
B_{MSY}	The equilibrium biomass that results from fishing at F _{MSY} . In the presence of recruitment variability, fishing a stock at F _{MSY} will result in a biomass that fluctuates above and below B _{MSY} (Can also be expressed as SB _{MSY})
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.
Depletion	B/B _{ref} where ref can be any reference related to biomass
E	Exploitation rate. The proportion of the stock removed by fishing
Error (Uncertainty)	Differences, primarily reflecting uncertainties in the relationship between the actual dynamics of the resource (described by the OMs) and observations.
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.
F_{MSY}	The fishing mortality rate that produces MSY
F_{TARGET}	The target fishing mortality rate
Harvest Control Rule (HCR)	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.
Implementation	The process of applying to the fishery the decision on exploitation, catch or effort levels proposed by a Harvest Strategy. Might include some level of divergence, termed implementation error.
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 B _{MSY} and to F _{MSY} , respectively. A Kobe plot is often divided into four quadrants by a vertical line at B=B _{MSY} and a horizontal line at F=F _{MSY} .
Limit Reference Point (LRP)	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 (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 Procedure (MP)	A management procedure has the same components as a management 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	<p>Some combination of monitoring, assessment, harvest control rule and management action designed to meet the stated objectives of a fishery. A fully specified management strategy that has been simulation tested for performance and adequate robustness to uncertainties is often referred to as a Management Procedure.</p> <p>Synonymous with harvest strategy. (But note that this is also used with a broader meaning in a range of other contexts.)</p>
Management Strategy Evaluation (MSE)	A process whereby the performances of alternative management 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.
MSY	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 F_{MSY} .
Operating Model (OM)	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	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).
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).
Reference Points	See definitions for Limit Reference points and Target Reference Points
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 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.
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 (TRP)	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.

Annex E. Guidelines for Review of Management Strategy Evaluation Simulations

OM

Data sources (External only)

- Has the best available data be used?
- Is data openly accesible?
- List data sources used, including years and level of aggregation.

Conditioning (External and Internal)

- Is the conditioning model well specified and documented?
- How is uncertainty being considered?
- Is subsampling being employed to trim down the OM?
- Are alternative OMs being defined, and how?

MP (External and Internal)

- Are the MPs well explained?

Observations (External)

- What data do they require and how will it be processed?

Estimation (External and Internal)

- Is the SA model fully specified?

HCR (External and Internal)

- Is the HCR clearly specified?
- What inputs does it require and what output does it produce?
- Are there limits to change in output?

Implementation (External and Internal)

- Is implementation error being considered as defined and how?
- What time lag exists between data availability, advice and management being in force?

Simulations

Tuning (External and Internal)

- Has tuning for a set of management objectives been carried out?
- How was this conducted?

Documentation

Platform (External)

- Is the platform developed using open source or freely available tools?

Documentation (External and Internal)

- Technical manual
- User manual

Ease of installation (Internal)

- Is the software easily avilabe to install on a personal computer?
- Does it require HPC facilities at any step?

Testing (External and Internal)

- Can the presented analyses be replicated fully?
- Has the software used to produce the simulation been tested?

Extensibility (External but optional)

- Can elements in the simulation be easily modified and rerun?
- Does it allow for different formulations (HCR, estimation method) to be introduced?

Performance (Internal)

- What is the performance of the platform (computation time and resources)?

Outputs (External)

- Are the outputs documented and ready for further analysis?

Visualization (External and Internal)

- Are there sufficient graphical outputs to explore the results?
- Can new visualization procedures be easily implemented?