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Report of the 4th Meeting of the MSE Development Group of the Working Party on Methods of IOTC.

Ispra, Italy

5-8 May 2015

SUMMARY

The MSE Development Group (MDG) of the IOTC Working Party on Methods (WPM) held its 4th meeting between 5 and 8 May 2015 in the European Commission Joint Research Centre in Ispra, Italy.

The MDG analyzed the current status of work on Operating Models (OMs) and test of evaluations of Management Procedures (MPs) for IOTC albacore and skipjack stocks. The impact of two recent IOTC meetings, the 2nd Management Procedures Dialogue and the 19th Session of IOTC was discussed.

Work currently starting on MSE for yellowfin and bigeye tuna was also discussed.

A workplan for those three lines of work was agreed, including the peer review process, and organization of tasks leading the next session of WPM and SC.

PARTICIPANTS

- Nokome Bentley, Trophia Ltd. (MD).
- Toshihide Kitakado, TUMSAT (JP). Vice-chair WPM.
- Dale Kolody, CSIRO (AU).
- Gorka Merino, AZTI Tecnalia (EU).
- Iago Mosqueira, EC JRC (EU). Chair WPM.
- Gerry Scott, ISSF.
- Rishi Sharma, IOTC.

1. Review of recent events and current status of MSE work

The MDG DISCUSSED the outcomes of the last round of IOTC meetings related to the WPM MSE work.

2nd Management Procedures Dialogue. 26 April 2015.

Various members of MDG took part in the 2nd Management Procedures Dialogue of IOTC, and presented the work being carried out on albacore and skipjack.

- Highlights
- Report

The issue of catch allocation among CPCs was raised by some participants when discussing MPs based on setting TACs. Changes in allocation across gears would have an effect in some MSE results given the likely changes in total selectivity and MSY-based reference points. It was AGREED by the MDG that the WPM should not analyse any future allocation scenarios unless specifically asked by COM or the SC in subsequent iterations.

The results of the survey circulated among participants at MPD02 indicated that effort and other input control would need to be considered, alone or in combination with catch controls. This will require some modifications to the current OMs, and alternative mechanisms were discussed. It was AGREED that effort controls should be kept relatively simple, with fleets aggregated at a level that will make the computation not too cumbersome.

19th Session of the IOTC. 27 April - 1 May 2015.

IOTC has now adopted Resolution 15/10, *On target and limit reference points and a decision framework* that includes several considerations with effect on the MSE work of WPM, including:

- Biomass and mortality reference points can now be based on proportions of the estimated virgin biomass (B_0) if those based MSY-based cannot be estimated reliably.
- Evaluation of MPs for ALB and SKJ shall be presented to IOTC in 2016, after endorsement of SC in 2015.

The MDG AGREED that the next SC needs to be presented with a final set of OMs for those two stocks, for their discussion and approval, so that the technical basis for future evaluations of alternative MPs is agreed. Furthermore, the WPM will present the SC with a comprehensive view of the technical framework being used for evaluation those MPs, but the MPs themselves need only to be agreed by IOTC in later sessions.

The WPM will also seek explicit endorsement from SC of the table of performance statistics being used to characterize the different MPs.

2. Reflection on the process of MSE development, discussion and adoption at IOTC

The MDG DISCUSSED the process that has been followed so far at IOTC for the presentation, discussion and possible adoption of MSE results at the IOTC COM level. The current format of an open dialogue workshop has many advantages, but it appeared to limit the impact it could have in the COM proceedings and final decisions. The MDG AGREED that the process needs to be further clarified and refined, with the responsibilities of scientists and managers being more clearly delimited.

Ideas for future dialogue or MSE meetings

The MDG DISCUSSED a number of ideas for future dialogue or MSE discussion meetings with managers and stakeholders. The amount of information being presented needs to be limited in order to avoid overwhelming participants with too many scenarios, options and alternatives. The MDG AGREED that if initial results of MSE simulations are to be presented in meetings taken place in 2016, a script could be followed along the following lines:

1. Present first a *basic comparison of 2 or 3 MPs*, highlighting any relevant difference in terms of information requirements, ability to achieve main objectives
2. Extend the comparison, if possible and necessary, to a wider range of MPs, but concentrate on the exploration of trade-offs as a way of separating them and selecting those of further interest to COM.

The MDG AGREED to develop a draft plan for presentation of both OMs and MP results for both the SC and COM/MPD meetings, to be discussed inter-seasonally and reviewed in WPM 06.

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

The MDG REVIEWED the current status of the work on albacore MSE simulations, with special attention to work to be carried out to finalize the OMs over the following months.

Progress

The development on the OMs and initial test of MPs for albacore has progressed little since the WPM and SC meetings in 2014. The results of the OM SS3 runs are being made available through the installation of as single R package, together with the code used to create the SS3 grid.

The presentation of these results to WPTmT was discussed, given the lack of a WPTmT session this year. It was AGREED that WPM chair and vice-chair will explore the best avenues for a dialogue with WPTmT members, and the possibility of a short informative session, to take place immediately prior to the SC meeting, involving the chairs and vice-chairs of WPM and WPTmT, together with any other interested WPTmT scientist.

Refinements

A number of refinements to the current OM were discussed and the following were AGREED to be of greatest priority

- Final review of code that converts SS3 population estimates into quantities to be used for MP evaluation. The code contained in the iotcFL package (https://github.com/iotcwpm/iotcFL) should be further tested given some apparent discrepancies in the aggregated quantities, e.g. total biomass and overall fishing mortality, as calculated from the age-disagreggated outputs and those directly reported by SS3.
- Resampling from the grid of SS3 results, with weighting based on a combination of subjective prior probabilities and final model likelihoods, should be applied again to the latest OM SS3 grid.
- A range of future recruitment scenarios should be constructed that draws on general knowledge about possible future productivity dynamics in the Indian Ocean and less on past estimated recruitments, as those are poorly estimated in the model, and only for the recent half of the historical period.

Workplan

- JUNE 2015
  - Rebuilt grid of SS3 runs
- JUL 2015
  - ALB OM R package v. 0.99 with OM code, results and visualization example
- SEP 2015
  - ALB OM R package and report readxy for external review

- OCT 2015
  - ALB OM 1.0 ready
  - Presentation at WPM06

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

The MDG REVIEWED the current status of the work on skipjack MSE simulations, with special attention to work to be carried out to finalize the OMs over the following months.

Progress

There has been relatively little progress since the presentation of this work to the WPM and SC in December 2014. Building of the software on machines running Windows is now supported. Work has been started on an R *driver* (a script for specifying parameter priors, and management procedure control parameters, and running the binary executable). Automated builds and testing for the project are now at https://travis-ci.org/iotcwpm/SKJ.

Refinement

Several potential refinements to the operating model were discussed:

- Potential changes in the regional structure (currently West, Maldives, East)
- Parameterisation of movement, growth and mortality
- Model conditioning
- Modelling of effort limits.

These will all be further explored in the short term.

Workplan

The following workplan is proposed. It is centred around version numbers for the operating model software with the view to having a 1.0 version to be accepted by the SC meeting in November 2015:

- Version 0.2 Due by July 31, 2015. For review by Advisory Committee and external reviewers. Includes revisions suggested by WPM and WPTT meetings during 2014 and early 2015.

- Version 0.3 Due by October 10, 2015. For presentation to WPM06 (19-21 October) and WPTT17 (23-28 October), Montpellier, France. Includes revisions requested by Advisory Committee. Final minor version before 1.0.
- Version 1.0 Due by November 20, 2015. For approval by Scientific Committee 18, 23-27 November, Bali, Indonesia. Includes any revisions requested by WPM and WPTT. To be used as the basis for evaluating an initial range of management procedures.

5. FUTURE work on Yellowfin and Bigeye OMs

The group reviewed a proposed workplan for BET and YFT MSE development, and endorsed the following approach.

The project should seek a 12 (?) month extension to the FAO contract to spread the work out over a longer time period. This is desirable because the current timeline would only allow for one iteration of feedback from the WPTT, SC and Commission. For the process to work properly, the stakeholders need to be educated about and engaged with the process, and must provide feedback about management objectives and tactical options (i.e. input and output controls). Toward this end it would be preferable for the ALB and/or SKJ process to be completed in advance of the YFT/BET, because they are perceived to be simpler systems.

The operating model software is expected to be based on either the Atlantic bluefin MSE framework (e.g. Carruthers et al. 2014), or the FLR packages (Kell, et al., 2007, http://flr-project.org/). Both approaches provide the advantage of improved reliability through the re-use of existing code, though both would require modification for the proposed application. The Atlantic bluefin OM currently has the capacity to represent stock structure and spatial disaggregation, but not multi-species. FLR is currently developing the necessary spatial dynamics, but can already represent and work with multi-species fisheries. Further comparison is required with respect to efficient implementation of combined catch and effort harvest control rules.

Stock Synthesis will be used as the conditioning model, to maintain some level of consistency with the stock assessment (BET assessments have been based on SS for several years; the 2015 YFT assessment is expected to be based on SS). However the conditioning models will be modified from the assessment, most notably in terms of a harmonized spatial structure that will allow Harvest Control Rules to be evaluated for both species simultaneously. The OMs for both species will consist of two areas - with a west-east split (and potential stock structure discussed below). Fleet disaggregation will be the same as the assessments. It is assumed that the Secretariat will be able to provide the data for both species at the desired stratification.

The initial grid of uncertainty for each species is expected to encompass the following combination of factors (with the expectation of future revision):

- 4 spatial options:
  - 2 areas - 1 stock, highly mixed (analogous to single region)
  - 2 areas - 1 stock, weakly mixed
  - 2 areas - 2 stocks, no overlap (i.e. 2 independent assessments)
  - 2 areas - 2 stocks, moderate overlap
- stock recruit steepness: 3 levels
- M: 2 levels
- longline selectivity: 2 functional options

Functionality for simultaneous multiple species evaluation will be built into the operating model, but this will not be the emphasis for the initial evaluation work (i.e. it is critical for evaluating effort control but not necessarily catch controls)

Harvest Control Rules:

- Data-based and simple model-based HCRs will be compared
- 2-3 tuning levels will be presented (spanning a range that is likely to be of interest to the Commission and consistent with ALB/SKJ), e.g. P(B(2030)>Btarget) = 50%
- Alternative data options may be explored to consider trade-offs in reducing reliance on CPUE, e.g. close-kin based mark recapture

Development timeline

Timing of development was discussed so as to allow IOTC to finalize the discussion and, possibly, adoption of MPs for albacore and skipjack, before embarking on a simnilar process for yellowfin and bigeye.

- OCT 2015 (WPM, WPTT) - presentation of initial software and single species (BET) OM and example HCR evaluation.

6. PRESENTATION of MSE

The presentation of MSE results, including comparisons of alternative MPs and visualization of trade-offs along performance statistics was discussed. The experience of the 2nd MPD meeting was considered very informative. Two main needs were identified, and each will require simnilar but different approaches.

The use of a simplified example for skipjack, running on a spreadsheet, was a very useful tool. A similar approach, but probably based on a more powerful platform, should be considered for future meetings. The MDG AGREED to develop a Concept Note on the

development of such a platform so that appropriate funding can be obtained, for example from ABNJ.

The skipjack and albacore OMs will have to be presented and explained to SC, and for this both authors are making installation of the required software much simpler. The MDG AGREED that demonstration code to allow graphical exploration of OMS inputs and outputs would be very useful and will be developed for use at the next WPM and SC sessions.

7. TRAINING and capacity building on MSE at IOTC

The possibility of a specific session on MSE, prior or parallel to the SC session, was considered. The MDG AGREED to develop an agenda for this session and discuss with the SC chair and the Secretariat the best format for this to take place.

8. tRFMO Activities

The electronic working group on MSE of the tuna RFMOs is in the process of agreeing on an agenda for a future meeting, likely to take place in 2015. The MDG provided the group co-ordinator, Dr Kell of ICCAT's Secretariat, with some feedback on this agenda, including the items in which it felt the need for prompt discussion and agreement across RFMOs would be most beneficial: the use of a common glossary of MSE-related technical terms, and an agreement on a common set of minimum performance statistics to be used across all oceans.

An agenda item being discussed is a common analysis of work being carried out in different oceans on OMs and MSE for albacore tuna. The MDG AGREED that this stock is a good candidate for such a study, so that models and assumptions across oceans can be compared and tested, but will request from the tRFMO MSE co-ordinator further details on the scope and structure of the study.

9. ISSUES for WPM06

The last SC requested the WPM chair to develop and present a document analyzing the possible ways in which a multiple-tier approach to stock assessments for IOTC stocks could implemented. This should define three or more levels of data availability and quality, and present the appropriate stock assessment and forecast methods that could be applied to each of them.

The WPM agreed that the system currently used by ICES could be a good starting point. The chair of WPM AGREED to develop a draft document and circulate it to all WPM scientists with a view of encouraging contributions and discussion.

10. PEER REVIEW process for WPM MSE

A peer review process for WPM work on ALB and SKJ is about to be set up. The WPM proposal included two nevels, internal and external. An internal review, to be carried out by scientists from WPM or the relevant species WPs, has proven difficult, given the lack of clear candidates. The MDG AGREED that the WPM chair should send a message to relevant CPCs' scientists for each of those stocks offering the chance to get involved or to find somebody to do so on their behalf. If no response is forthcoming, the internal review process will be limited to the presentation to WPM and SC.

Two external reviewers should be selected, one per stock. Their contribution would be to review the OMs and simulation platforms prior to WPM, take part on the WPM deliberations, and immediately after that submit a written report. They should also take part on the SC session, presenting their report and evaluating the improvements made by the authors to take on their findings.

The possibility of making use of NOAA's contribution in kind to the ABNJ project was mentioned, and later confirmed with the ABNJ co-ordinator. The MDG identified a number of candidate scientists, that will be contacted by the WPM chair to seek their availability. Candidates who givew a positive response will be later announced and discussed with WPM, WPTT and WPTmT.

11. Any other issues

Tuning of MPs

The MDG discussed the utility of *tuning* MPs (i.e. as used in IWC and CCSBT). This process ensures that the performance of different MPs is identical with respect to the highest priority management objective. For example, one possible tuning objective might be identifying the HCR parameters that result in $P(B_{time=T} > B_{target}) = 0.50$. This simplifies the process of evaluating the relative performance of MPs with respect to secondary objectives (i.e. given that all candidate MPs meet the biomass conservation objective, which provides the best total catch and catch stability?). In addition to simplifying the MP selection process, this approach demonstrates to the Commission how management objectives might be prioritized and operationalized. The disadvantage is that the choice of example tuning criteria might create the perception that scientists are trying to influence Commission value judgements.

The MDG AGREED to develop the necessary output to follow this line of analysis of results to be used if necessary, and once the COM has agreed some initial precedence on management objectives.

Current work on Reference Points for North Atlantic albacore in ICCAT

The preliminary results produced within a EC funded project were presented with regards to North Atlantic albacore MSE development. As it is now, the MSE evaluates a series of alternative Harvest Control Rules with regards to ICCAT management objectives, including conservation (probability of being in the green zone of the Kobe plot and probability of exceeding the interim Limit Reference Point defined for this stock), and fisheries performance (discounted catch and stability on discounted catch and fishing effort).

The Operating Models used in this MSE are the stock assessments produced using alternative series of abundance indexes with the Multifan-CL model. These results were used to provide stock status diagnostics in the latest stock assessment session of North Atlantic albacore.

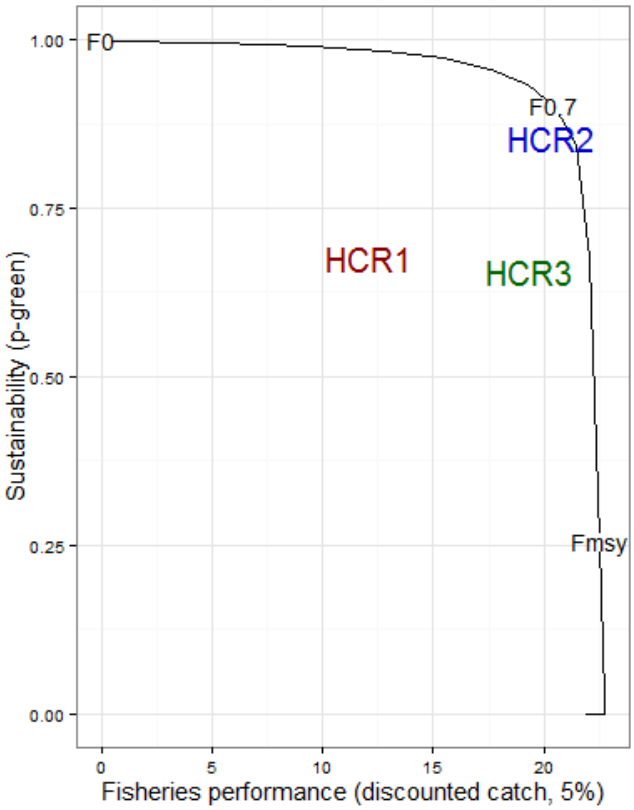
In relation to the Management Procedure, this is composed of (1) a surplus production model, which fits the abundance indicators from the OMs through an Observation Error Model, (2) target (TRP = B > BMSY , F < FMSY and high catch) and limit reference points (LPR=0.4xBmsy) estimated by the surplus production model, and (3), three Harvest Control Rules (with decision thresholds based on the estimated reference points) that reflect alternative fisheries management performance trade-offs.

The performance of the HCRs was evaluated against the potential achievement of management objectives in the case of perfect knowledge and perfect capacity to manipulate the system towards management objectives.

Use of Pareto front plots to represent the MP performance frontier.

The presentation of ICCAT's work on N-ATL ALB included the use of plots of the *Pareto front* that explicitely show the frontier of performance of the MPs being tested along two performance statistics, and given the current knowledge on future dynamics (e.g. future recruitment). The example below presents the performance of 3 alternative MPs along two dimensions: sustainability, calculated as the probability of being in the green area of the Kobe plot at the end of the period, and fisheries performance, calculated as the discounted overall catch. The line represents the maximum achievable value for those two statistics for different values of fishing mortality, from $F = 0$ to F_{MSY}, and given perfect knowledge about the status of the stock.

The MDG AGREED that this could be an useful tool to present trade offs and the limits of suatainable exploitation when comparing candidate MPs. These plots will be added to the outputs generated when evaluating MPs.


1.00
0.75
0.50
0.25
0.00
Sustainability (p-green)
F0
F0.7
HCR2
HCR1
HCR3
Fmsy
0
5
10
15
20
Fisheries performance (discounted catch, 5%)