Updates on development of MSE analyses for Indian Ocean albacore tuna

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Abstract

The work on a new OM for albacore tuna is presented here. An alternative method (ABC) is being developed that is not based on a grid of stock assessment runs. This OM will be reviewed by WPM and SC, and will be ready to be used for MP evaluation in 2024.

Introduction

The current suite of operating models developed for IOTC MSE work have been developed with the species-specific stock assessment as a starting point. A grid of models is assembled that considers alternative options for a number of assumptions and input choices. This include, for example, natural mortality and stock-recruitment steepness, on the stock biology side, and the choice of CPUE series or selectivity function, on the fishery side.

The last operating model (OM) for Indian ocean albacore tuna was assembled through a grid of stock assessment model runs. The base case assessment developed by WPTmT in 2019 was used as starting point for a grid over 6 model assumptions. The model was then updated from it final estimate, 2017, using the yearly nominal catch reported to IOTC. A large proportion of model runs contained estimated populations that could not explain some of those observed catches. A proposal was made to the Working Party on Methods (WPM) to explore an alternative approach for conditioning an OM for the albacore tuna stock. A first version was presented at discussed in 2022 at WPM (IOTC 2022a), while the Scientific Committee (SC) reported on the interest and need for further tests(IOTC 2022b).

Development work has continued, and a more complete version has been reviewed by the last WPM MSE Task Force 2023 meeting. A brief summary of the approach and results is presented here. A final version is expected to be presented to the upcoming session of the WPM (October 2023) so that the model could be

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endorsed by the SC as an appropriate platform for the evaluation of candidate management procedures for this stock.

This work has been progressing through a collaboration between researchers in WMR (The Netherlands) and CSIRO (Australia).

Status of work

Work is being carried out on an alternative methodology for conditioning of operating models for IOTC stock, tailored to those cases where the assessment model grid approach, employed successfully in a number of stocks like bigeye, is not working.

The methodology being developed for albacore builds on the ideas that were already applied to the first operating model for skipjack tuna (Bentley and Adams 2015), which formed the basis for the analyses that led to the adoption of Resolution 16/02 *On harvest control rules for skipjack tuna in the IOTC area of competence*. There, a large number of possible population trajectories, generated from a series of prior distributions, are compared to observed data and deemed *feasible* to be part of the OM or not (Bentley and Langley 2012). The methodology being applied to albacore mostly formalizes this approach by making use of Approximate Bayesian Computation (ABC), a robust statistical method that is applied in many other fields.

The objective of the method is to be able to generate a series of plausible hypothesis on stock dynamics and current status, given the data available and the accumulated knowledge on both the biology of the stock, and the dynamics of the fleets exploiting it. An emphasis is placed on characterizing and incorporating uncertainty about any of those processes, as well as error in both data and scientific knowledge.

Data

The same datasets employed by the stock assessment model are applied here, most notably total catches and length-frequency samples by fleet, and one or more indices of abundance derived for some CPUE series.

Prior distributions

Prior distributions are specified for a number of population parameters, starting with those that were covered in the previous OM by alternative values in the model grid, for example natural mortality, or steepness of the stock-recruitment relationship. Priors are also specified for current depletion level and MSY-related values. For this, information can be obtained still from the stock assessment and incorporated to the model if deemed useful.

Model structure and dimensions

The model mimics the main elements of the stock assessment. It is a seasonal model, considering both sexes modelled with separate growth and selectivity, and a single recruitment event per year. The number of fleets considered has been simplified to include four longline fleets, a purse seine fleet, plus all remaining fleets reporting catches of this stock.

As the objective of the OM is to provide a platform for testing future performance of alternative MPs, the method does not attempt to reconstruct the full history of stock abundance and exploitation. Only cohorts currently alive need to be generated, so the algorithm limits itself to the last 20 years of data. This greatly improves model efficiency.

Initial results

The operating model generated by this algorithm contains a full representation of the stock abundances and fishing mortalities at age, and a measure of the uncertainty in recent dynamics and stock status. Time series of recent SSB (Figure 1) or recruitment (Figure 2), for example, are similar to those reported for other OMs.

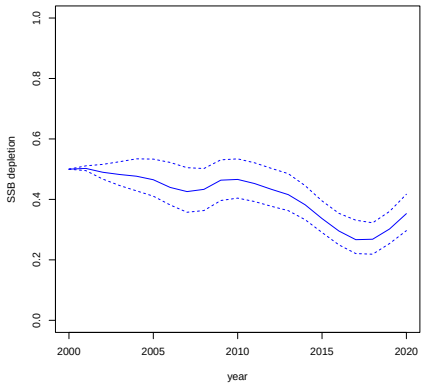

Figure 1: Time series of female spawning stock biomass (SSB), as median plus 95% credibility intervals.

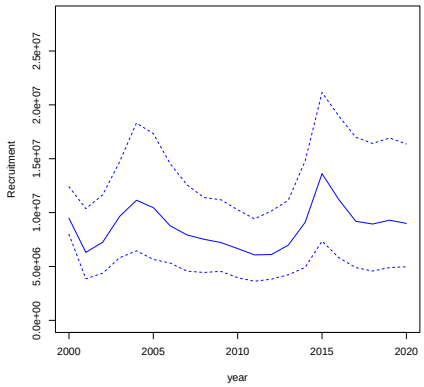

Figure 2: Time series of total recruitment, as median plus 95% credibility intervals.

Similarly, the quality of the model conditioning can be inspected by comparing the agreement between the

generated indices of abundance and the CPUE observations (Figure 3), or with the length-frequency data (Figure 4).

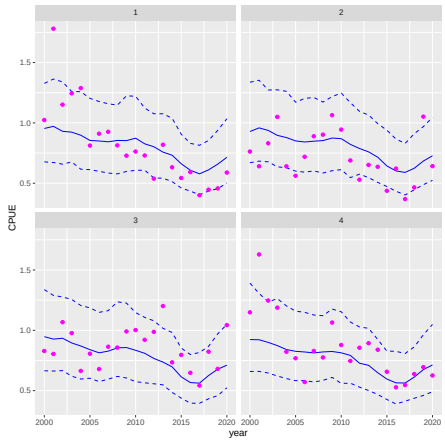

Figure 3: Model agreement with the CPUE data, in this case the Japanese longline series, in each quarter. Dots show the CPUE input observations, while lines show the median and 95% credibility intervals over the OM.

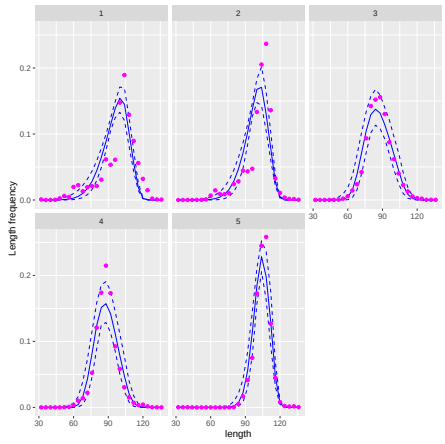

Figure 4: Model agreement with the length frequency data for the five main fleets (longline for seasons 1 to 4, and purse seine). Dots show the accumulated proportions at length, while lines show the median and 95% credibility intervals over the OM.

Discussion

An alternative method for conditioning operating models for IOTC stocks is being developed for albacore tuna. This method extends into a broader statistical approach the method applied in the past to Indian ocean skipjack OM conditioning. The IOTC toolset could benefit from a method that can be used in stock for which the assessment model grid presents problems.

The decision to follow this route for albacore has delayed the progress on MSE analyses for this stock. A full version of the OM will be presented to and reviewed by the upcoming session of WPM in 2023. This could lead to a new OM being endorsed by the SC this year, which would then form the basis on which a complete analysis of candidate MPs for the stock would be run. The results of those tuning runs would be available for TCMP to explore and review in 2024.

The stock assessment grid is likely to continue forming the basis for conditioning of other operating models in IOTC. Current OMs for swordfish and skipjack, for example, provide a reasonable basis for the evaluation of candidate MPs. Having an alternative methodology, however, is likely to be an useful asset, specially in those cases where the stock assessment model does not provide a strong basis for OM conditioning. Current work on albacore could lead to a similar approach being used in other stocks, for example those without a statistical catch-at-age assessment model.

References

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