

Working towards the evaluation of reference points and harvest control rules for IOTC stocks

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1 Introduction

A fundamental shift in fisheries advice over the last 10 or 15 years has been the stronger role that uncertainty and precaution have been playing in the decision making process on fish stocks. The precautionary approach can be seen as the precise translation in management terms of a trend already present in the scientific advice process, that of moving from single point estimates of stock status and productivity to coherent understanding of the uncertainties involved and their effect on our ability to manage natural populations. This has shifted the emphasis from optimality to robustness, and from attempting to extract the most out of a stock to ensuring as far as possible that the resource, and the industry and livelihoods that depend on it, are not placed at risk.

The comprehensive consideration of uncertainty and risk has been greatly helped by recent advances in computational power and technical developments. Management Strategy Evaluation (MSE), also termed the Management Procedure approach, has emerged as the main method by which these ideas are used. A simulation procedure is used to understand the ability of alternative management rules at achieving a set of objectives, under a range of scenarios believed to encompass the most likely sources of noise and bias in a fishery system (Holland, 2010).

Recent decisions by the IOTC plenary and the Scientific Committee have endorsed proposals for development of MSE analyses for IOTC stocks, and WPM needs now to start working on the development of the necessary models and simulations. The objective of this document is to provide arguments for discussion of the multiple steps involved in an MSE process, so that WPM can start the necessary work under the widest possible agreement.

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2 Reference points and the precautionary approach for IOTC stocks

Although the objectives of the IOTC Agreement (“conservation and optimal utilization of stocks”) do not specifically include a reference to the precautionary approach or an exact set of reference points to consider its measuring rod, recent resolutions have started to clarify the situation. In practice, the SC and the Commission have both assumed MSY, or a similarly defined quantity, to be the management target, while no limits had been considered.

IOTC Recommendation 12/14 has now changed this by defining a set of interim target and limits reference points (see below). More important, IOTC Resolution 12/01 has brought IOTC in line with UNCLOS and UNFSA by agreeing to apply the precautionary approach, and to do so by adopting:

stock-specific reference points (including, but not necessarily limited to, target and limit reference points), relative to fishing mortality and biomass, and

associated harvest control rules, that is, management actions to be taken as the reference points for stock status are approached or if they are breached

Paragraph 2 of IOTC Resolution 12/01

The two main pieces of work the Commission will now require are thus clearly defined: an analysis of appropriate reference points for IOTC stocks, and an evaluation of candidate harvest control rules, both for subsequent discussion and adoption of robust management plans.

3 Development and application of management plans in IOTC

The first step in successfully developing any complex modelling procedure, like that involve in an MSE process, is to identify, explore and agree of what tasks the work precisely involves. A simulation process like MSE does not consist of a series of linear steps, and instead feedback and rethinking need to be done at various steps. It is till convenient to build an image of the whole process as if carried out step by step. For this the suggestion is to follow the seven steps presented by Punt & Donovan (2007), summarised as follows:

1. Specify and prioritize **objectives**, qualitative/quantitatively
2. Translate objectives into **performance measures**
3. Develop **operating models**

4. Identify possible **management procedures**
5. **Simulate** the application of management procedures
6. Compare management procedures **performance** and robustness to uncertainty
7. **Select** management procedure that best fits performance criteria

We would like to explore in detail a number of issues involved in carrying out those steps in the previous list under the responsibility of WPM, exclusively or shared with the Scientific Committee.

3.1 Objectives

Defining the objectives that the management plans will attempt to achieve is the responsibility of the IOTC contracting parties and should be decided by the plenary, ideally after sufficient consultation with other stakeholders to ensure the largest possible support. The plenary has already recognized this need and agreed to initiate a consultative process among managers, stakeholders and scientists (para. 27 of IOTC S16 report; IOTC, 2012), although no precise steps or timetables have been adopted.

Despite the lack of defined management objectives at this point in time, we would argue that work should still proceed around a set of interim objectives, which could be derived from the IOTC convention text (IOTC, 1996), other international agreements to which IOTC is bound (e.g. United Nations Convention of the Law of the Sea), and recent IOTC resolutions and recommendations. Recommendation 12/14 on Interim Target and Limit Reference Points, endorsed in 2012 by the 16th session of IOTC, has defined a series of target and limit reference points, in terms of spawning stock biomass (SSB) and fishing mortality (F), defined around those levels expected to produce in the long term the Maximum Sustainable Yield (Table 1)

Stock	Target	Limit
ALB	$B_{MSY}; F_{MSY}$	$0.4 \cdot B_{MSY}; 1.4 \cdot F_{MSY}$
BET	$B_{MSY}; F_{MSY}$	$0.3 \cdot B_{MSY}; 1.3 \cdot F_{MSY}$
SKJ	$B_{MSY}; F_{MSY}$	$0.4 \cdot B_{MSY}; 1.4 \cdot F_{MSY}$
YFT	$B_{MSY}; F_{MSY}$	$0.4 \cdot B_{MSY}; 1.4 \cdot F_{MSY}$
SWO	$B_{MSY}; F_{MSY}$	$0.4 \cdot B_{MSY}; 1.4 \cdot F_{MSY}$

Table 1: Interim target and limit reference points for IOTC main stocks (IOTC-2012-S16-R)

These limits and targets are not simple to translate, as required, into performance criteria to be applied across simulation scenarios, as they do not specify the risk associated with each of them that the managers are willing to accept, nor a time frame by which those probabilities need to be achieved. In contrast, the first management objective for the management plan for Southern bluefin tuna is that any evaluated management procedure should have

“a 70% probability of rebuilding the stock to the interim rebuilding target reference point of 20% of the original spawning stock biomass by 2035”. (CCSBT, 2010)

The second task to advance in the definition of clear and agreed objectives is to initiate the dialogue process the IOTC plenary has already agreed on. This process could take various forms, and involve different actors and different times, but ideally should be carried out without excessive delay. It can also be expected for the discussion on these issues by all stakeholders to lead to one or more processes of dialogue with the SC, until objectives are formulated in a way that allows for its quantitative evaluation.

Various ideas on how to proceed with this step could be considered by WPM for later discussion at the SC. Matching this dialogue with the discussion on allocation could prove useful, as the Technical Committee on Allocation Criteria (TCAC) should have a full representation of contracting parties and many other stakeholders, and its discussions revolve around issues on the future needs and wishes of the participants in the fishery. An overarching management consideration, that of fishing capacity, should form a central element in the discussion.

Discussion on management objectives is likely to be fruitful only if carried out with sufficient information and understanding of the exact nature of management procedures: how scientists intend to test them and against what range of scenarios, what managers are expected to read and interpret in the final results, and what are the possible advantages and disadvantages of the system.

The SC could attempt to organize, with the help of WPM and the agreement of the chairs of IOTC and TCAC, a workshop session covering some of the issues involved in a discussion of management objectives, including:

- Target and limit reference points
- Uncertainty and risk
- Variability and predictability of stock dynamics
- Testing of management procedures with MSE
- Interpretation of results

If such a workshop is to be proposed, preparations would need to start without delay, and the WPM could agree during this meeting on an initial agenda, focused on what elements would it need to cover, and what tools could be used to present them.

3.2 Performance measures

A set of fairly obvious performance measures can be derived from the definition of the target and limit reference points under scrutiny. The probability of reaching the targets, and of exceeding the limits, will have to be considered, although no risk has been specified as acceptable, so no direct measure of failure or success exists. This will be essential when comparing harvest control rules and specially if referring to limit reference points: should they never be exceeded or is there an acceptable risk limit? An *interim* interpretation in risk terms of the interim reference points might be required if no further advice on management objectives in those terms is provided by the Commission when required in the modelling process.

WPM could propose suitable avenues to explore appropriate risk levels given existing practice or recommended guidelines. An initial setup could be based on the already accepted Kobe2 Strategy Matrix (K2SM), by specifying the risks associated with a set of initial performance indicators along some short to medium term time frames.

3.3 Operating models

An Operating Model (OM) for a fishery needs to be as complex as the range of questions that will be later explored by simulation. If one of the alternative management rules involves a time-area closure, then the operating model needs to have the appropriate spatial and temporal resolution. The availability of data, in both scale and quality, will still need to be considered, as it is the case with stock assessment models, although in a less limiting way.

It is not uncommon for complex stock assessments to form the basis for an OM, but the assessment methods needs to be able to incorporate and/or calculate the uncertainty in key parameters and inputs, to be then transformed into a probabilistic view of fishery and stock. Two of the stock assessment methods currently employed in IOTC, Stock Synthesis 3 and Multifan CL, appear to be suited to this use. They can be extended to account for higher complexity (in time, space, number of fleets, ...), and could in principle use auxiliary information to provide model parameters, and derived quantities such as biomass or numbers-at-age, in probabilistic terms. Other tuna RFMOs, e.g. IATTC and WCPFC, are also working on using this models as basis for OMs.

Initial tests of one of those models (the 2011 SS3 assessment for IOTC yellowfin), has also shown some of the difficulties in the process, as the model outputs did not provide the full range of derived quantities necessary. Some extra work, and the involvement of experts with experience using any of these two platforms, would be require to advance in their use, but the overall amount of work could be relatively small, and an initial set of OMs could be developed at least for some stock with relative ease.

An alternative approach is the construction of a complete model of stock and fishery, like it was the case for the recent work on evaluation of management plans

by CCSBT (http://www.ccsbt.org/site/management_procedure.php). The time and expertise required for this is likely to be significantly higher, although the resulting model could possibly be more flexible and adapted to the specifics of IOTC stocks.

An initial exploration of a range of uncertainties and processes to be considered by the OMs could be carried out in the meeting. Sensitivity analyses of current stock assessments already indicate the importance of certain data sources and parameter assumptions. We would propose that a review of the results of those analyses is produced and an initial table is agreed by the group. Among those, for example:

1. Stock structure and spatial dynamics, and its relationship with effort distribution and environmental processes
2. The technical and trophic interactions among target and related species
3. Error and bias in fishery-dependent and (possibly) independent measures of stock abundance or fishing mortality
4. Robustness of stock assessment to uncertainties in both data and model structure
5. Effect of assumptions on biological processes (e.g. growth, stock-recruitment relationship)
6. Stationarity of biological parameters
7. Quality and completeness of data

3.4 Candidate MPs

Selection of candidate management procedures in an MSE process has as an usual starting point in the existing management framework for a given stock, or variations on it. In the case of IOTC, the management procedures currently employed are very limited in scope, and could be summarized along two main lines: a limitation on overall capacity for some fleets (Resolution /) and a reduced spatio-temporal closure (Resolution /). The first imposes an overall limit in the growth, in nominal terms of part of the fishery, but does not effectively restrict future growth in many fleets or the actual effort exerted on the stocks.

The current setting may give the scientific community of IOTC a role to play in the discussion, not by proposing particular types of management procedure, but by analyzing for the benefit of managers the advantages and disadvantages of different ones when applied to the stocks and fisheries of IOTC. The 15th Session of the Commission showed its willingness to hear the case for and against any management options when it

“agreed that the Technical Committee on Allocation Criteria while devoting most of its efforts to develop a mechanism for quota allocation shall also consider appropriate alternative management measures. In this regard the Commission stressed the need for all IOTC CPCs to work inter-sessionally towards achieving this objective as soon as possible” (para. 103 of the S15 report).

We would like to propose that the WPM raises the issue for the SC to consider offering its independent scientific advice on the major factors to be weighted when choosing across a range of possible management measures, or a combination of them, specially those that could have an impact on the ability of the SC to provide quantitative advice, through MSE, on any of them.

3.5 Simulations

Carrying out the whole set of simulations involved in an MSE analyses requires an appropriate infrastructure, as even relatively simple procedures will have to be repeated thousands of times. The computational power at scientists’ disposal is now greater than ever was, and it is being made available more simply and economically by many recent web-based technologies.

The software platform that has been used so far for WPM work, based on the R statistical programming language (R Core Team, 2012), is able to make use of various technologies for High Performance Computing (HPC), including dedicated clusters and computing grids¹.

4 Team and expertise

The activities of WPM will have to be carried out inter-sessionally by a minimum number of scientists with the necessary availability and resources, helped and directed by a larger group of interested scientists. Assembling this team and organizing its work in the very near future is a key element for the success of WPM’s mandate on management plans.

It is very likely that even a team of dedicated scientists will not be able to cover certain specific elements of the work, and the necessary expertise might need to be sought elsewhere. Any such element that could be identified by WPM could be considered by IOTC to be covered under an specific contract with suitable consultants, if funds are available and both SC and Secretariat consider this an appropriate mechanism. Subsequent discussions on the WPM workplan for 2012-2013 should ideally identify as soon as possible any area in which consultancy work could be useful and explore the possibilities with SC and Secretariat. The agreed rules on accessibility and transparency of the work under WPM (open source code, validation before acceptance, . . .) would obviously apply to contracted work.

¹See, for example, <http://cran.r-project.org/web/views/HighPerformanceComputing.html>

More generally, WPM should discuss and identify any elements of its work that would benefit from an specific source of funding, and suggest to the SC, after discussion with the Secretariat, that this be transmitted to the Commission.

Needs for training and capacity building need also to be identified, and possible ways of fulfilling those needs could be explored. Other institutions are already carrying out training programmes in line with those that could arise out of WPM work, and potential synergies could be exploited to IOTC's advantage. For example, the International Council for the Exploration of the Sea (ICES) includes in its training programme a course on Management Strategy Evaluation, with the European Commission Joint Research Centre (EC JRC) is also offering courses on R for fisheries science.

5 Conclusion

This document has explored in further detail the different elements that make up the comparative analysis of management options that the WPM has been asked to perform. A number of issues have been highlighted that should be considered when deciding on a future course of action and a workplan for the 2012-2013 period.

6 References

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