Received: 7 & 16 October 2013

Progress and Arrangement for Management Strategy Evaluation of Indian Ocean Skipjack Tuna

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Summary

One of the conditions of MSC Certification of Maldives pole-and-line skipjack fishery was that limit and target reference points for the stock are appropriate and there is a well-defined and effective harvest control rule in place. Maldives Seafood Producers and Exporters Association (MSPEA) as the MSC Certification Client has agreed to implement the MSC Client Action Plan (CAP) where these objectives have to be achieved for the Indian Ocean skipjack within the first five- year cycle of the Certificate.

Formal recognition of reference points and harvest controls are now mandatory in the IOTC following the adoption of the Resolution to implement the Precautionary Approach for managing tuna species in the Indian Ocean.

In order to achieve the overall objective of establishing reference points and harvest control measures for major Indian Ocean tuna species the Working Party on Methods has formulated a work programme for undertaking Management Strategy Evaluations (MSE). The MSE Work Programme focuses initially on albacore the most heavily exploited stock in the IOTC area. Maldives, as part of their commitment in implementing the CAP has taken the initiative to conduct MSE work on skipjack side by side with the IOTC-supported albacore work. This paper reports the ongoing Maldives-lead SKJ MSE work and the arrangements in place for communicating and coordinating this work with the broader MSE work programme of IOTC.

Background and Context

Maldives has a long history of fishing for tuna using the highly selective livebait pole-and-line method. Traditionally the catch was cooked, smoked and sun-dried to produce Maldive fish exported almost exclusively to Sri Lanka. The fleet underwent a revolutionary change in the mid 1970s following motorization of the sailing fleet. The efficiency of the fleet increased thereby tripling the total catch by mid 1980s.

By early 1980s Maldives was exporting frozen tuna to Thailand and soon exporting canned tuna to Europe. Maldives has always fared well with the 'tuna sustainability movement' because of its highly selective method of harvesting tuna.

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Despite the Maldives' environmentally friendly 'pole-and-line' brand there was pressure from European buyers for the Maldives to obtain MSC Certification for its tuna fisheries to guarantee access to premium market, but also to champion sustainable management of the tuna in the Maldives and in the Indian Ocean. At the same time many European buyers publicly announced they would only purchase products sourced from pole-and-line fisheries (Greenpeace, 2012) gaining additional credibility and need to MSC certification of the fishery.

MSC Certification process started in 2007. With successful MSC pre-assessment of "Maldives Pole-and-line and Handline line Fisheries" in 2008, the full assessment process started in 2009. However, for reasons of assessed stock status, yellowfin and bigeye tuna components of the pole-and-line fishery was dropped and so as the handline yellowfin tuna component. The pole-and-line skipjack fishery continued its assessment but later has to be suspended in response to stakeholder concerns on lack of proper model-based assessment of Indian Ocean skipjack stock.

The Working Party on Tropical Tuna, 2011 meeting provided the first model-based assessment of the Indian Ocean skipjack tuna stock that announced the status of the skipjack stock was healthy (IOTC, 2011). Resumption of pole-and-line skipjack assessment started in mid 2012 and finally the fishery was certified in November 2012 with 8 conditions to be addressed in the first five-year cycle of the certificate (www.msc.org, 2013)[4]. The Client Action Plan (CAP) agreed between the CAB (Certification Conformity Body) and the Client (MSPEA and MoFA) details the work programme for fulfilling those conditions (www.msc.org[5], 2013).

CAP Requirements on MSE

The most important MSC CAP requirements are on reference points and harvest controls. These are given in Conditions 1 and 2 which states that:

1. the limit and Target Reference points should be appropriate for the stock
2. that there is well defined and effective harvest control rule in place

Because they are meant for the whole stock, the management unit of the IOTC, it requires Maldives to collaborate with the IOTC, the Contracting Parties of the Commission and other stakeholders for their support of this work.

The milestones to achieve for the limit and target reference points are:

[4] http://www.msc.org/track-a-fishery/fisheries-in-the-program/in-assessment/Indian-ocean/Maldives-pole-and-line-and-handline-tuna, accessed 07 October 2013.
[5] http://www.msc.org/track-a-fishery/fisheries-in-the-program/certified/indian-ocean/maldives_pole_line_skipjack_tuna, accessed October 2013.

- Year 1: That IOTC has adopted a Resolution on interim limit and target reference points, and a process to be in place for Management Strategy Evaluation (MSE) that include skipjack and progress are reported in IOTC Meetings.
- Year 2: Maldives to provide evidence of engagement with other skipjack fishing members gaining support for the adoption of appropriately precautionary formal, reference points
- Year 3: Adoption of formal, appropriately precautionary and scientifically based target and limit reference points.

The CAP requirement on harvest control is very detailed. The Plan talks of the need to work during inter-sessionally with the Secretariat, CPCs and the international NGOs to promote and establish an agreed position on the adoption of formal harvest control rules consistent with the harvest strategy in place. The milestones to achieve are:

- Year 1 - Have proposed interim harvest control rules for consideration for adoption and have promoted the need to define formal harvest control rules with the IOTC, related to the definition of interim reference points for skipjack tuna
- Year 2 - Have identified the options of harvest control rules and IOTC have proposed resolutions for adoption by the IOTC
- Year 3 - IOTC have adopted formal scientifically-based harvest control rules
- Year 4 - Adopted Resolution for formally binding harvest control rules related to the adoption of formal and appropriately precautionary biological reference points.

Existing RPs and HCRs

Considerable progress has been made on interim measures while the work of formalizing them under MSE framework takes place. With the adoption of the implementation of the Precautionary Approach in 2012[6], interim measures on reference points were also adopted as a Recommendation[7]. Further progress was achieved in 2013 when those interim limit and target reference points were adopted as a Resolution[8]. The Resolution 13/01 titled 'on interim target and limit reference points and a decision framework' also included a reference to elements of harvest control rules should the stock reaches to limits and targets on the Kobe plot.

Resolution 13/10 clearly states that interim reference points shall be assessed and further reviewed by the IOTC Scientific Committee and results are presented at Commission for adoption.

The Resolution 13/10 also calls to Scientific Committee to assess as soon as possible and more particularly through management strategy evaluations process the robustness and the

[6] IOTC Resolution 12/01: On the implementation of the Precautionary Approach
[7] IOTC Recommendation 12/14: On interim target and limit reference points
[8] IOTC Resolution 13/10: On interim target and limit reference points and a decision framework.

performance of the of the interim reference points based on the guidelines of the International agreements.

Interim reference points adopted are as follows:

Table 1: Interim Target and Limit Reference Points adopted in Resolution 13/10

Stock	Target Reference Point	Limit Reference Point
Albacore	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$
Bigeye tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.50\ B_{MSY}$; $F_{LIM} = 1.30\ F_{MSY}$
Skipjack tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.50\ F_{MSY}$
Yellowfin tuna	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$
Swordfish	B_{MSY}; F_{MSY}	$B_{LIM} = 0.40\ B_{MSY}$; $F_{LIM} = 1.40\ F_{MSY}$

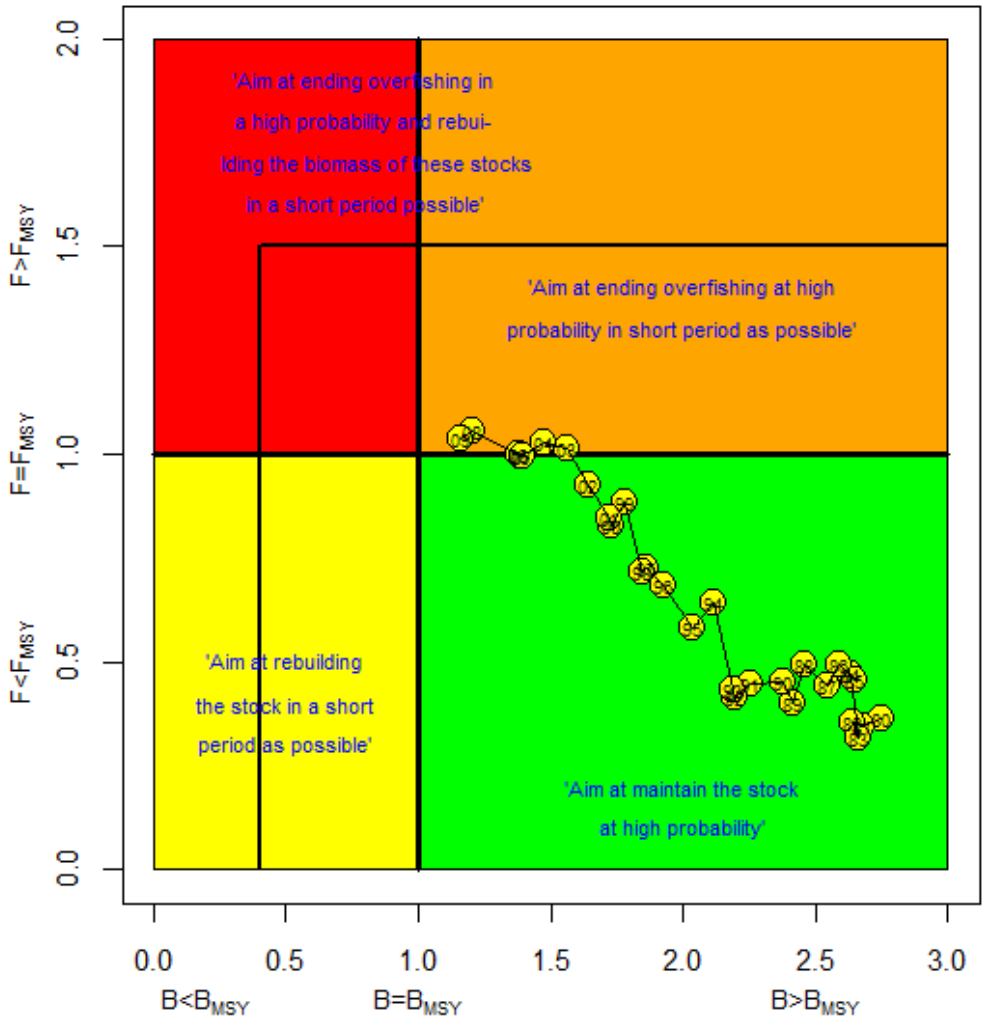

Figure 1: Harvest control rule – qualitative statements for that formed the decision framework.

For the skipjack and indeed for all others, the target reference points were taken as biomass and fishing mortality levels of the stock that would produce the maximum sustainable yield.

For skipjack tuna interim limit reference points were set as $0.4B_{MSY}$ and $1.50F_{MSY}$ of the biomass and fishing mortality respectively

There are no explicit harvest controls agreed in the interim period. However, Resolution 13/01 talks of a decision framework and provides some guidelines decisions based on the assessed stock status in relation to the Kobe Plot (Figure 1). Again, the recommendation is that robust harvest control rules should be developed for major species of the IOTC.

What is MSE?

Management Strategy Evaluation is a process of simulating the reality or how things may operate in a simulated world, under a range of management scenarios and prescribed target objectives, which harvest control rules performs best. In other words it is an exercise that involve assessing the consequence of range of management options through computer simulations

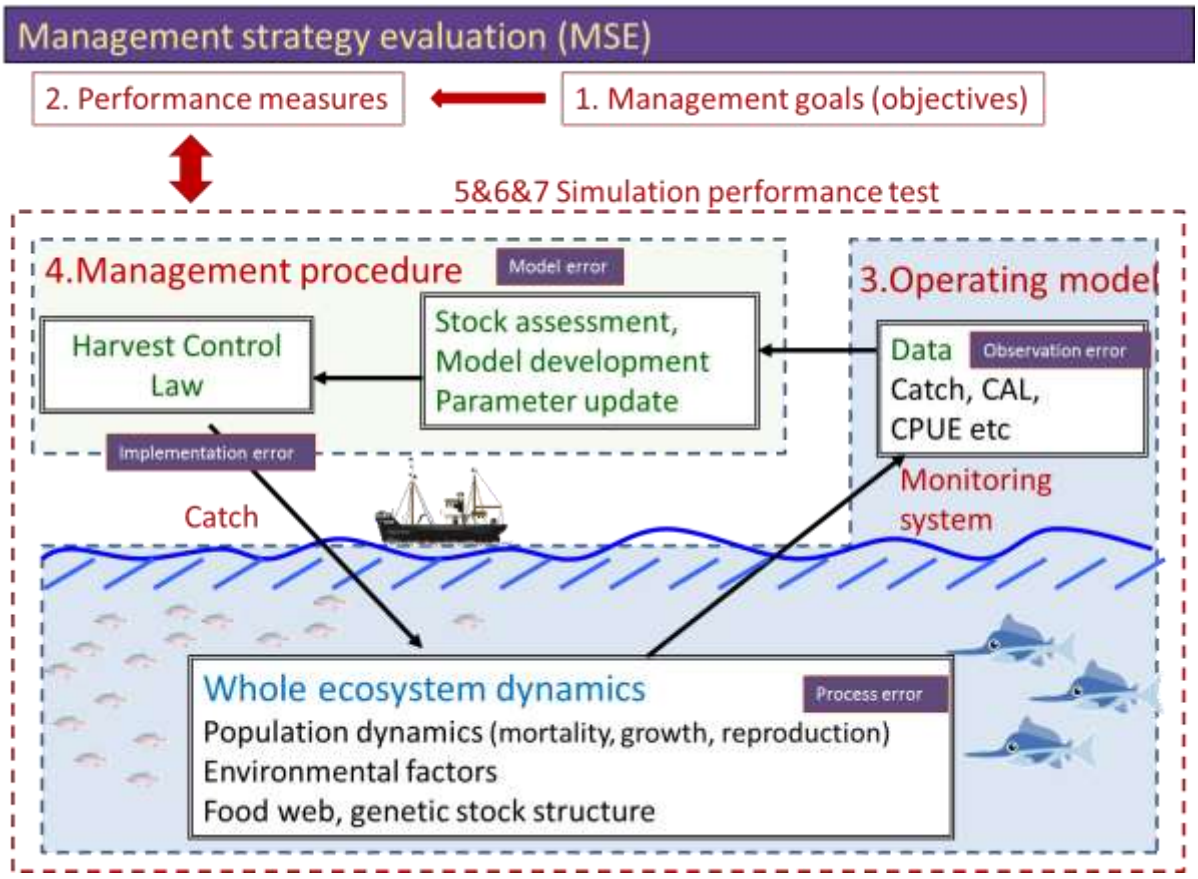

Figure 2: Conceptual sketch of Management Strategy Evaluation (From Dr. T. Kitakado, pers. Comm.)

The most important aspect of this exercise is building a 'system state' model, also called the operating model. Ideally the operating model should capture the full complexity of stock dynamics and its interaction with the ecosystem. Often conditioning of the model with

existing data is required so in practice the model predictions are roughly consistent with the observations.

Simulated sampling of the data (the fishery and fishing) takes take place from an observation model where the simulated fishery data is fed into the stock assessment models. The assessment results are subjected to harvest control rules (or management actions) depending on the state of stock framed on the Kobe plot. The simulation (of sampling the catch, undertaking the assessment, applying the harvest control rules if required) is repeated for several thousand runs so that full range of uncertainty can be be captured and presented.

Finally for each stock assessment cycle and with progressive advancement of time horizon, the performance of the management procedure is tested against the stated objectives. By this way a whole series of management procedures can be tested against series of harvest control rules to select an appropriate procedure that would achieve stated objectives.

The MSE process through simulation effectively captures the process error (in operating model), the observation error (in observation model), the model error (in the stock assessment model) and the implementation error in the application of harvest controls. The process is depicted in Figure 2.

IOTC Programme of Work on MSE

Following the adoption of the Precautionary Approach and Recommendation on interim reference points, the Working Party on Methods has recommended an MSE Work Programme which is now endorsed by the Scientific Committee in 2012.

The Report of WPM-2012 (IOTC, 2012) states the requirement for clear management objectives and the need for translating them into performance measures. Advice on development of operating models and conditioning of the model with existing data has been recommended so that model predictions are roughly consistent with observations. The MSE work plan is in Appendix 1. It was agreed to hold inter-sessional meetings to be attended by core-modelers and interested national scientists.

The priorities for MSE work identified by the IOTC were albacore followed by the other tropical species. Maldives' requirement on SKJ MSE work was urgent and so as stated in the CAP; Maldives has started a programme for working on SKJ MSE by hiring a private consultant to work along with the Programme work of IOTC with support from the stakeholders.

Identifying a Consultant

The WPM04 work programme indicated an IOTC-supported consultant to work closely with the Chair of the WPM and during the inter-sessional periods to work on building operating

model for albacore tuna. It was Maldives' thinking that their consultant doing MSE work on skipjack tuna should also work closely with the IOTC team and the Chair of the WPM. The process of identifying and selecting a consultant was therefore undertaken in close consultation with the Chair of the WPM and the IOTC Secretariat. The Proposal by the Maldives for Indian Ocean Skipjack Management Strategy Evaluation Work[9] was circulated to a number of potential groups and experts working in the area. The contacts were actually based on the recommendations made by the Secretariat and the WPM Chair. The consultant identified for the MSE work was Nokome Bentley of Trophia Ltd, New Zealand, who has right expertise and credentials to do this work.

Financial Support

The CAP suggests that MSE work ought to be done with the support of CPCs and NGOs. This is critical as buy-in from stakeholders is required. Funding for the MSE work so far has been provided by the International Pole-and-line Foundation[10] (IPNLF), Maldives Seafood Processors and Exporters Association (MSPEA) and the Maldives Ministry of Fisheries and Agriculture. Some aspect of the work is also supported by the International Seafood Sustainability Foundation (ISSF) and by WWF.

Advisory Committee

MSE exercises are highly technical work requiring expertise on modeling fisheries population dynamics, but also in depth knowledge on fisheries in questions. In the context of the tRMFO and the skipjack stock, it is also important to gauge what might be best for the group. In order to provide advice to the Consultant and steer the work for broader acceptability by the Indian Ocean Community and international group of experts have been identified to provide advice formally or on ad-hoc basis.

The Advisory Committee for Maldives-lead MSE Skipjack work consists of the following

1. Prof. Keith Sainsbury, Professor – Marine Systems Management, Institute of Marine and Antarctic Studies, UTAS, Australia; Vice Chair – MSC Board of Trustees
2. Dr. Campbell Davies - Program Leader, Integrated Marine and Coastal Assessment and Management, CSIRO, Australia
3. Dr. Gerald P. Scott, Member of ISSF Scientific Advisory Committee
4. Mr. Alejandro Anganuzzi, Former Executive Secretary, IOTC; Member of ISSF Scientific Advisory Committee
5. Dr. Victor Rastrepo, Chair of the ISSF Scientific Advisory Committee; Member Technical Advisory Board, MSC

[9] Funding Proposal by the Maldives for Indian Ocean skipjack Management Strategy Evaluation, January 2013.
[10] www.inpnlf.org (International Pole-and-line Foundation), accessed, October 2013

6. Dr. Iago Mosqueira, Research Scientist, European Commission – Joint Research Center; Chair of IOTC Working Party on Methods
7. Dr. M. Shiham Adam – Director General, Marine Research Centre, Maldives, Vice Chair, IOTC-WPTT, and Advisory Committee Coordinator

Support for the Advisory Committee is provided by the International Seafood Sustainability Foundation (ISSF).

Consultation Workshops

The nature of the work requires engagement of stakeholders in every stage. Feedback from the stakeholders on what is possible and what is not possible as control measures will be important to create wider buy-in before the results are formally presented to the Commission. Two consultation workshops have been planned in 2014 that are expected to be supported by the NGOs.

The plan is to communicate the exact nature of management measures considered (for e.g., seasonal / areas closure, other effort controls) to stakeholders as early as possible to create buy-in and acceptability. There are plans to present the progress of this project so that greater buy-in and acceptance is received before the references and harvest controls are presented formally to IOTC

Documentation and Reporting

One of the conditions of the contract with the consultant is to make available the source code of the operating model and that used for the simulations and integration of the operating model with the stock assessment models being used in the IOTC. The arrangement by the WPM Group has been to have all the source code of MSE work available on GitHub (a source code version control service). Presently the operating model source code is hosted on Trophia Ltd's GitHub account (http://github.com/trophia/ioskj). Draft documentation for the operating model is already available on a dedicated site (Model documentation: http://trophia.github.io/ioskj/; Source code documentation: http://trophia.github.io/ioskj/doxygen/html/index.html). Documentation will be an ongoing as the coding work progresses. The important thing is that the source code and the documentation are available on the public domain for the stakeholders.

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Appendix I

Work plan for management strategy evaluation for Indian Ocean skipjack tuna

Revision: 20 August 2013

Experience has shown that, in most cases, management strategy evaluation is best approached as an iterative process of design, development, evaluation and revision rather than as a linear series of tasks. An iterative process allows for more constructive input from a variety of stakeholders and engenders a greater degree of ownership and buy-in. As such, this document avoids being too prescriptive and is intended as a general plan rather than a definitive set of tasks and milestone dates.

August 2013

- Model structure determined:
    - Preliminary pending input from WPM and WPTT in October 2013
    - Fish population: area and age structured (possibly also size to allow for proper modelling of size specific exploitation).
    - Fishing fleet: area and method structured (although noting some combinations will be minor/zero)
    - Areas:
        - West (**W**): west of 75° E excluding Maldives
        - Maldives (**M**): 70° E to 75° E, 8° N to 2° S
        - East (**E**): east of 75° E
    - Methods:
        - Purse seine FAD/log-associated schools (**PSA**)
        - Purse seine free schools (**PSF**)
        - Pole and line (**PL**)
        - Gillnet (**GN**)
        - Longline (**LL**)
- Code repository established
- C++ code architecture established (i.e main classes and functions, naming and calling conventions etc)

September 2013

- Unit testing established
- Documentation system established
- Data sets collated (to be used for conditioning OM):
    - Quarterly catches by area and method
    - Quarterly pole and line CPUE (for area M)
    - Annual purse seine CPUE (for area W)
    - Z-estimates from tagging (for area W)
    - Quarterly (?) length frequency by area
- Prior parameter distributions defined
    - Preliminary pending input from WPM and WPTT in October 2013

  - All parameters will require priors, possibly uninformative, for use in conditioning algorithm

October 2013

- Preliminary conditioning completed
  - conditioning implemented and run
  - conditioning diagnostics prepared (e.g fits to data, prior v posterior parameter distributions)
- Presentations given to WPM and WPTT:
  - project aims, rationale and work plan,
  - preliminary model, priors and conditioning results
  - illustrations of how model will be used to evaluate alternative management procedures/harvest control rules for IO SKJ
  - presentation to WPTT more general, presentation to WPM focussing on technical aspects (e.g conditioning algorithms, improving fits to data)

November 2013-April 2014

Timing of tasks to be revised closer to the period and subject to finalisation of meeting dates (e.g. interim meeting of WPM)

- Revisions made based on input from meetings of WPM & WPTT October 2013
  - Revise model structure
  - Revise priors
  - Revise conditioning
- Preliminary set of performance statistics defined
  - Preliminary pending input from IOTC working parties
  - Target and limit reference points already defined in IOTC Resolution 13/10
- Preliminary management procedures/harvest control rules designed
  - Preliminary pending input from IOTC working parties
  - Model-free MPs potentially including indicators from:
    - CPUE
    - Tagging-based estimates (e.g. Z)
    - Size composition data
  - Model-based MPs unlikely to be fully developed this round (to start simple) but simple model-based MP may be useful for illustration
- R interface established (to allow MP evaluations to be run from within R)
- Presentation to interim meetings of WPM & WPTT?

May 2014-onwards

Finalisation of MSE and presentation to appropriate IOTC meetings