REPORT OF THE 5th WORKSHOP on MSE, IOTC WPM

The 5th workshop on Management Strategy Evaluation of the Working Party on Methods of IOTC was held at the Shinagawa campus of Tokyo University of Marine Science and Technology (TUMSAT), Tokyo, from 5-8 April, 2016. The list of participants is given in Annex A. The Group is composed of members of WPM actively involved on the development of MSE simulations for IOTC stocks, and others willing to follow these developments and provide feedback and advice.

1. Introductory items

1.1 Opening remarks

Kitakado welcomed the participants to the workshop and to Tokyo. 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 and BET.
2. To agree on how best to present MSE results to both IOTC SC and COM.
3. To plan in detail the upcoming Management Procedures Dialogue (MPD03), and reflect on the SC proposal for a Technical Committee on MPs to take over its role.
4. To plan future activities related to training on MSE, collaboration across all tRFMOs on MSE, and peer-review of IOTC MSE work.
5. Develop a possible roadmap for the next 2 years of MSE work.

The agreed agenda is given as Annex B. The list of documents and presentations is given as Annex C.

1.2 Election of Chair and appointment of rapporteurs

Kitakado served as Chairman. Rapporteur(s) for each agenda item are shown in brackets in Annex B.

2. Review of current state of affairs

2.1 Update on MPD02 and COM(S19) in 2015

The MPD02 was held in Busan, Korea on 26 and 28 April 2015. The MPD is mandated under IOTC Resolution 14/03 on enhancing the dialogue between fisheries scientists and managers. The session first aimed at clarifying the various elements of a Management Procedure, and how the process of MSE is utilised to assess the performance of candidate MPs. In COM(S19), a list of performance indicators, as endorsed by SC, were presented but there was no formal agreement or support. The list was subsequently modified and clarified during WPM06 & SC18.

2.2 Update on WPM06 and SC18 in 2015

The WPM06 developed an updated list of performance measures representing a suite of candidate management objectives and this was then endorsed by the SC18 (see Appendix VI, SC18 report).

Regarding the Management Procedures Dialogue (MPD), the WPM06 was concerned by the lack of adequate communication in the IOTC process between the SC and Commission to date and recommended that the SC considers the draft outline to establish a formal communication channel for the science and management dialogue to enhance decision making by proposing a "Technical Committee on MP" for bidirectional dialogue between scientists and managers. The SC18 shared this view and recommended it to the Commission.

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

The group REVIEWED the current status of the work on albacore MSE simulations,

with special attention on the conditioning of the OM from SS3 given the WPM reviewers comments, the current MPs, the perfdormance of the software to carry out the projections, the software developed (I as an R package, oalbmse) and other technical details.

3.1 Progress and updates

The development of the OM has been significant since the last meeting of the MSD. The group discussed the alternatives for the OM set up, and discussed some of the plots developed.

With regards to technical details, the group discussed a series of model set up alternatives

including the CV of CPUE series in the OM and in the projections, in line with the WPM reviewers feedback. The group agreed on the use of alternative CV values in the CPUE to demonstrate the benefits of improving CPUE series in the future. For example, it could be shown that CPUE series with CV higher to certain values could make it impossible to run a stock assessment and get reliable results and advice. The group ended up comparing the model set ups for the OMs of all the four species currently under development (see Table 3).

3.2 Discussion of problems and solutions

In the presentation, the comments from the Working Party on Methods on the development of this MSE were discussed and the actions taken to address these comments were presented.

A series of preliminary results were shown and the figures discussed. The group welcomed the use of box-and-whisker plots and the inclusion of past series in the projections too. The group recommended to add the box-and-whisker plot for the first year of the simulations so managers can check the impact of alternative MPs in the short term. These plots should be produced for each run, but managers will be shown a simplified version, focusing on the trade-offs between MPs.

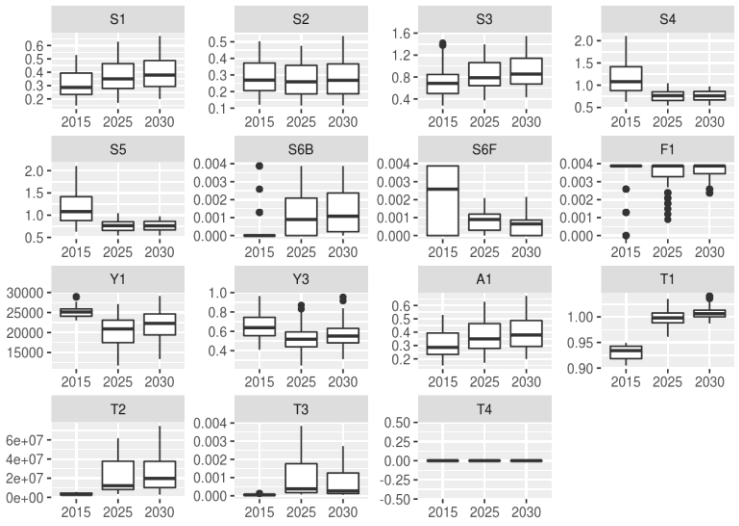

Figure 1: Example box-and-whisker plot showing the distribution of values for every performance indicators at three time steps, and for a single MP run on ALB.

With regards to the future workplan for this MSE, four tasks are expected before June 2016:

1. to carry out the full set of runs and tunning for 2 MPs
2. incorporate the additional runs to the OM
3. the finalization of the "ioalbmse" package with all required package documentation
4. adding MP runs to the shiny application for visualization of MSE results.

Please refer to Table 3 for a comparison of the elements of the ALB MSE.

The Group also discussed the expectations for development of the MSE of albacore due to the possible limits to the involvement of the current developer in the future.

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

The Group reviewed the current status of the work on skipjack MSE simulations, with special attention to work to be carried out to finalize simulation outcomes to be presented at MPD03 in May, just before S20.

4.1 Update on status and issues

Since WPM06 & WPTT16 (October 2016), a number of steps have been taken. The feedback received from WPM and WPTT, and SC, which have all endorsed the SKJ OM, has been addressed; independent reviewer comments and suggestions have been received and considered; the OM and outcomes from alternative MPs classes were presented at a workshop in the Maldives in February, 2016, which narrowed focus on one of the MP classes considered – the BRule which was of main interest to a number of IOTC CPCs attending; and an investigation of performance of the so called “Mald2016” MP has been initiated. Further updates based on feedback at this meeting are anticipated, including further definition of appropriate ranges for MP control parameters and for adequately capturing uncertainty in the operating model.

4.2 Discussion of problems and solutions

The Group identified some topics that require some additional investigation both before and subsequent to the MPD03. The MDG noted that the SKJ OM considered the recommendation for 4 areas, but further consideration resulted in reverting to 3 areas and supports this outcome. The OM has been revised to a regionalized SRR based on prior recommendations, although alternative

SRR formulations, as suggested by the independent reviewers, have not yet been implemented. MDG recommended that such alternatives (e.g. Ricker or something other than Beverton-Holt formulations used in the OM) be considered in the future in the context of additional robustness tests, since the available stock-recruitment estimates do not represent a sufficiently large dynamic range to clearly select amongst a range of alternatives. Allowing for senescense was recommended in previous discussions and that functionality has now been incorporated. Sensitivity of performance statistics to this feature requires additional investigation.

It was also noted that it will be useful to place the MP performance statistics in the Kobe context to ease digestion of Commissioners. As the operating model assumes that the fleet is able to take the entire catch limit, the group discussed the option to include a maximum catch limit on MPs to avoid very large catch limits when stock status and absolute biomass estimates are high. This feature would constrain the catch to a limit (e.g. maximum historic catch + 10%) and reduces cyclic behaviour in projections.

It was noted that the OM may produce pessimistic performance statistics due to the assumption that the catch limit set by a MP is always taken. In reality, when the stock biomass is low relative to the catch limit, the entire catch limit is unlikely to be taken because fishing capacity cannot expand and/or there is no economic incentive to do so. Placing restrictions on the changes in catch limit (e.g. 20%) from one year to the next does not necessarily address this issue and could actually compound it. An alternative means of adressing it could be to limit effort changes between years in the simulations.

The Group noted that the model-based MPs for skipjack do not fully define the stock assessment method and instead assumes that an assessment estimate will be available with known error characteristics.

Please refer to Table 3 for a comparison of the elements of the SKJ MSE.

5. Review of status of work on yellowfin and bigeye OMs and MPs

5.1 Progress report

The preliminary software for supporting the technical needs of yellowfin and bigeye OMs and MSE is on track for completion mid-June 2016. Demonstration cases were selected and

presented for review by the group. Key software features are as follows:

- The base code is derived from Carruthers et al. (2014) platform devised for Atlantic bluefin, with many modifications to suit the tropical tuna requirements
- Spatially-disaggregated with age-dependent movement, age structured, quarterly dynamics, multiple fleets with age-based selectivity.
- The option for multiple stocks with independent biological characteristics is implemented, but not tested.

The R version catch dynamics are based on an approximation to the Baranov equations, and can accept a mix of annual TACs and TAEs (only one per fleet). TACs are distributed proportional to the distribution of recent catches and TAEs are represented as multipliers to recent effort (in both cases the distribution is calculated as the mean by quarter and fishery over the most recent two years in the stock assessment).

A C++ based projection subroutine is being implemented with the standard Baranov equations, to improve speed, and provide an independent check on the general integrity of the R code and appropriateness of the approximation of the Baranov equations.

Demonstration OMs were defined based on a balanced grid of model assumptions derived from recent Stock Synthesis assessments (key assumptions are defined and compared with skipjack and albacore in Table 3). For bigeye, the OM consisted of 18 SS specifications = 3 steepness x 3 M x 2 CPUE catchability assumptions. For yellowfin, the OM consisted of 36 SS specifications = 3 steepness X 3 M X 2 CPUE catchability X 2 tag likelihood weighting assumptions.

Simple deterministic projections demonstrated that

1. in the absence of future fishing, the total biomass, recruitment dynamics and CPUE are estimated to recover to levels very consistent with historical estimates and observations (though a small inconsistency in spawning biomass currently remains unexplained)
2. long term projections with constant recent effort levels appear to be consistent with stock assessment inferences (bigeye status is estimated to remain in the Kobe green zone, while yellowfin has a high probability of remaining in the red Kobe zone).

Two feedback-based demonstration MPs were presented, with a range of control parameters that spanned a broad area in the management performance trade-off space:

- CPUE-based MP, in which the TAC tends to increase if current CPUE exceeds a CPUE

target (or has an increasing trend), or tends to decrease if current CPUE is less than the target (or has a decreasing trend), ideally stabilizing the population at a desired CPUE level.

- A simple model-based rule, in which a Pella-Tomlinson surplus production model is fit to the catch and CPUE time series every time a TAC setting is required, and a "40:10"-type rule is used to set the TAC as a function of the estimated MSY and B(Y)/B0.

5.2 Key Issues and group recommendations

The question was raised on whether the current suite of features and options in the operating models is adequate to represent the uncertainty required for developing robust management procedures. The group did not consider the multi-stock and spatial features to be an urgent priority at this time. However, the group discussed that fleet definitions should be homogenized and standardized among species specific stock assessment in order to develop a multi-species MSE.

The group thought that the current set of features in the software was sufficient to proceed to the next phase of the MP development process (noting that attempting to include too many details in the first iteration of the MP process could overwhelm progress). Completing the C++ based projection subroutine, and improving the R-based speed/memory management issues and documentation were considered to be the highest priorities.

The group recognized that the demonstration case OMs spanned key uncertainties of the assessments, but did not discuss other possible specifications such as different growth functions and selectivity for LL and expected that future WPM/WPTT/SC meetings would probably request additional specifications which could be addressed in the next iteration of the review process.

A number of specification ambiguities were identified, with the following recommendations:

- Data time lags – a 3 year lag between available data and MP implementation were deemed to be consistent with the current commission data collection and decision process.
- Failure to meet TAC or TAE targets in the simulation process will be ignored by the MPs (i.e. no carry-overs or paybacks)

5.3 Workplan

- June 2016 (end of current contract) – the basic projection software, demonstration case OMs for BET and YFT, and example MP evaluations will be completed, documented and released to the IOTC community.

- July-October 2016 – The bigeye OM should be updated in relation to a new stock assessment. Demonstration case results for bigeye and yellowfin should be presented to the WPTT for scientific review.
- 2017 – external peer review of bigeye and yellowfin MSE has been tentatively scheduled (see section 11).
- 2018 – presentation of preliminary results is scheduled for the Commission.

It was recognized that additional funding will be required to support the BET/YFT MSE work from July 2016 to June 2018. The current developers have drafted a concept note for an extension to the work, and received in-principle support for co-investment through CSIRO. This concept note will be circulated to potential funding bodies in the near future. However, it is recognized that a larger collaborative project across species and research agencies would be a more effective way to support this type of work in the long term (see item xx).

A remaining question is if the uncertainty characterized through the OM is adequate for the purpose of robustness testing through examination of the performance statistics. While the Group could not fully address this issue, it was decided to harmonize, to the degree possible, the approaches used in the SKJ, ALB, YFT, and BET OMs. Table 3 provides the pertinent qualities agreed by the Group to nuse across the OMs for the species of interest.

6. Future work on swordfish MSE

The group noted that Taiwanese scientist Nan-Jay Su had expressed interest in being involved with IO swordfish MSE, and would be contacted by the chair. However, it was recognized that if the Commission considers swordfish MSE to be a priority, it may need to provide adequate funds to ensure that the work can be undertaken.

7. Presentation of MSE

The group agreed to standardize the performance measures and graphical presentation across species.

7.1 Performance Statistics

The performance measures proposed in IOTC-2015-WPM06 were reviewed and updated in Table 1. The following changes were made:

- Arithmetic means replace geometric means (in part due to reviewer concerns about zeroes)
- "Safety" measures based on BLim were added (for albacore, yellowfin and bigeye) to recognize that explicit (interim) limit reference points have been defined.
- "Probability of fishery shutdown" has been revised to reflect the reality that total catches of zero are not realistic for the Indian Ocean.
- Typo in the "Mean absolute proportional change in catch" was corrected.

Time series will be calculated over projection windows of 1, 5, 10 and 20 years, where year 1 is the first year that a TAC or TAE is applied (i.e. as opposed to the first year of projections which might be based on a known or assumed catch because of data and decision process time lags). While it is recognized that MSE is intended to look at medium to longer term performance, one year is included because it is inevitable that industry stakeholders will want to know what the implications of adopting an MP will be in the first year (and they may be particularly disruptive in a rebuilding situation).

The performance indicators described in Table 1 are calculated for each stochastic realization, and then presented as percentiles (10, 25, 50, 75 and 90%) from the distribution of all realizations

It was noted that there is currently an inconsistency in the identified management objectives in that achieving target reference points of F_{MSY} and B_{MSY} with near perfect precision would correspond to roughly equal probabilities of being in the green and red Kobe quadrants, while a high probability of being in the green quadrant implies $F < F_{MSY}$ and $B > B_{MSY}$.

7.2 Time series plots

Time series (quantiles plus some individuals iterations) plots will be used to describe key MSE outputs, including SB/SB_{MSY} (SB/SB0, B/B_{MSY}, B/B0), Catch, F/F_{MSY}, Recruitment and/or CPUE:

- Interim reference point reference lines should be included (green target, red limit) when appropriate.
- Plots are to indicate the median with a line, and the 25-75th and 10-90th percentiles with shaded ribbons.

- When appropriate, 3 individual realizations should be plotted on top, corresponding to the 25, 50, 75th percentiles of SB/SB_{MSY} (or SB/SB0) over the 20 year projection period. These same three individual realizations should then be plotted in all relevant time series plots (i.e. irrespective of which percentile the realization corresponds to in the other plots)

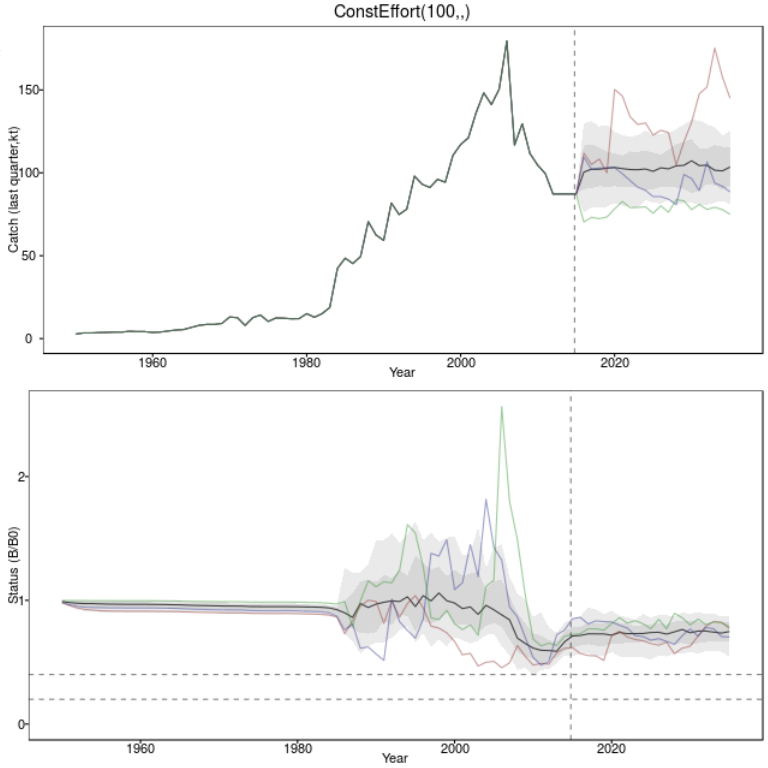

Figure 2: An example of a projection time series plot (this example if for a constant effort of 100% of recent effort). The shaded ribbons indicate the 25-75th and 10-90th percentiles, the black line the median and the coloured lines the individual realizations corresponding to the 25, 50 and 75 percentiles of the of mean SB/SBMSY (or SB/SB0) over the 20 year projection period.

7.3 Bivariate Trade-off plots

Four core trade-off plots, computed for each of 10 and 20 years of projection (i.e. year 1 = first TAC/TAE implementation)

1. SB/SB_{MSY} (or SB/SB0 for skipjack) vs. Yield
2. Pr(Green Kobe) vs. Yield
3. Pr(SB > BLim) vs. Yield
4. mean($1 - C_y/C_{y-1}$) vs. Yield

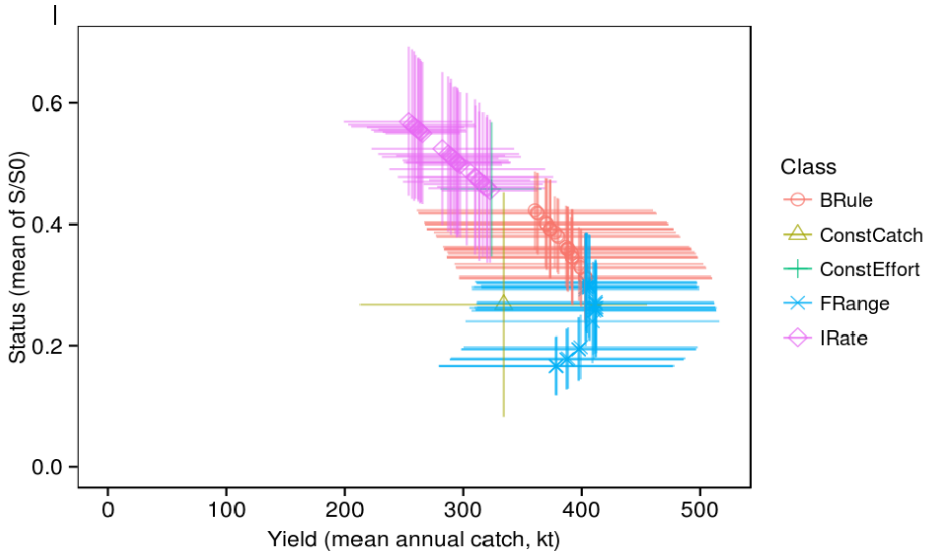

Figure 3: An example of a trade-off plot. This example indicates alternative classes of management procedure using alternative colours and symbols. The vertical and horizontal lines indicate the 25-75th percentiles.

7.4 Confidence interval plots (double whisker aka udon-soba plots)

The summary statistics from Table 1 will be summarized graphically by their median, thick confidence interval whiskers for the 25-75th percentiles, and thin whiskers indicating 10-90th percentiles. These plots can compare several MPs for a single performance statistic within a single panel and can pack a lot of information into a small space, but they are less convenient for

identifying broad patterns than the other plot types.

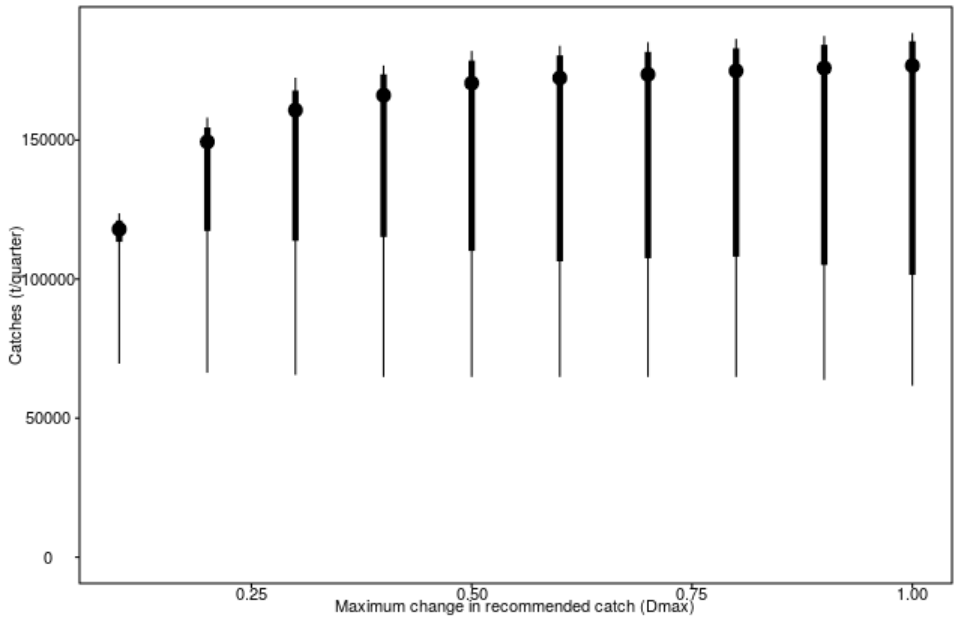

Figure 4: An example of a percentile plot. This example, summarises the effect of one management procedure parameter (Dmax) on the average catch performance statistic.

7.5 Preparation for MPD03

The Group, which includes most of the scientists responsible for the running of the upcoming MPD03, developed further the draft agenda for the session. The emphasis this year will be first on showing real examples of MPs in action, as available from the results of the simulations for skipjack and albacore, and then on the issues related to the adoption of any MP on which the plenary of IOTC would have to agree and decide.

The presentations for MPD03 will show the whole structure of an MP, including the essential part of data collection on the input side, and of implementation on the output. Those two elements will only be able to play their part in the management system if IOTC takes certain decisions with regards to data quality and submission, and carefully considers the tools that might be needed for effective implementation of any adopted MP.

The draft annotated agenda for the MPD03 is included in Appendix C.

8. Training and capacity building on MSE at IOTC For

the Report - Capacity Building

MDG noted considerable capacity building activities have been undertaken at various levels and with varying focus of the IOTC science process. In general a long term approach of continuous and sustained capacity building will be required to realize the expectation of the Commission on conservation of the resources. MDG recognized the need for continued capacity building both within the SC and more broadly across the various CPCs in an open and transparent manner.

MDG also noted that as the Management Procedures Dialogue becomes more formalized, sustained capacity building activities specific to management strategy evaluation / management procedures are needed. In this regard, MDG felt that Secretariat shall continue to seek support from the interested NGOs and international arrangements for capacity building and/or consider including direct IOTC financial support for the required work.

9. Collaboration with other organizations

9.1. tRFMO MSE MEETING

WDG discussed the current situation of the plans for a tRFMOs joint MSE meeting, which was originally planned to be held in the 1st quarter of 2016, but has not yet been formally announced. Past 2015 WDG meetings reviewed the tentative agenda, however it was recognized that the meeting time, place, and participation has not yet been formally decided or announced. The meeting is being arranged mainly by the ICCAT Secretariat. MDG will continue communication with scientists involved in MSE and seek clarification of the joint tRFMO MSE meeting. WGD considers it important to schedule this meeting well in advance in order to avoid conflicts in schedules as calendars for 2016 are already well established for many potential participants.

9.2. ABNJ

ABNJ supports the MSE work in the IOTC as well as in other tRFMOs. It also supports management-science dialogue and capacity building activities in the region. Additional capacity building workshop(s) in the Indian Ocean region are possible, should there be a need identified. MDG recognized the need for such capacity building both within the SC and more broadly across various CPCs.

MDG further discussed progress on MSE in other tRFMOs, including WCPFC and ICCAT. WCPFC has had recent focus on SKJ and has agreed a workplan for other stocks. ICCAT has also progressed on MSE for ALB and BFT and MPs for these have been taken up in dialogue meetings. A workplan for development of an ALB work plan was agreed by ICCAT in 2015, which requires the SC to advise on MPs meeting ICCAT management objectives to be discussed at the 2016 Commission meeting.

10. Presentation on MSE work for N-ATL albacore

ICCAT's management objective is to maintain high long-term catch with a high probability of stocks not being overfished or overfishing occurring and a low probability of being outside biological limits. Harvest Control Rules (HCRs) are sets of pre-agreed defined rules that can be used to determine annual management actions (i.e. annual quotas). These HCRs need to be agreed by policymakers and stakeholders, which is often difficult due to the many uncertainties inherent to fisheries. For this, Management Strategy Evaluation (MSE) is used to estimate different levels of probability of achieving management objectives by alternative HCRs taking into account the existing uncertainties that affect fisheries' dynamics. In this study we have developed a MSE for North Atlantic albacore and simulated the impact of alternative HCRs, concluding that stable high long term catches and conservation objectives are achievable with certain levels of precaution.

The group discussed the suitability of these results to be used by policymakers in defining a management procedure for North Atlantic albacore. There are plans at Commission level and part of their decision will be based on the results presented in this document. In general, the group agreed on the use of this work but proposed some points for improvement:

- The group suggested that estimating the cumulative catch in the short term would be informative.
- With regards to the abundance index used, new simulations could be run to evaluate the impact of using fleet specific CPUEs instead of a total abundance index.Alternatives to the shape parameters used in the MPs could be explored, where the shape parameter is fixed within each MP independent of the OM scenario..

It would be convenient to compare the relative biomass in the OM and the MP to see if the HCR produces catch restrictions when real biomass is below the threshold RP and how many times management action is taken without being necessary.

11. 2016-18 MSE Workplan

11.1 Plan toward WPM07, SC19 and COM20

The MDG decided to put together over the next few weeks a concept note detailing the work necessary to carry out beyond June 2016 for completion of the MP evaluations requested by the COM in Resolutions 14/03 and 15/10, and an estimate of the workload and budget required. This note will be circulated to the Secretariat and the Chair of IOTC for exploring possible avenues for funding.

11.2 Peer review process for WPM MSE

External peer review is currently scheduled for bigeye and yellowfin MSE in 2017. It was considered premature to define the dates or terms of reference for the review, as the process has not yet had feedback from the relevant scientific working parties within the IOTC or other stakeholders (managers and industry) who are required to engage in the MSE process.

11.3 Two-year workplan

The group outlined the MSE workplan until 2018 (Table xxx). Achieving these objectives is contingent on securing sufficient resources to support the required work, which have not been confirmed beyond June 2016 for any species.

Future work on MSE development for the different stocks is currently based on the work carried out by the reduced group of developers. The work of some of them is dependent on short term contracts that are either finalizing very soon, or uncertain about any future extension, while another is likely to see his dedication to this work limited. The MDG considered putting together a unique workplan for the four MSE studies currently in progress and another one, SWO, that has been requested by COM. A single workplan would emphasize the linkages between these pieces of work, stronger in the case of stocks captured in the same fisheries (e.g. tropicals).

12. Other business

In this point of the agenda the group discussed the SC recommendation of establishing a Technical Committee on Management Procedures Dialogue. It was agreed that the establishment of the technical group is important to ensure the process of MSE as is expected that will facilitate the

identification and recommendation on management strategies for the IOTC fisheries which are consistent with the objectives of the IOTC Agreement.

The group discussed about the functions, structure and possible Terms of References of the Technical group. The latter include the development of management strategies, establishment of Target and Limit Reference Points, Management Procedures and the risks to the fisheries and the resource at these Management Procedures, all in accordance with the requirements indicated in Resolution 14/03 and 15/10.

The group noted that is important that the Technical Committee specifies the roles and responsibilities of both fisheries managers and scientists and facilitate the establishment of interactions between them.

13 Adoption of report

The meeting closed at 16:00 on 8 April 2016 after reviewing the draft reports. Kitakado thanked the participants for their cooperative and constructive discussion, in particular thanked the MSE developers, Mosqueira, Bentley and Kolody, for their hard work before/during the workshop. He also appreciated the rapporteurs. The meeting thanked the Chair, and it also thanked TUMSAT for providing an efficient working environment and the local hosts for their outstanding hospitality.

Table 1: Naming and labelling to be used for the performance statistics suggested for the evaluation of management procedures.

Abbreviation	**Status : maximize stock status**		
BoB0avg	Mean spawner biomass relative to pristine	B/B_0	Arithmetic mean over years
BoB0min	Minimum spawner biomass relative to pristine	B/B_0	Minimum over years
BoBMSYavg	Mean spawner biomass relative to *Bmsy*	*B*/*Bmsy*	Arithmetic mean over years
FoFTARavg	Mean fishing mortality relative to target	*F*/*Ftar*	Arithmetic mean over years
FoFMSYavg	Mean fishing mortality relative to *Fmsy*	*F*/*Fmsy*	Arithmetic mean over years
PrGreen	Probability of being in Kobe green quadrant	*B*,*F*	Proportion of years that $B \geq Btar$ and $F \leq Ftar$
PrRed	Probability of being in Kobe red quadrant	*B*,*F*	Proportion of years that $B < Btar$ and $F > Ftar$
	Safety : m*aximize the probability of remaining above low stock status (i.e. minimize risk)*		
PrSBgt20	Probability of spawner biomass being above 20% of B_0	*B*	Proportion of years that $B > 0.2B0$
PrSBgtSBMSY	Probability of spawner biomass being above B_{Lim}	*B*	Proportion of years that $B > 0.1B0$
	Yield : maximize catches across regions and gears		
Cavg	Mean catch	*C*	Mean over years
CFRavg	Mean catch by region and/or gear	*C*	Mean over years
Mean proportion of	**C/MSY????**		

MSY			
	Abundance: maximize catch rates to enhance fishery profitability		
Iavg	Mean catch rates by region and gear (for fisheries with meaningful catch-effort relationship)	*I*	Arithmetic mean over years
	Stability: maximize stability in catches to reduce commercial uncertainty		
Cmap	Mean absolute proportional change in catch	*C*	Mean over years of abs(1-C_t/C_{t-1})
Cvar	Variance in catch	*C*	Variance over years
Ccollapse	Probability of shutdown	*C*	Proportion of years that $C < 0.1MSY$

Table 2: Naming and labelling to be used for the performance statistics suggested for the evaluation of management procedures.

Code	Name	Description	Formula
S1	mean(SB/SB_0)	Mean spawner biomass relative to unfished	yearMeans(SB/SB0)
S2	min(SB/SB_0)	Minimum spawner biomass relative to unfished	apply(SB/SB0, c(1, 3:6), min)
S3	mean(SB/SB_{MSY})	Mean spawnwer biomass relative to BMSY	yearMeans(SB/SBMSY)
S4	mean(F/Ftarget)	Mean fishing mortality relative to target	yearMeans(F/Ftarget)
S5	mean(F/F_{MSY})	Mean fishing mortality relative to FMSY	yearMeans(F/FMSY)
S6B	mean(SB/SB_{MSY})	Mean spawning biomass relative to B_{MSY}	yearSums(SB > SBMSY)/length(SB)
S6F	mean(F/F_{MSY})	Mean fishing mortality relative to F_{MSY}	yearSums(F > FMSY)/length(F)
F1	P(SB > 0.20 SB_0)	Probability that spawner biomass is above 20% SB_0	yearSums(SB > 0.2 * SB0)/length(SB)
F2	P(B > Blim)	Probability that spawner biomass is above Blim	yearSums(B > Blim)/length(B)
Y1	mean(C)	Mean catch over years	yearMeans(C)
Y3	mean(C/MSY)	Mean proportion of MSY	yearMeans(C/MSY)
A1	mean(CR)	Mean catch rates	yearMeans(SB/SB0)
T1	mean(C_t / C_{t-1})	Mean absolute proportional change in catch	yearMeans(C[, -1]/C[, -dims(C)$year])
T2	var(C)	Variance in catch	yearVars(C)
T3	var(F)	Variance in fishing mortality	yearVars(F)

Code	Name	Description	Formula
T4	P(C=0)	Probability of fishery shutdown	yearSums(C < 1)/length(C)

Table 3: Comparison of structure and options for the OMs and MPs used in different stocks.

		ALB	SKJ	YFT	BET
OM spec	**Stock/Area**	1 stock/1area	1 stock/3 areas	1 stock/4 areas	1 stock/1 area
	CPUE Conditioning, quarterly	0.1, 0.2, 0.3	Not used	0.3 (independently by quarter and region)	0.1
	CPUE Projected, annual	CV=0.2-0.5	CV=0.2-0.5	CV=0.2-0.5	CV=0.2-0.5
	CAS (Conditioning)	ESS=20, 50, 100	Not used	AC=0.5	AC=0.5
	CAS (generation)		NA	100	100
	Rec	B-H	B-H	B-H	B-H
	Steepness	0.7, 0.8, 0.9	Beta with mode0.9	0.7, 0.8, 0.9	0.7, 0.8, 0.9
	Rec temporal CV (LN, annual)	CV=0.6, AC=0,0.5	U(0.4, 0.8)	CV(quart)=0.6 AC(annual)=0.5	CV(quart)=0.6 AC(annual)=0.5
	Rec Spatial	N/A	Region-specific stock-recruitment	Region-specific distribution, CV=0 in spatial variability	N/A
	Non-stationarity in Bio/eco	None	None	None	None
	M	5 age-specific vectors	U(0.8, 1.2)*Mref	(0.6, 0.8, 1.0)*Mref	(0.6, 0.8, 1.0)*Mref

	growth	stationary	stationary	stationary	stationary
	Selectivity	Time-invariant and aggregated wrt age (=final year of assessment year) , and same as the outcomes of final assessment	Time-invariant and age-based fishery-specific (=final year of assessment year) , and same as the outcomes of final assessment	Time-invariant, age-based fishery-specific from final year of SS model	Time-invariant, age-based fishery-specific from final year of SS model
	Movement	None	Time-invariant (non-seasonal) age-specific	Time-invariant (non-seasonal) age-specific	None
	q	TWN yearly increase by 0 or 1%	time-invariant	Aggregated index (LL) yearly increase by 0 or 1%	Aggregated index (LL) yearly increase by 0 or 1%
	Weighting to tag data	None	NA	0, 1	None (tags not used)
	Robustness Scenario	Nonstationary wrt rec etc?	Robustness testing can be done by widening range of prior, nonstationality in future	Nonstationary wrt rec and movement?	Two separate stocks propoed for software demonstration
	OM scenario weighting	uniform over balanced factorial design grid, filtering algorithm wrt K	Independent parameter-specific prior distributions plus qualititative filtering algorithm	uniform over balanced factorial design grid	uniform over balanced factorial design grid

MP	**Projection period**	20 years	25 years	20 years	20 years
	MP update interval	2 years	1-3 years	1-3 years	1-3 years
	MP lag	4 years	3 years	3 years	3 years
		Example 2014 Data to be used 2016 Assess, MP, SC 2017 COM approveTAC 2018TAC implemented	Example 2015 Data to be used 2016 Assess, MP, SC 2017 COM approved TAC 2018TAC implemented	Example 2015 Data to be used 2016 Assess, MP, SC 2017 COM approved TAC 2018TAC implemented	Example 2015 Data to be used 2016 Assess, MP, SC 2017 COM approved TAC 2018TAC implemented
	HCRs				
	Empirical	CPUE-based “catch proportional to CPUE”	CPUE-based “catch proportional to CPUE”	CPUE-based "aim for target"	CPUE-based "aim for target"
	Model-based	Explicit: Fit surplus production model model and apply "40-10" type rule	Implicit: assumes that WPTT will provide assessment with B(T), Etarg,xxx estimates with independent CV= (xxx-xxx); apply F-based HCR (incl. MAL2016)	Explicit: FitPella Tomlinson surplus production model and apply "40-10" type rule	Explicit: FitPella Tomlinson surplus production model and apply "40-10" type rule
	Implementation error (LN dist) (for catch)	CV=0.2/quarter (0.1 annual) by single aggregated fleet	CV=0.2/quarter (0.1 annual) aggregated over fleets	CV=0.2/quarter (0.1 annual) independent by fleet	CV=0.2/quarter (0.1 annual) independent by fleet

Table 4. Tentative 2-year work plan.

		ALB	SKJ	YFT/BET
2016	MSE-WS (April)	Update	Update	Update
	MPD/COM (May)	New sets of OMs Complete evaluation of tuning of MPs Finalize presentation	Finalize presentation and report	Revise OMs Evaluation of tuning of MPs Completion/Documentation/publication of software
	WPM (Nov 5-7) SC (Dec 5-9)	Extend OMs/MPs upon Com requests		YFT/BET: Internal Review by WPM/WPTT BET: OMs updated based on assessment
2017	MSE-WS (LateMarch?)	External Review?		
		Preparation for TCMP		
	TCMP/COM (May?)	Depend on Com requests		
	WPM/SC			

Annex A: List of Participants

- Toshihide Kitakado, Tokyo University of Marine Science and Technology, Japan
- Iago Mosqueira, Joint Research Centre, European Commission
- Shiham Adam, MRC/Ministry Fisheries &Agriculture, Maldives
- Nokome Bentley, Trophia Ltd
- Dale Kolody, CSIRO, Australia
- Gorka Merino, AZTI, Spain, EU
- Hilario Murua, AZTI, Spain, EU
- Gerald Scott, International Seafood Sustainability Foundation, USA
- Ai Kimoto, National Research Institute of Fae Seas Fisheries, Fisheries Research Agency, Japan

Annex B: Agenda

1. Introductory items (Kitakado)
    1.1 Opening remarks
    1.2 Appointment of chair and rapporteurs
2. REVIEW of current state of affairs (Kitakado)
    2.1 UPDATE on WPM06 and SC18 in 2015
    2.2 UPDATE on MPD02 and COM(S19) in 2015
3. REVIEW of status of work on Albacore OMs and MPs (Merino)
    3.1 UPDATE on status and issues
    3.2 DISCUSSION of problems and solutions
4. REVIEW of status of work on Skipjack OMs and MPs (Scott)
    4.1 UPDATE on status and issues
    4.2 DISCUSSION of problems and solutions
5. REVIEW of status of work on Yellowfin and Bigeye OMs and MPs (Kolody, Murua)
    5.1 Current on status and issues
    5.2 DISCUSSION of problems and solutions
    5.3 CONSIDER multispecies issues
6. FUTURE work on Swordfish OMs (Kolody)
7. PRESENTATION of MSE (Kolody)
    7.1 Explaining models and presenting results
    7.2 Others
8. TRAINING and capacity building on MSE at IOTC (Adam)
9. Collaboration with other organizations (Scott, Kimoto)
    9.1 tRFMO MSE MEETING
    9.2 ABNJ
10. Other ISSUES for WPM07 (Mosqueira)

10.1 3-tier approach document

10.2 Methodology for updating K2M for unassessed stocks

11. 2016-17 ROADMAP (Kolody, Mosqueira, Kitakado)

11.4 Plan toward WPM07, SC19 and COM20

11.5 Peer review process for WPM MSE

11.6 Two-year workplan

12. OTHER BUSINESS (Merino)

12.1 Draft agenda of MPD03

12.2 Other matters

13. ADOPTION of report

Annex C: List of documents/presentations

Toshihide Kitakado: "5th IOTC-MSE workshop: Overview"

Iago Mosqueira: "IOTC albacore MSE update"

Nokome Bentley: "IOTC skipjack tuna MSE update"

Dale Kolody: "IOTC Yellowfin & Bigeye Management Strategy Evaluation Technical Development Update April 2016"

Gorka Merino: "Evaluation of Harvest Control Rules for North Atlantic albacore through Management Strategy Evaluation"

Annex D: Draft agenda for MPD03

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi

IOTC–2016–MPD03–01[E]

DRAFT: AGENDA FOR THE 3RD MANAGEMENT PROCEDURES DIALOGUE

Last updated: 20 April 2016

Date: 21 May 2016
Location: La Reunion, France
Venue: Exposition and Congress Centre "Auguste Legros", Sainte-Clotilde Cedex
Time: 09:00 – 17:00
Facilitators: Graham Pilling (SPC); Toshihide Kitakado (Japan) & Iago Mosqueira (EU)

1. **OPENING OF THE SESSION AND ARRANGEMENTS** (Facilitators; IOTC Secretariat)
2. **OVERVIEW OF THE EVALUATION OF MANAGEMENT PROCEDURES IN THE IOTC** (Chairperson of the Working Party on Methods - WPM)
3. **IOTC SCIENTIFIC COMMITTEE RECOMMENDATIONS, *INTER ALIA* THE RECOMENDED PERFORMANCE MEASURES** (Chairperson of the Scientific Committee)
4. **STATUS OF THE MANAGEMENT PROCEDURE EVALUATION/OPERATING MODELS** (Chairperson of WPM)
   - **4.1 ALBACORE TUNA** (Iago Mosqueira, Vice-Chairperson of the WPM)
   - **4.2 SKIPJACK TUNA** (Nokome Bentley, Consultant)
   - **4.3 YELLOWFIN AND BIGEYE TUNAS** (Toshihide Kitakado, Chairperson of the WPM)
5. **DISCUSSION ON THE ACTIONS NEEDED FOR THE ESTABLISHMENT OF MANAGEMENT PROCEDURES** (Facilitators)
6. **FUTURE DIRECTION OF THE MANAGEMENT PROCEDURES DIALOGUE AND THE SCIENTIFIC COMMITTEE PROPOSAL ON THE ESTABLISHMENT OF A TECHNICAL COMMITTEE ON MANAGEMENT PROCEDURES** (Facilitators)