[*insert species*] MSE – Structure & Status

Introduction

This document describes the structure and core concepts of the [*insert species*] management strategy evaluation (MSE), the current status of that work and associated results to date. The intention is to provide sufficient knowledge to facilitate:

- Discussion of MSE work and candidate management procedures (CMPs) among scientists, fishery managers and other stakeholders at the Technical Committee on Management Procedures (TCMP)
- The development of advice by TCMP to the Commission (and/or MSE technical groups) regarding MSE and CMPs
- The decision-making processes of the Commission in relation to development and implementation of MPs in the IOTC

Background

The IOTC, at its 15th Session in 2011, endorsed the development of a MSE process and the Scientific Committee endorsed a roadmap for its development later that same year. In addition, a meeting of all the tuna RFMOs (i.e., Kobe III) also in 2011 decided on a general move towards this approach for setting catch limits. In 2016 the IOTC established the Technical Committee on Management Procedures (TCMP) specifically to "enhance the decision-making response of the Commission in relation to management procedures", including MSE.

The MSE for [*insert species*] specifically, has been in development since [*insert year*].

MSE Overview

Operating Models

The MSE's historical period is from [*insert year*] through to [*insert most recent data year*], and analysis of projections focuses on the next [*insert number*] years. [include if relevant: The MSE computer code was independently reviewed in [*insert year*], and [no substantive problems were found/substantive problems are being addressed.]

Each operating model (OM) in the MSE represents a plausible scenario/a potential truth for the dynamics of the stocks and the fishery. The [*insert species*] MSE includes [*insert number*] main operating models (i.e., the "reference set or grid of OMs") based on [*insert number*] major sources of uncertainty:
[example from BET:

1. *Recruitment: the number of age 1 fish; reflects stock productivity over time (3 options)*
2. *Natural mortality: the percent of individuals who die of natural causes at a given age (3 options)*
3. *Tag recapture: different weightings on the reliability of the tagging data (3 options)*
4. *Assumed longline catchability trend: whether or not catchability will increase in the longline fishery (2 options)*
5. *Regional scaling of longline CPUE (2 options)*
6. *Longline fishery selectivity (2 options)*
7. *Size composition input Effective Sample Size (ESS) (2 options)]*

The [*insert number]* OMs allow for all combinations of these options. [If the OMs are weighted, include: The relative plausibility of each assumption has been ranked by the [*TCMP/MSE taskforce/WP/SC*] according to a schema, referred to as "weighting," so that the results reflect more importance given to the more plausible OMs. *[insert any relevant (brief) description of the weighting (e.g. expert opinion v data availability).]* There are *[insert number]* additional "robustness" OMs to evaluate less likely but still possible scenarios, similar to more extreme "sensitivity runs" in a stock assessment.

Management objectives

[insert brief summary of current management objectives including the meeting at which they were agreed such as the following example from BET:
While formal management objectives have not yet been agreed for bigeye tuna, the Commission adopted an interim limit reference point of 50%B_{MSY} in Resolution 12-14 and interim target reference points of B_{MSY} and F_{MSY} in Resolution 13-10. The quantitative performance measures used to evaluate performance of these management objectives are outlined in* ***Appendix A****.]*

Candidate Management Procedures

There are currently [*insert number*] candidate management procedures (CMPs) under consideration (**Appendix B**). All currently assume a [Y]-year management cycle and calculate a total allowable catch (TAC) for the entire IOTC management area. [*insert very brief description of differences, e.g. Some include limits on maximum or minimum TAC, or on the percent change in TAC from one management cycle to the next.*]

To enable comparison across the CMPs, they are "tuned" to achieve a common objective on stock status. [*insert species relevant description, e.g.: For bigeye, the two tuning objectives are an exactly 60% or 70% probability of being in the Kobe green quadrant (i.e., not overfished and no overfishing) in years 11 through 15 of the projection*.] By standardizing this stock status, performance against other management objectives can be compared. For example, with a 70% probability of being in the Kobe green quadrant locked in as a requirement, which CMP gives highest average yield?

Preliminary results

We present [preliminary/final] results in Attachment 1 from CMPs to show key performance tradeoffs for competing management objectives. All CMPs will be refined and improved over [*insert time period*].

The performance of each CMP can be summarized as:

[insert 1-2 sentence summary of the performance of each CMP such as the following example:

- *MP1 performed very well for maintaining high catches and performed average for maintaining high catch rates and low catch variability. However, MP1 performed very poorly at maintaining biomass and fishing mortality away from limit reference points and close to target reference points. There is a 20% risk that MP1 will cause the spawning biomass to fall below the limit reference point and a 50% risk that MP1 will cause the fishing mortality to exceed the limit reference point over the next 20 years.]*

Next steps

[*insert a summary of the process to adoption of the MP from this point. e.g. WP in [date] to recommend a reduced number of CMPs to be presented to the TCMP in [date] with the view to the TCMP endorsing one for an MP CMM proposal to the Commission.]*

Other resources

[*insert link to detailed modelling report*]
[*insert link to current MP glossary (e.g. IOTC–2019–TCMP03–INF02)*]
[*insert any relevant IOTC or other MSE resources such as Harveststrategies.org MSE outreach materials (multiple languages)*]

Attachment 1: Preliminary Results

[insert standard plots and tables as shown below]

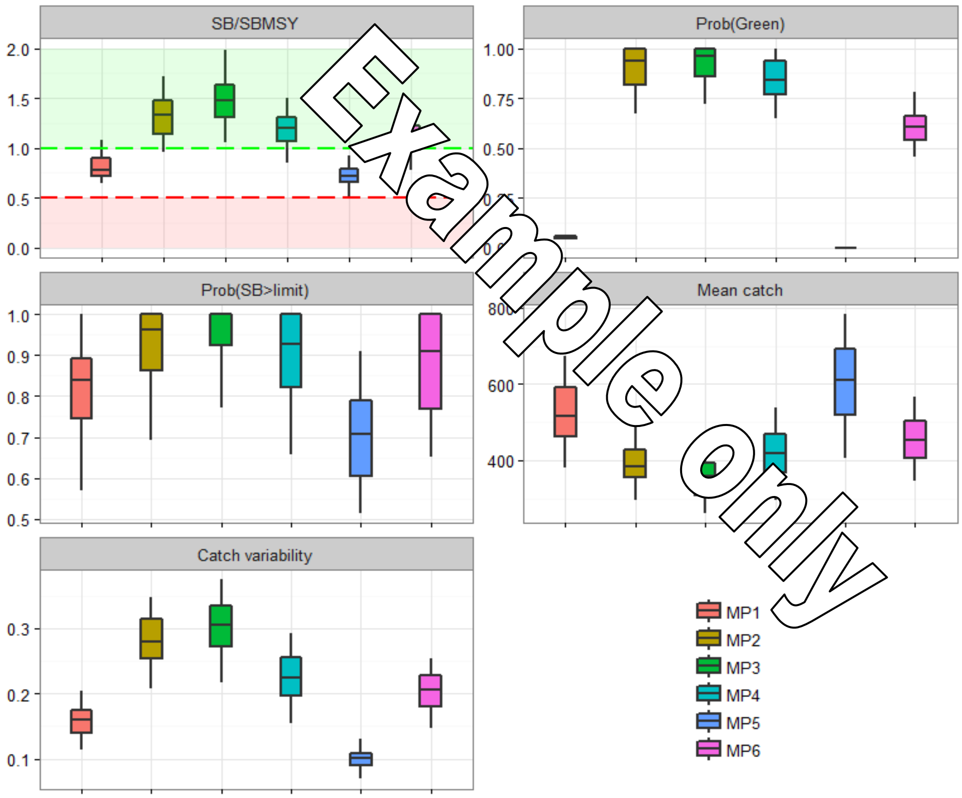
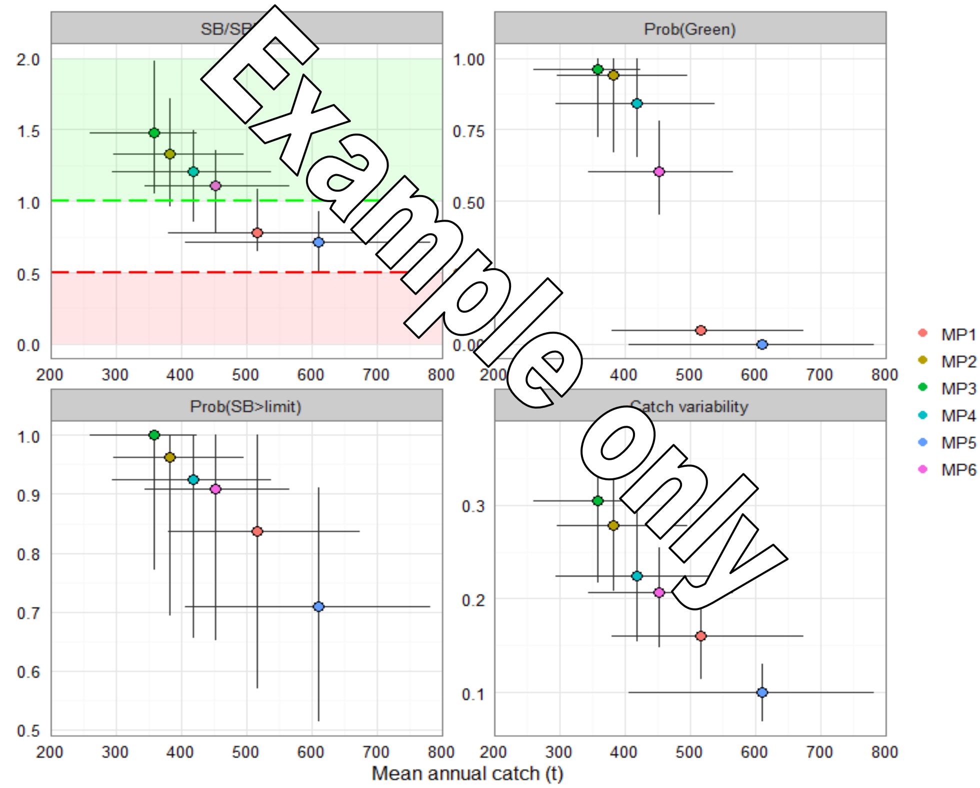
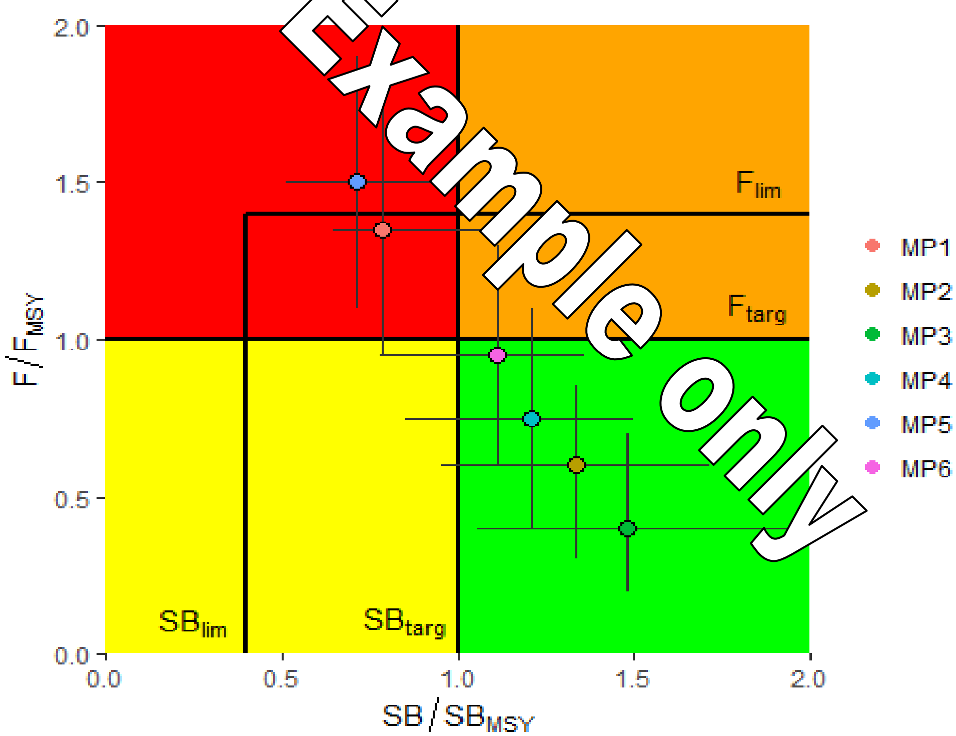


Figure 1: Comparison of MPs against a range of metrics. Each data point represents the median over 20 years of simulation in the projection period as the horizontal line, $25^{th} – 75^{th}$ percentiles as the coloured bars, and $10^{th} – 90^{th}$ percentiles as the thin lines. Limit and target reference points are indicated in the SB/SBmsy plot by red and green dashed lines respectively.



Example only

Figure 2: Trade-off plots. These plots indicate the trade-off in performance against a range of metrics of the candidate MPs. Each data point represents the median over 20 years of simulation in the projection period and error bars the 10th – 90th percentiles. Limit and target reference points are indicated in the SB/SBmsy plot by red and green dashed lines respectively.



Example only

Figure 3: Kobe plot. Each data point represents the median over 20 years of simulation in the projection period and error bars the 10th – 90th percentiles.

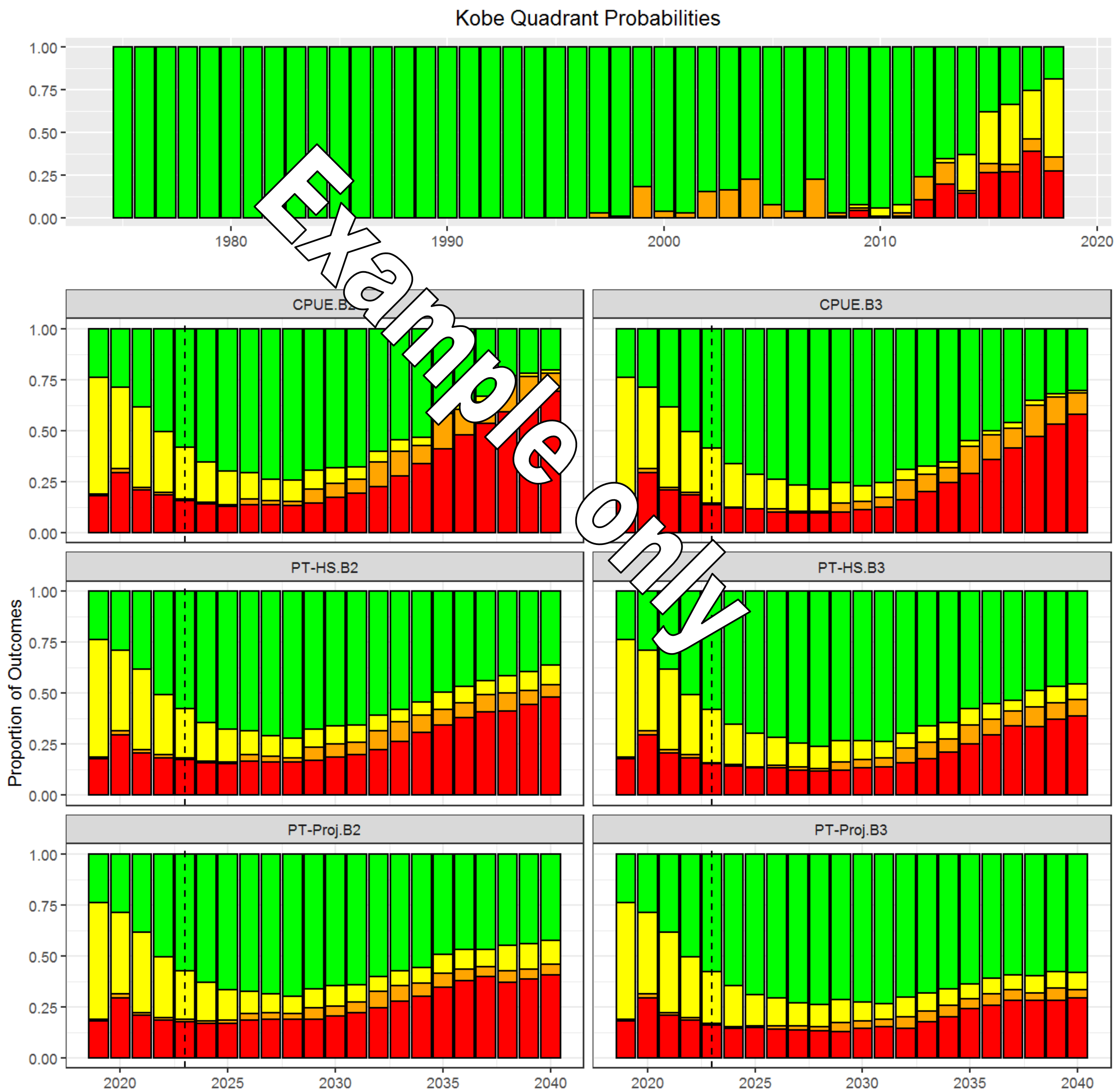


Figure 4: Time-series plots for Kobe quadrant. Proportion of simulations in each of the Kobe quadrants over time for each of the candidate MPs evaluated with the reference set Operating Model. Historical estimates are included in the top panel. The lower panels are projections, with the first MP application indicated by the broken vertical line (*insert year*)

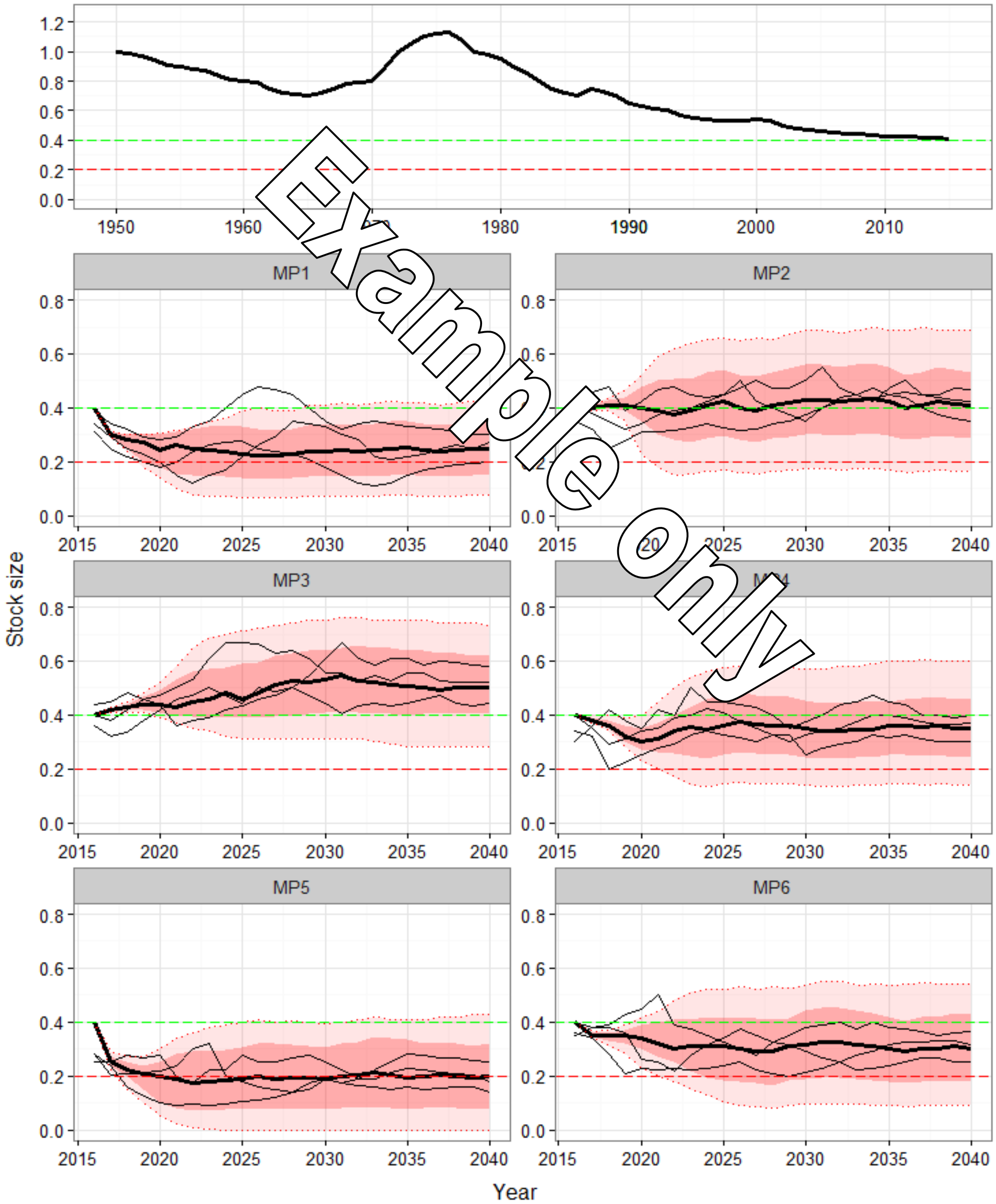


Figure 5: Time series of spawning stock size for the candidate MPs evaluated with the reference set Operating Model. The top panel represents the historical estimates from the reference case operating model, and lower plots represent the projection period. The median is represented by the bold black line, the dark shaded ribbon represents the 25th - 75th percentiles, the light shaded ribbon represents the 10th - 90th percentiles. Thick broken lines represent the target (green) and limit (red) reference points. The 3 thin coloured lines represent examples of individual realizations (the same OM scenarios across MPs and performance measures), to illustrate individual variability.

Table 1: Summary table of performance of candidate Management Procedures (MPs). Performance of 6 MPs against 5 performance measures averaged over 20 years of simulation in the projection period. Shading indicates the relative performance for each MP (dark = better, light = worse).

Management Procedure	**Performance Measure**				
	SB/SB_{MSY}	Prob(Green)	Prob(SB>limit)	Mean Catch	Catch variability
MP1	0.78	0.05	0.84	516	0.16
MP2	1.33	0.94	0.96	383	0.28
MP3	1.48	0.96	1	358	0.3
MP4	1.21	0.84	0.93	419	0.22
MP5	0.72	0	0.71	611	0.1
MP6	1.11	0.61	0.91	452	0.21

Example only

Table 2: Details of performance of MPs across all indicators

Status : maximize stock status		1 year						5 years					
		MP1	MP2	MP3	MP4	MP5	MP6	MP1	MP2	MP3	MP4	MP5	MP6
1. Mean spawner biomass relative to pristine	*SB/SB*0	0.5	0.8	0.9	0.7	0.4	0.6	0.5	0.8	1.0	0.7	0.4	0.6
2. Minimum spawner biomass relative to pristine	*SB/SB*0	0.3	0.6	0.6	0.5	0.2	0.4	0.3	0.5	0.6	0.5	0.2	0.4
3. Mean spawner biomass relative to SB_{MSY}	*SB/SBMSY*	0.8	1.3	1.4	1.2	0.7	1.1	0.9	1.2	1.3	1.1	0.7	1.2
4. Mean fishing mortality relative to target	*F/Ftar*	1.4	0.6	0.4	0.8	1.5	0.9	1.4	0.6	0.4	0.8	1.5	0.9
5. Mean fishing mortality relative to *Fmsy*	*F/FMSY*	1.4	0.6	0.4	0.8	1.5	0.9	1.5	0.5	0.4	0.8	1.6	0.9
6. Probability of being in Kobe green quadrant	*SB,F*	0.5	0.9	1	0.8	0.3	0.7	0.5	0.9	0.9	0.8	0.3	0.7
7. Probability of being in Kobe red quadrant	*SB,F*	[illegible]	0.1	0	0.1	0.5	0.2	0.3	0.1	0.0	0.1	0.5	0.2
Safety : m*aximize the probability of remaining above low stock status (i.e. minimize risk)*													
8. Probability of spawner biomass being above 20% of *SB0*	*SB*	0.8	[illegible]	0.9	0.8	0.7	0.8	0.8	0.8	0.9	0.8	0.7	0.8
9. Probability of spawner biomass being above *B*Lim	*SB*	0.8	[illegible]	1	0.9	0.7	0.9	0.8	1.0	1.0	0.9	0.7	0.8
Yield : maximize catches across regions and gears													
10. Mean catch (1'000 t)	*C*	520	390	[illegible]	430	600	460	551	417	378	434	600	460
11. Mean catch by region and/or gear (1'000 t)	*C*	250	200	[illegible]	[illegible]	310	220	248	194	176	229	335	218
12. Mean catch relative to MSY	*C/MSY*	1.1	0.7	0.6	0.8	1.2	0.9	1.2	0.6	0.6	0.8	1.3	1.0
Abundance: maximize catch rates to enhance fishery profitability													
13. Mean catch rates (by region and gear) (for fisheries with meaningful catch-effort relationship)	*I*	3.2	3.8	3.9	2.7	2.5	[illegible]	3.0	3.8	4.0	2.6	2.3	2.8
Stability: maximize stability in catches to reduce commercial uncertainty													
14. Mean absolute proportional change in catch	*C*	0.2	0.3	0.3	0.2	0.1	0.2	[illegible]	[illegible]	0.3	0.2	0.1	0.2
15. % Catch co-efficient of variation	*C*	20	25	24	18	12	21	[illegible]	27.3	26.2	17.6	11.5	21.0
16. Probability of shutdown	*C*	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Example only

Status : maximize stock status		10 years						20 years					
		MP1	MP2	MP3	MP4	MP5	MP6	MP1	MP2	MP3	MP4	MP5	MP6
1. Mean spawner biomass relative to pristine	*SB/SB*0	0.5	0.8	0.9	0.7	0.4	0.6	0.5	0.8	1.0	0.7	0.4	0.6
2. Minimum spawner biomass relative to pristine	*SB/SB*0	0.3	0.6	0.6	0.5	0.2	0.4	0.3	0.5	0.6	0.5	0.2	0.4
3. Mean spawner biomass relative to SB_{MSY}	*SB/SBMSY*	0.8	1.3	1.4	1.2	0.7	1.1	0.9	1.2	1.3	1.1	0.7	1.2
4. Mean fishing mortality relative to target	*F/Ftar*	1.4	0.6	0.4	0.8	1.5	0.9	1.4	0.6	0.4	0.8	1.5	0.9
5. Mean fishing mortality relative to *Fmsy*	*F/FMSY*	1.4	0.6	0.4	0.8	1.5	0.9	1.5	0.5	0.4	0.8	1.6	0.9
6. Probability of being in Kobe green quadrant		0.5	0.9	1	0.8	0.3	0.7	0.5	0.9	0.9	0.8	0.3	0.7
7. Probability of being in Kobe red quadrant	*SB,F*	0.3	0.1	0	0.1	0.5	0.2	0.3	0.1	0.0	0.1	0.5	0.2
Safety : m*aximize the probability of remaining above low stock status (i.e. minimize risk)*													
8. Probability of spawner biomass being above 20% of *SB0*	*SB*	[illegible]	0.9	0.9	0.8	0.7	0.8	0.8	0.8	0.9	0.8	0.7	0.8
9. Probability of spawner biomass being above *B*Lim	*SB*	0.8	[illegible]	1.0	0.9	0.7	0.9	0.8	1.0	1.0	0.9	0.7	0.8
Yield : maximize catches across regions and gears													
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Stability: maximize stability in catches to reduce commercial uncertainty													
14. Mean absolute proportional change in catch	*C*	0.2	0.3	0.3	0.2	0.1	[illegible]	0.2	0.3	0.3	0.2	0.1	0.2
15. % Catch co-efficient of variation	*C*	20	25	24	18	12	21	19.4	27.3	26.2	17.6	11.5	21.0
16. Probability of shutdown	*C*	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Appendix A

Management objectives (from [*insert relevant citation*]), and the proposed corresponding performance measures.

Management Objectives	Comments	Proposed Performance Measures
[insert MO as quoted in cited documentation]	*[insert any additional explanatory comments]*	*[list proposed performance metric]*

Appendix B

Table of candidate management procedures

CMP	**Brief description and formulae for calculating TACs**	**References**
[name]	*[Brief description of the MP including the formula for calculating the TAC]* *[Example: Full recommended exploitation rate when current biomass is equal to or greater than 20% of unfished biomass; No exploitation when current biomass less than 20% of unfished biomass.* *SSB/SSBo<0.2, TAC = 0* *SSB/SSBo≥0.2, TAC = full exploitation rate]*	*[Reference to IOTC meeting doc]*