

## Annex D

### PROPOSAL OF REVISED STANDARD METHODS FOR THE PRESENTATION OF MSE RESULTS

#### Introduction

The Indian Ocean Tuna Commission (IOTC) management strategy evaluation (MSE) work program was initiated following adoption of the proposal to implement the precautionary approach for managing IOTC species in 2012 (Resolution 12/01). From this Resolution, the IOTC Scientific Committee (SC) was instructed to assess the performance of candidate management procedures (MP) through MSE, and provide the Commission with advice on their performance against Commission objectives. The IOTC Working Party on Methods (WPM) leads the technical development of MSEs for key IOTC species.

Effective and consistent communication of MSE results is important to ensure that decision makers are clearly informed about the likely consequences of implementing different MPs or harvest control rules (HCR). The use of standardised terminology and presentation formats for MSE results would facilitate a better understanding and maximise the engagement of all partners in the MP dialogue. This proposal outlines some guidelines for standardising the communication of MSE results to the Technical Committee on Management Procedures (TCMP) and Commission.

#### Proposal for presenting MSE results

It is important that decision makers are presented with a selection of candidate MPs (or HCRs) from which to evaluate the relative performance against the Commission objectives. However, consideration needs to be given to limit the number of MPs (or HCRs) and performance measures that are presented to avoid saturation and confusion. As a guide, a maximum of 6 candidate MPs (or HCRs) and 6 performance measures would seem to allow sufficient coverage of the range of potential MPs of interest whilst limiting the amount of information to communicate.

The key elements of the presentation material are as follows:

1. **Illustrate the MPs** that have been evaluated in a figure and/or briefly define them in text.
2. Present the results for the performance of each MP in:
  - a. **Boxplots** for a representative subset of performance measures
  - b. **A summary table** that ranks the performance of each MP against a subset of performance measures
  - c. **Trade-off plots** for a representative subset of performance measures
  - d. **A Kobe plot** for the  $B/B_{MSY}$  and  $F/F_{MSY}$  performance measures
  - e. **Time series plots** for stock size and fishing intensity performance measures.
3. Provide a clear and **succinct summary** of the performance of each MP.
4. Provide the numerical results for each MP across all 16 performance measures endorsed by the SC in a table in an appendix.

#### *1. Illustrate the Management Procedures*

It will be important that decision makers have a clear understanding of the MPs (or HCRs) that have been evaluated. To achieve this, a clear description of each MP (or HCR) should be

presented prior to the MSE results, along with an explanation of the relevant decision steps involved. Example figures are illustrated in Figures 1 and 2.

## *2. Performance of Management Procedures*

### *a. Boxplots*

The key plots for communicating MSE results should clearly indicate the relative performance of each MP (or HCR) against a representative subset of performance measures from the categories of status, safety, yield, abundance and stability. These plots should clearly indicate the uncertainties in the MSE using error bars to represent percentiles. Example boxplots are illustrated in Figure 3. The summary period(s) which were used to generate the results should be clearly indicated.

### *b. Summary table*

A summary table that ranks the performance of each MP against the key performance measures is shown in Table 1. The numbers in the table indicate the performance of each MP while the colours represent the relative ranking.

### *c. Trade-off plots*

Trade-off plots provide useful information for evaluating the trade-off between different performance measures, particularly between yield (catch) and other performance measures. Example trade-off plots are illustrated in Figure 4. The summary period(s) which were used to generate the results should be clearly indicated.

### *d. Kobe plot*

An example Kobe plot indicating the performance of MPs is illustrated in Figure 5. Consistent with the adopted guidelines for presenting stock assessment results, the Kobe plot indicates target and limit reference points. The summary period(s) which were used to generate the results should be clearly indicated.

### *e. Time series plots*

Example time series plots are illustrated in Figure 6 for the stock size performance measure and in Figure 7 for the fishing intensity performance measure. Time series plots for additional performance measures may also be relevant. The key elements depicted in these figures are the median of all runs and the 75<sup>th</sup> and 90<sup>th</sup> percentiles and the target and limit reference points. A sample of individual realizations should be included in the projections to illustrate the typically erratic nature of individual trajectories.

## *3. Summary performance of Management Procedures and management advice*

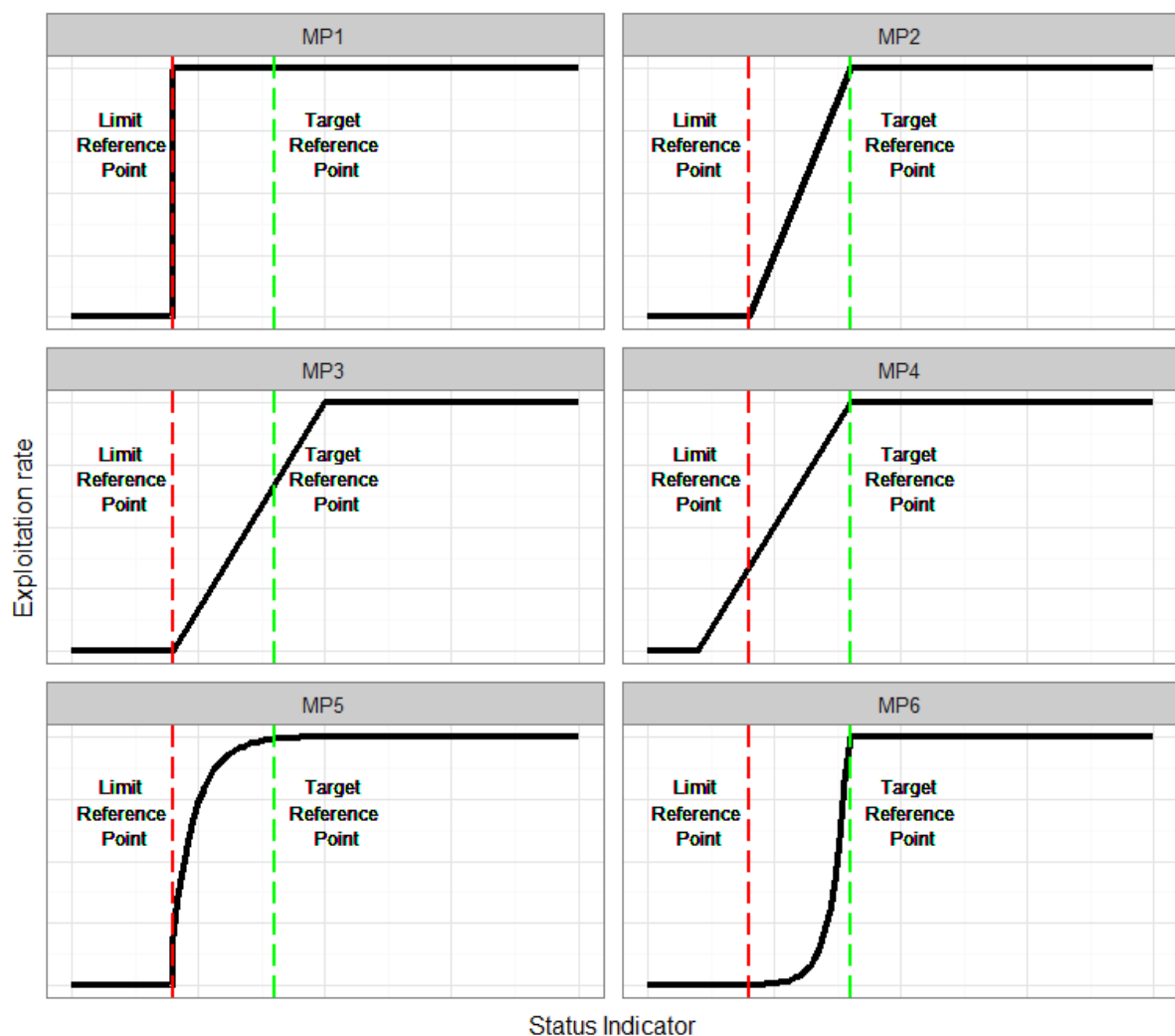
To assist with decisions on adopting candidate MPs, the Commission will require some guidance on the performance of each candidate MP, in addition to the figures and tables provided. A clear and succinct summary statement comparing the relative performance of each MP against the performance measures would allow the Commission to evaluate the trade-offs among alternative MPs when making such decisions.

The following statement provides an example summary of the performance for a hypothetical MP.

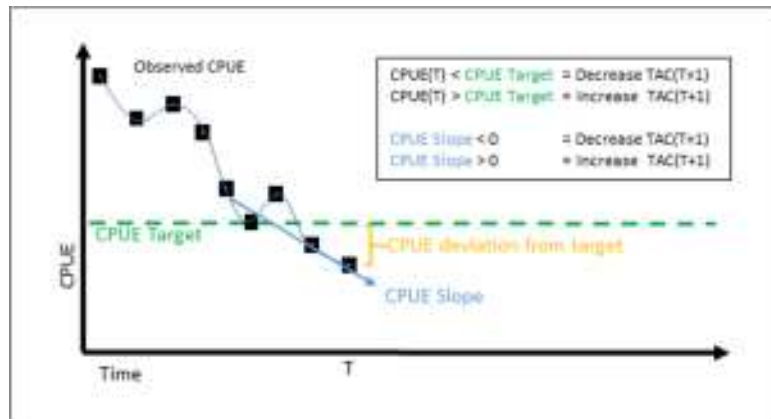
- MP1 achieved the second highest catches, and second lowest level of catch variability. There was a 5% chance that MP1 would be at or above the biomass target reference point and 2% chance it would be at or below the fishing mortality target reference point. There is a 25% risk that MP1 will cause the 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.

#### 4. Full set of results for each Management Procedure

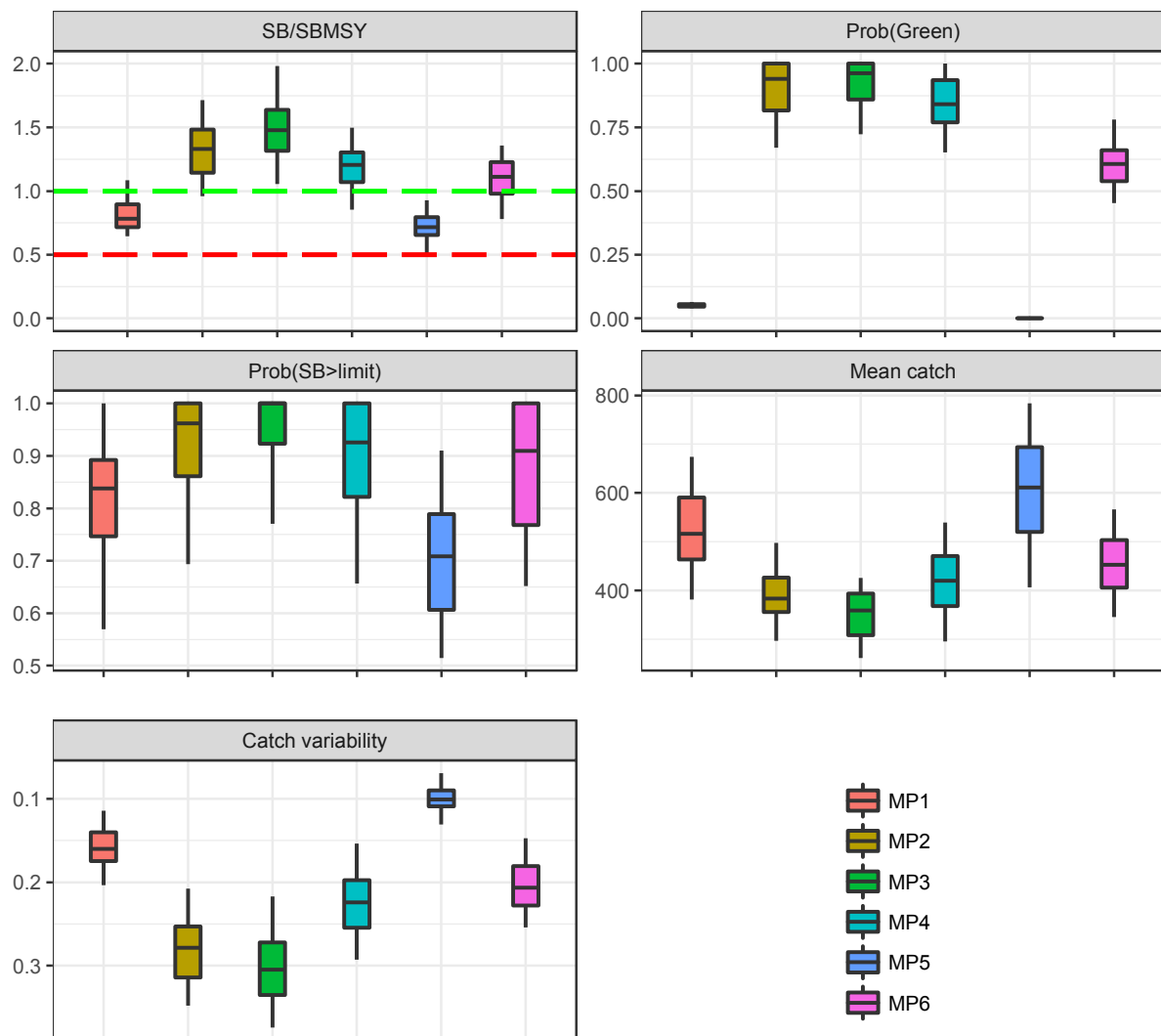
While the main presentation of MSE results should focus on a selection of key performance measures summarised for a single time period, it is possible that the Commission will have interest in seeing the results for other performance measures or the same performance measures for a different summary time period. Therefore, the numerical results for each MP across all 16 performance measures and for the different time periods evaluated should be provided for reference in a table in an appendix, but not reported or presented in the main results. Table 2 provides an example table of MSE outputs comparing the performance of 6 MPs against all IOTC performance measures for 4 time periods (1, 5, 10, and 20 years). Additional information, such as percentiles ranges, could be added in parentheses for each value.



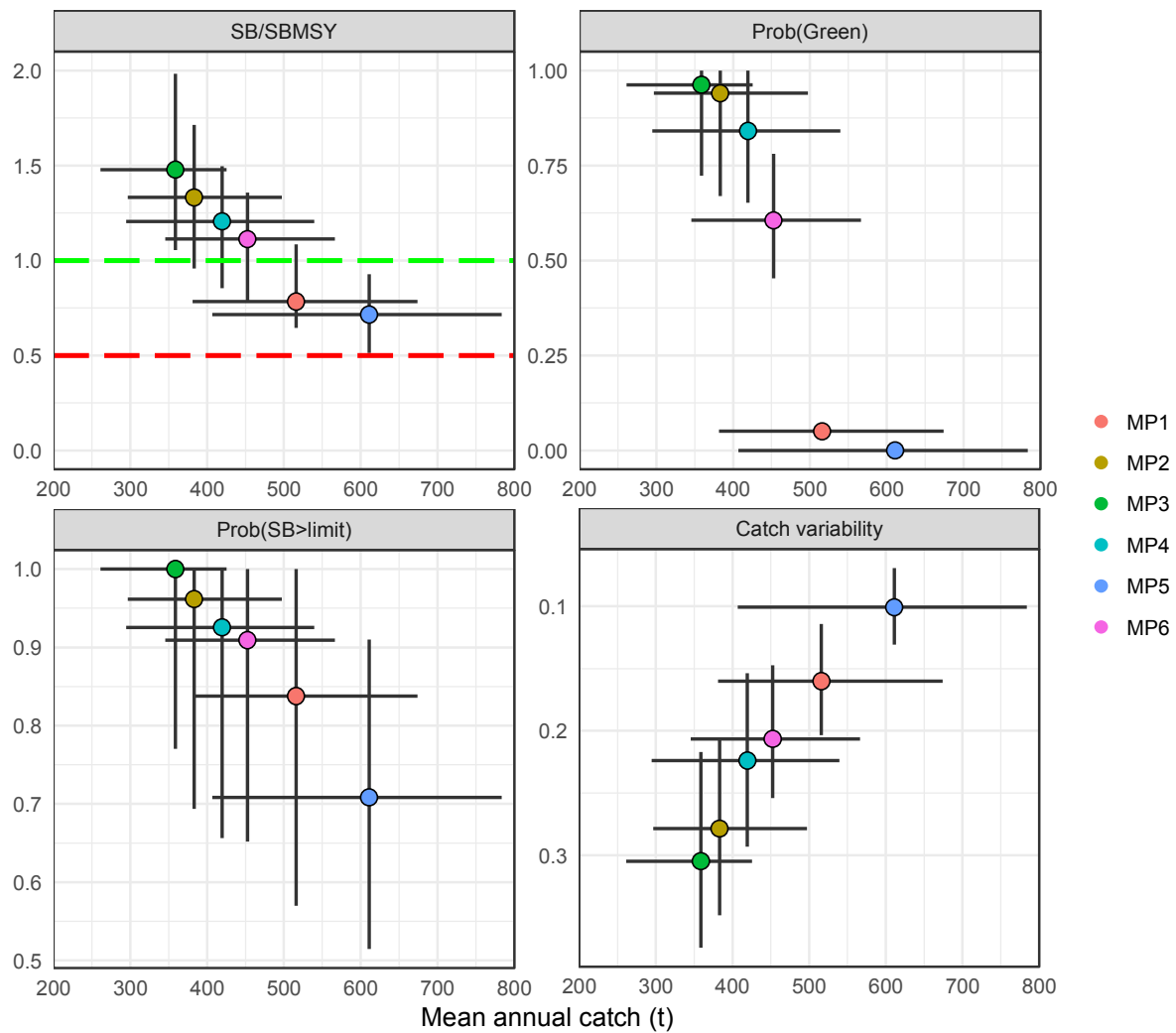
**Figure 1.** Illustration of six hypothetical example management procedures (MPs) relating the recommended exploitation rate to status indicator. The limit and target reference points are indicated by red and green dashed lines respectively.



**Figure 2.** Illustration of an example catch per unit effort (CPUE) management procedure (MP) relating changes in the recommended TAC to changes in the CPUE over time. The target CPUE reference point is indicated by the green dashed line.



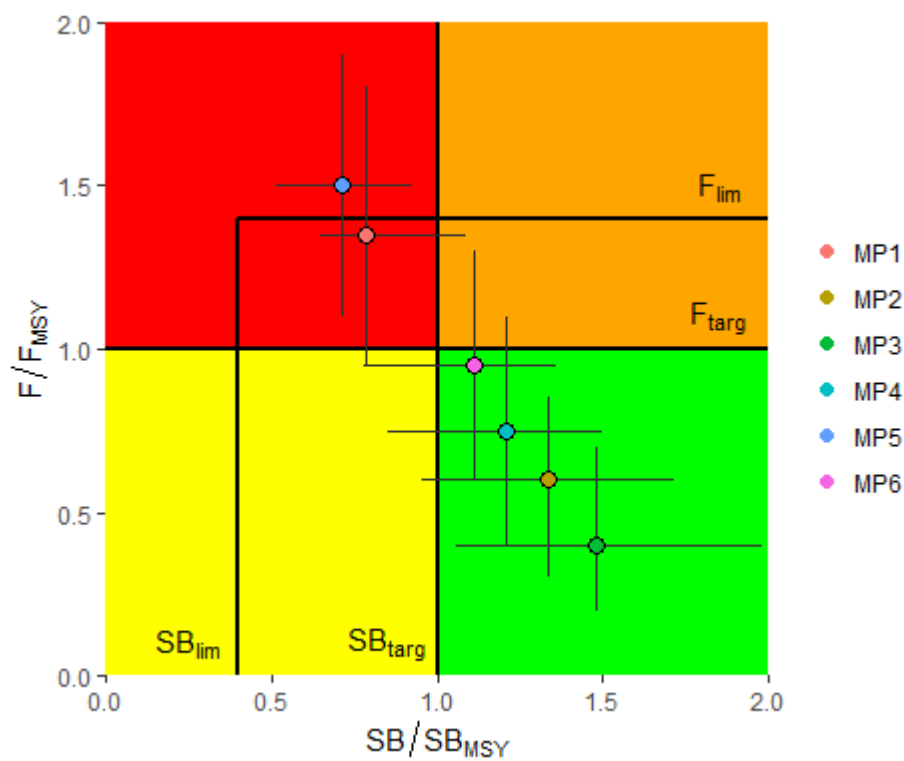
**Figure 3.** Example of MSE outputs comparing the performance of 6 management procedures (MPs) against 5 performance measures. Each data point represents the median over the last 20 years of the projection period as the horizontal line, 25<sup>th</sup> -75<sup>th</sup> percentiles as coloured bars, and 5<sup>th</sup> -95<sup>th</sup> percentiles as thin lines. Limit and target reference points for the biomass performance measure are indicated by red and green dashed lines respectively. Note the y-axis for catchability is reversed.



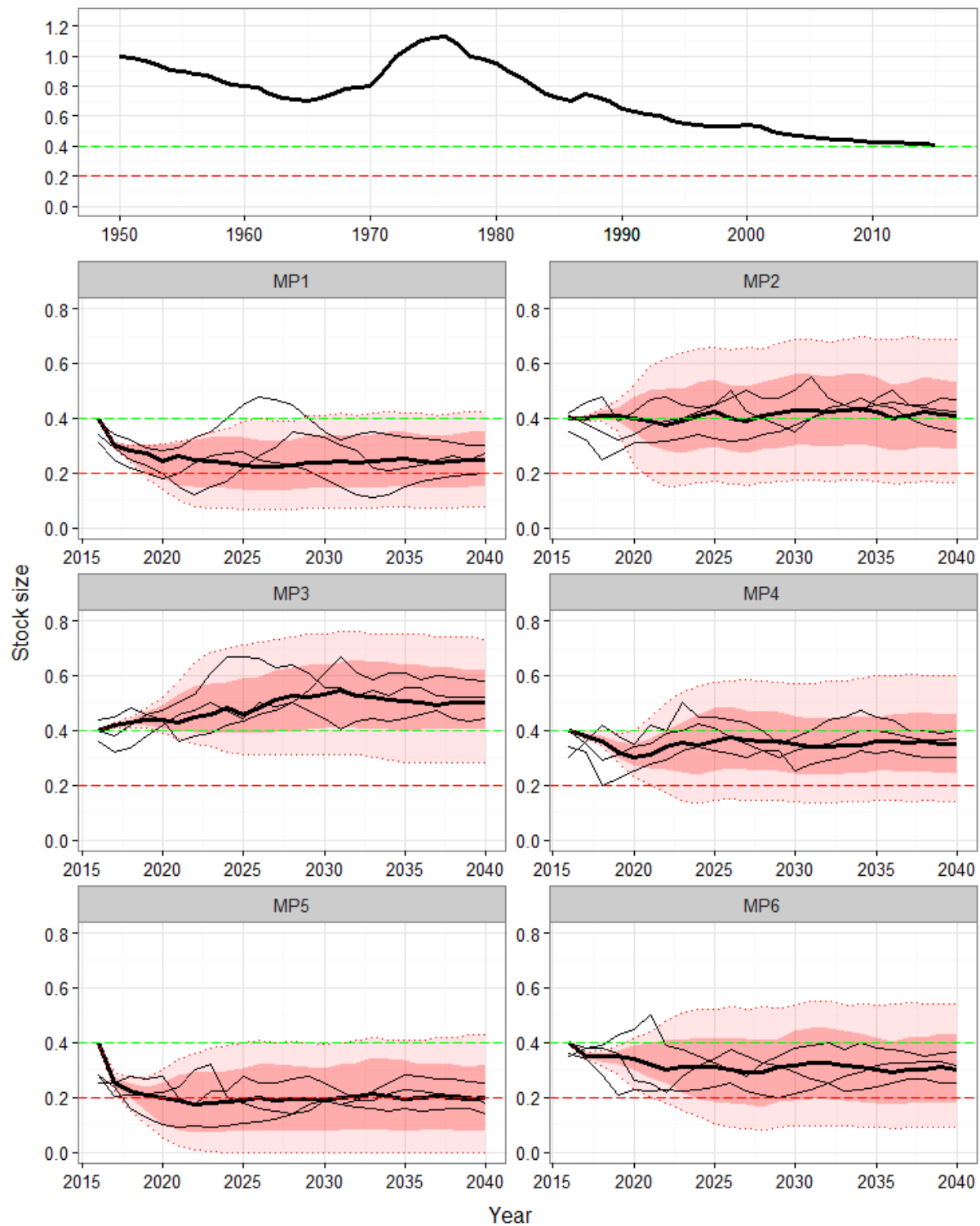
**Figure 4.** Example trade-off plots indicating the trade-offs in performance of 6 management procedures (MPs) between yield (catch) and 4 performance measures. Each data point represents the median over the last 20 years of the projection period and the errors bars represent the 25<sup>th</sup> - 75<sup>th</sup> percentiles as thick lines, and 5<sup>th</sup> - 95<sup>th</sup> percentiles as thin lines. Note the y-axis for catchability is reversed.

**Table 1.** Performance of six hypothetical example MPs against five key performance measures averaged over the last 20 years of the projection period. Shading indicates the relative performance for each MP (dark = better, light = worse). See Figures 2 and 3 for more detail on performance of each MP.

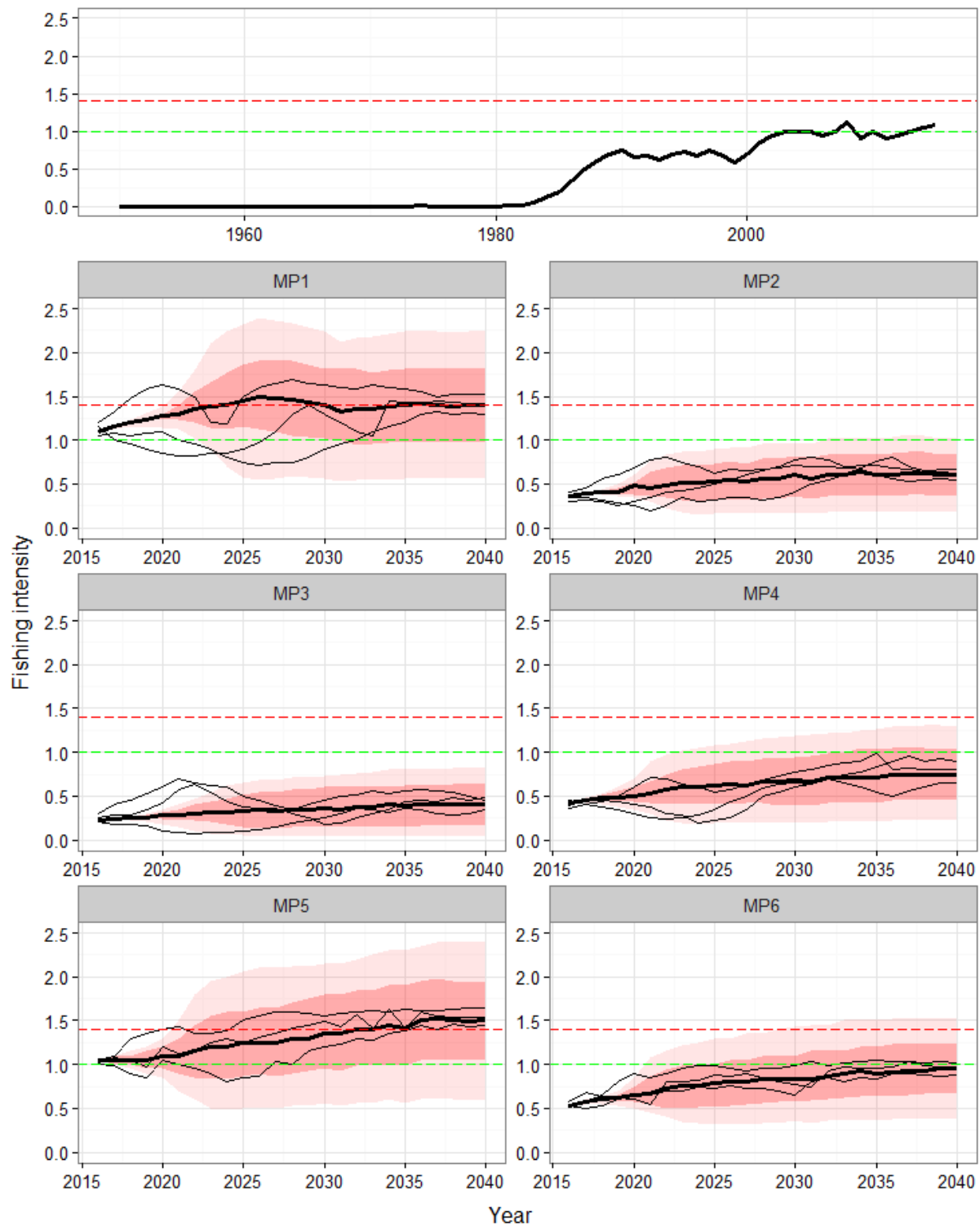
Management Procedure	Performance Measure				
	SB/SB <sub>MSY</sub>	Prob(Green)	Prob(SB>limit)	Mean Catch	Catch variability
MP1	0.78	0.05	0.84	516	0.16
MP2	1.33	0.94	0.96	383	0.28
MP3	1.48	0.96	1	358	0.3
MP4	1.21	0.84	0.93	419	0.22
MP5	0.72	0	0.71	611	0.1
MP6	1.11	0.61	0.91	452	0.21



**Figure 5.** Kobe plot for hypothetical example of MSE outputs comparing 6 management procedures (MPs) against performance measures for  $SB/SB_{MSY}$  and  $F/F_{MSY}$ . Each data point represents the median in the final year of the projection period and the error bars represent the 95<sup>th</sup> percentiles. Target ( $SB_{targ}$  and  $F_{targ}$ ) and limit ( $SB_{lim}$  and  $F_{lim}$ ) reference points are indicated by black lines.



**Figure 6.** Time series plots for a hypothetical example of the performance of 6 MPs against the stock size performance measure. The top panel represents the historical period (1950-2015) and the bottom 6 panels represent the projection years (2016-2040). The median for each MP is represented by the bold black lines, a dark ribbon shades the 25<sup>th</sup>-75<sup>th</sup> percentile region and a light ribbon shades the 10<sup>th</sup>-90<sup>th</sup> percentile region. Three additional thin black lines show individual realizations. Horizontal lines indicate depletion-based target (green) and limit (red) reference points.



**Figure 7.** Time series plots for a hypothetical example of the performance of 6 MPs against the fishing intensity performance measure. The top panel represents the historical period (1950-2015) and the bottom 6 panels represent the projection years (2016-2040). The median for each MP is represented by the bold black lines, a dark ribbon shades the 25<sup>th</sup>-75<sup>th</sup> percentile region and a light ribbon shades the 10<sup>th</sup>-90<sup>th</sup> percentile region. Three additional thin black lines show individual realizations. Horizontal lines indicate depletion-based target (green) and limit (red) reference points.



**Table 2. cont.** Hypothetical example of MSE outputs comparing the performance of 6 management procedures (MPs) against all IOTC performance measures for 2 time periods (10 years and 20 years).

[illegible]