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**(OMMP Agenda Item 3)**

# Desirable Behaviour and Specifications for the Development of a New Management Procedure for SBT

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# Contents

# Executive Summary

The CCSBT has embarked on development of new Management Procedure (MP). This paper provides an overview of the process for the development and testing of Candidate MPs to assist the deliberations of the Strategy and Fisheries Management Working Group meeting (6-9 March 2018) and the provision of guidance on objectives and desirable performance characteristics for a new MP to the Operating Model and Management Procedure (OMMP) Technical Group and the Extended Scientific Committee (ESC).

The current CCSBT stock assessment indicates that:

- Current SSB is 13% (11-17%, 80% CI) of $SSB_0$ (where $SSB_0$ is the unfished spawning biomass[1]), up from 9% (8-12%, 80% CI) for the 2014 assessment.
- The stock may be more productive than understood when the current MP was adopted and implemented in 2011.
- The interim rebuilding target (20% $SSB_0$) may be achieved considerably earlier than expected (between 2023-2030 for current set of Operating Models).
- The expected rebuilding time is strongly influenced by the recent strong recruitments, which have only been observed in the aerial survey to date and, as a result, there is high uncertainty around these estimates.

Given the Bali Procedure was designed to the rebuild the spawning stock from a low level, the current MP is not suitable for setting TACs once the rebuilding target has been achieved. Hence, the OMMP Technical Group and ESC require guidance on objectives and desirable performance for a new MP, which is expected to be in operation beyond the rebuilding target, i.e. over the next decade or more.

Given the current interim rebuilding target (20% $SSB_0$ by 2035 with a probability of 0.7) and the performance charactersitics that were important in the selection of the Bali Procedure (e.g. low probability of TAC decrease after a TAC increase, relative stability in TAC, low probability of future declines in SSB below historical levels, etc), the SFMWG should consider these aspects of MP behaviour and provide advice on objectives and desirable behaviour for a new MP.

The following are provided as examples of the nature of guidance required by the OMMP Technical Group and ESC to advance the development of candidate MPs (They are not recommendations.):

- Desirable level to rebuild the stock, beyond the interim rebuilding target, and a time frame for this to be achieved. For example, 0.3 or 0.4 of the unexploited biomass ($SSB_0$), or the spawning biomass likely to achieve Maximum Sustainable Yield (0.28[2]), by some time in the future with a specified probability.

[1] Spawning biomass (SSB) is used here to refer to the total reproductive output (TRO) a new proxy for SSB used by the ESC based on a revised spawning potential estimate introduced into the operating model in 2014 with the incorporation of the close-kin data (paragraph 104, Anon 2017).
[2] This estimate (0.28) of the level of depletion of SSB that corresponds to MSY is the average (median) value across the Reference Set of Operating Models used for the 2017 stock assessment (see Table 3).

- Low probability of spawning biomass declining below 20% (i.e. the interim rebuilding target) over the evaluation period.
- Maximise average catch over the evaluation period.
- Low probability of TAC reduction over some period in the short to medium term.

For continuity, the probability of meeting the interim rebuilding target by 2035 will be included as a performance statistic in the MP testing with the aim to have ***at least*** 70% of the simulated trajectories rebuild to higher than 20%$SSB_0$ by 2035.

Similarly, the operational constraints for the current MP (e.g. 3 year TAC blocks, 3000t maximum TAC change, 100t minimum TAC change, carry-over provisions within TAC blocks) will be retained as defaults for the initial round of evaluations.

In terms of guidance for the initial round of MP evaluations, it would be suffcient for the SFMWG to specify an initial range for of values for each objective (aspect of performance).

Candidate MPs will be evaluated against this initial guidance by the OMMP and reviewed by the ESC. The results will be provided to the 2018 meeting of the Commission for more specific guidance and further refinements of candidate MPs by the OMMP Technical Group in the first half of 2019 and a second round of review by the ESC. The current schedule is for the Commission to select a final MP at the 2019 Commission meeting. There is contingency for this decision to be made in 2020, should the additional time to refine and decide on a final MP be required.

# 1 Background

At its 2015 meeting the Commission for the Conservation of Southern Bluefin Tuna (CCSBT) agreed to implement a new recruitment monitoring program, using gene-tagging, to estimate absolute abundance of 2 year olds. The impetus for this decision revolved around the cost and logistic frailty of the existing recruitment monitoring series, derived from the scientific aerial survey (Anon. 2015). The aerial survey provides the current recruitment index of relative abundance of 2-4 year olds (Eveson and Farley 2017), which is used in combination with the standardised longline CPUE in the CCSBT "Bali Procedure".

The change in the method used to estimate recruitment means it will be necessary to develop a set of new Candidate Management Procedures, which will be tested using Management Strategy Evaluation. A single, new Management Procedure (MP) will be selected by the Commission, based on advice from the ESC, for implementation (Anon. 2016, 2017a). The CCSBT has agreed to a 2 to 3-year work program for the development, testing and selection of a new MP. The first TAC decision using the new MP is scheduled for 2020, with the new MP selected in 2019 and TAC decision made in 2020 for the 2021-2023 quota block (Anon 2017b).

## 1.1 Rationale for MP approach in CCSBT

The CCSBT has been at the forefront of tuna RFMOs in development and implementation of Management Procedures as the basis for recommending changes in the level of fishing to meet the objectives of the Commission and its members (Hillary et al 2016). The impetus for this approach arose from a break-down in the institutional decision-making process arising from: a) high uncertainty in the status and productivity of the stock, b) conflicting views on the best approach to resolve this uncertainty, c) alternative methods for assessing the stock status, and d) lack of an agreed basis to determine the global TAC based on the scientific advice.

The issue of uncertainty in stock status and productivity was addressed by agreeing to develop a set of population dynamics models that encapsulated the range of plausible stock and fishery dynamics. This set of models are known as the CCSBT Operating Models (OMs). The SBT OMs have been modified and refined over the years to reflect the addition of data to existing datasets and new data streams (e.g. aerial survey (2009), close-kin (2013), gene-tagging (scheduled for 2018) and revision of assumptions as appropriate. The SBT OMs are used for i) periodic assessments of stock status, and ii) simulation testing of candidate Management Procedures (see section 2).

The previously contentious issue of determining the global TAC, based on scientific advice and in a manner consistent with the Commission's objective, was resolved via the development and testing of a wide variety of candidate Management Procedures and the selection and implementation, in 2011, of the "Bali Procedure" (Anon. 2011, Hillary et al 2015, Hillary et al, In press).

A management procedure (MP) is the combination of monitoring data, method for analyses of those data, the decision rule (also known as Harvest Control Rule (HCR)) and implementation of a management measure to achieve the specified change in the level of fishing (Figure 1).

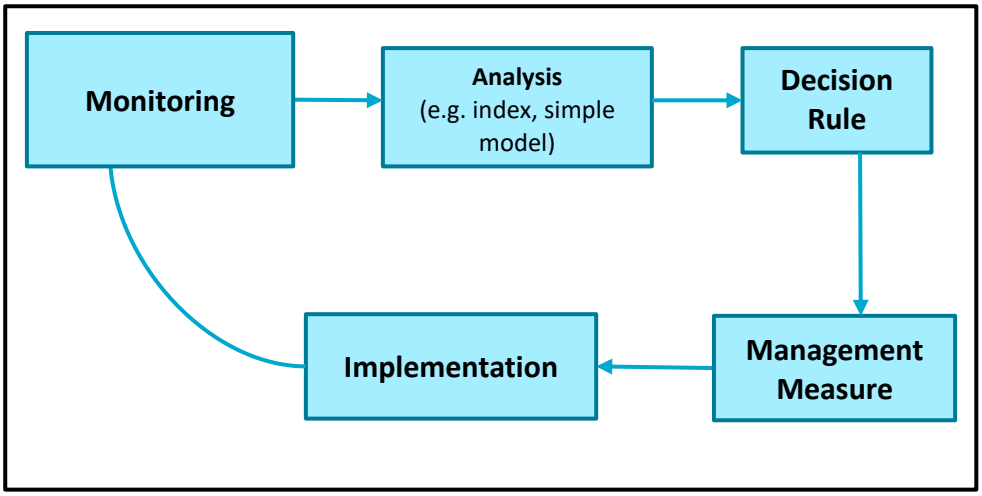


**Figure 1: Components of a Management Procedure. An individual Management Procedure is defined by each component, in combination. If one component is modified, or replaced, then you have a different Management Procedure.**

In the CCSBT case, the Bali Procedure includes the following components:

- *Monitoring*: Index of recruitment (aerial survey, 2-4 yr olds) and index of harvested age classes (Longline CPUE, 4yr old+)
- *Analysis*: A biomass dynamics model that uses these two data-series to estimate a short time series of juvenile and adult biomass.
- *Decision Rule*: an algorithm that uses, separately, the trends and absolute levels of the juvenile and adult time series, relative to historical levels (as limits and targets), to determine a change in the TAC. The TAC is reviewed by the ESC and recommended to the Commission.
- *Implementation*: Decision by the Commission to set the global TAC according to the member allocations. In the case of the Bali MP, the implementation of the TAC is assumed to be exact. That is, there is no allowance for variation between the recommended TAC and the actual catch taken.

## 1.2 Role of stock assessment and management procedure

### 1.2.1 Regular assessment of stock status

The CCSBT Scientific Committee completes a "full stock assessment" every three years, as specified in the Meta-rules for the Bali Procedure. The stock assessment process uses:

- A ***Reference Set*** of CCSBT OMs to provide a plausible range of estimates of current stock size. The reference set is revised for each stock assessment.
- A range of ***Sensitivity Tests*** to explore the potential implications of more "extreme" assumptions about the stock, fishery or monitoring on the estimates of stock status, also regularly revised and updated at each assessment, and

- An evaluation of ***Fisheries Indicators***. These include data and information sources that are not included directly in the OMs, but are considered by the ESC to provide indications of trends in the stock or the fisheries.

The stock assessment provides information on whether the stock is rebuilding, the projected timeframe to meet the objective of the rebuilding plan (i.e. 20% of $SSB_0$) and current stock size and fishing mortality relative to commonly used reference points.

The stock assessment is **not** used to:

- Run the MP
- Recommend the TAC.

### 1.2.2 Running of MP for TAC advice

The Bali Procedure is used to calculate the global TAC recommended by the ESC to the Commission for decision.

As outlined above, the Bali Procedure uses **only** the two monitoring series as inputs, the defined analyses and decision-rule to recommend the change in TAC. The MP is fully specified (as originally tested in the MSE process) and is not changed following selection by the Commission in 2011.

The running of the MP is independent of the SBT OMs. The MP uses the aerial survey and CPUE data (from 1993) in a simplified model that calculates a shorter-term time-series of juvenile and adult biomass estimates. The recent trends and relative values in the MP time-series are used in the decision rule for changing the TAC.

The MP is **not** used to:

- Estimate the spawning stock biomass
- Estimate if the interim rebuilding target has been met.

## 1.3 Current understanding of stock status and productivity

The most recent SBT stock assessment (Anon 2017a) indicates that:

- Current median spawning biomass is estimated to be 0.13 of the unfished level with an 80% confidence interval of 0.11-0.17, which is higher than the 2014 assessment results (9% (8-12%, 80% CI);
- The productivity of the stock and the associated rate of rebuilding may be higher than understood when the MP was tested in 2011**.**

The implications of the, potentially, higher productivity is that the Commission's rebuilding target of reaching at least 20% of the unfished level by 2035 with 70% probability may be achieved substantially sooner than expected (relative to when the MP was tested and first implemented). Projections of future rebuilding under the Bali MP indicate that the rebuilding objective is likely to be achieved between 2023 (i.e. 70% of trials are above the interim rebuilding target for the Reference Set of OMs) and 2030 (for the most "pessimistic" sensitivity test), (See Attachment 10, 2017 ESC report).

This projected earlier rebuilding is the result of two interacting factors:

- The most recent stock assessment estimated higher productivity than at the time the MP was tested and implemented, and;
- The positive trend in recent recruitment (since 2001) and, in particular, the very high abundances estimated for the most recent year classes.

The most recent year classes are always the most uncertain in a stock assessment because they have been observed for the least number of years. In addition, these most recent year classes have only been observed in the aerial survey and are not yet apparent in the longline data. It is expected that they will enter the longline fisheries in the coming year(s) and, therefore, the uncertainty in the true abundance of these cohorts may be reduced in the next full stock assessment (scheduled for 2020).

Due to the interaction between the strength of these recent cohorts and the estimated higher productivity of the stock, it is possible that the estimated productivity and the range of expected rebuilding times may change after the OMs are reconditioned using most current data (currently scheduled for 2019 according to the MP development work plan, see Section 2.1.3).

## 1.4 What this means for the CCSBT rebuilding plan

It is possible that the rebuilding objective may be met sooner than originally expected, possibly as early as 2023, and within the operating time frame of a new MP.

This raises a number of issues for consideration:

I. Objectives for the stock and the fishery beyond the Commission's interim rebuilding target;

II. The form of a "***tuning criterion***[3]" for comparing candidate management procedures; and

III. Understanding the uncertainties associated with the higher estimated productivity and that this may change prior to the adoption of a new MP.

## 1.5 Additional considerations for design and testing of new management procedure

In addition to the estimated high productivity of the stock and potential for earlier rebuilding, there are additional considerations that need to be taken into account in the design of a new MP, which is likely to be in place for at least the next decade. These include:

- Ensuring, to the extent possible, that a new MP is robust to all sources of mortality on the stock.

[3] As part of the MP testing process, each candidate MP is "tuned" to a single specific criterion. This is done so that candidate MPs can legitimately be compared across the other dimensions of performance in a consistent manner. In the case of the Bali Procedure, candidate MPs were tuned to the rebuilding objective (i.e. 20% of $SSB_0$ by 2035 with probability of 0.7). This means that of the thousands of trials run for each Candidate MP using the SBT OMs, 70% of those trials rebuilt to 20% of $SSB_0$ by 2035 for each candidate MP. The selection process then focussed on comparison across other aspects of performance (e.g. average TAC, TAC in the short-term, CPUE, timing and frequency of TAC decreases, lowest SSB and SSB trajectory etc.), knowing that each candidate MP achieved the same SSB rebuilding.

- Potential for changes in selectivity (changes in the size ranges preferentially selected by the aggregate fisheries) under expected rebuilding trajectories.

## 1.6 Purpose of this document

This paper is aimed at providing an introduction, or refresher, on the sometimes abstract concepts and terminology associated with the technical process in the interests of informed discussions.

In particular, it is aimed at ensuring that the process of MP development, testing and selection and the implications of the most recent CCSBT stock assessment are clearly understood and taken into account in preparations for the Strategy and Fisheries Management Working Group meeting scheduled for the 6-9 March 2018.

# 2 Overview of MP development, testing and implementation process

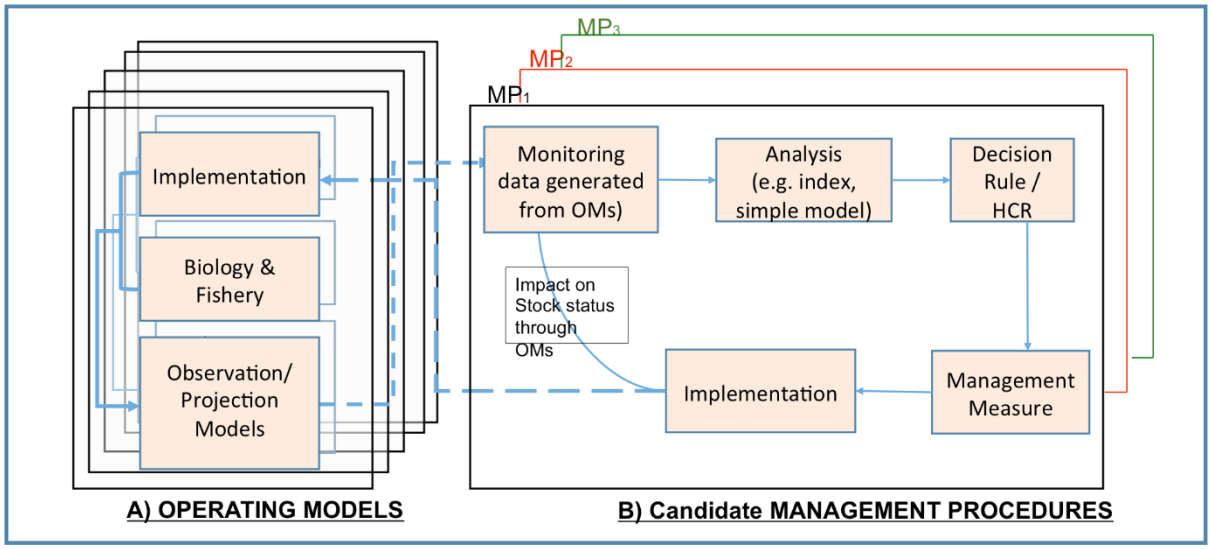


**Figure 2: Schematic representation of the components of a) the Operating Models and b) candidate Management Procedures used as part of Management Strategy Evaluation (MSE) for testing MPs. The MSE process starts with development of multiple Operating Models, which define the status and dynamics of the stock, fisheries and monitoring data, including the plausible uncertainty in them. Multiple candidate MPs are developed, and their relative performance compared across a range of criteria, given that each candidate MP has been "tuned" to meet a single objective.**

## 2.1 MP development and testing

### 2.1.1 Monitoring series

#### Recruits

The second round of MP development (2009-2011) included the requirement for candidate MPs to include an index of recruitment, given the low status of the stock and the historically low recruitments at the turn of the century (Anon. 2009). While there have been positive indications in recruitment and the status of the spawning stock in recent years (Hillary et al., 2017a), the ESC continues to consider a fishery independent index of recruitment an essential monitoring series for input to an operating MP (Anon. 2015). This is a function of the late maturity of SBT and the fact that the majority of the fleets target predominantly juvenile and sub-adult fish. The combination of these two factors results in a substantial delay between catches being taken and their impacts propagating through to the spawning stock.

#### Sub-adults

Longline CPUE data are used in the current MP as an index of the abundance of sub-adult, or "harvested" component of the population. The actual CPUE index used as input in the Bali Procedure is the average of two standardised CPUE indices that have been adjusted for an intermediate hypothesis about plausible effects of unreported catches (for the historical period where that applies). The CPUE combines data across age classes from age 4 upwards and is

assumed to represent the relative abundance of sub-adult fish, as these have been the dominant age classes in this component of the fishery over the past few decades.

### Spawning adults

Until recently, there was no direct monitoring of the abundance of the spawning stock. The advent of the Close-kin Mark Recapture methods (Bravington et al. 2014) has filled this gap to some extent, provided the biological sampling and quality control programs that underpin the approach can be maintained. Bravington et al. (2017) describes the processing of ~17,000 samples of adults and juveniles to identify 77 Parent-Offspring Pairs (POPs) and 140 Half-Sibling Pairs (HSP) which have been incorporated into the most recent reconditioning of the SBT OMs (Hillary et al. 2017c)[4].

## 2.1.2 Forms of MP

A range of candidate MPs will be developed by member scientists that use the identified monitoring series and different analysis methods and decisions rules. Davies et al. (2016 and 2017) outline this process in more detail, including some of the relevant considerations for the development of candidate MPs and alternative forms of decision rules. See Hillary et al. (2016) for recent examples of potential forms of MP that would use the agreed monitoring series.

**Table 1: Candidate monitoring series for recruits, sub-adult and spawning adult life-history stages of SBT for potential inclusion in MPs (modified from Table 9 of OMMP8 report; Anon. 2017). *The concept of a recruitment index based on relative CPUE of 4-year olds from LL1 was proposed at OMMP8, but the statistical properties of this index are yet to be evaluated.**

| Life-history stage | Candidate monitoring series | Index | Date Available | Times series available by 2018, 2019 | |
|---|---|---|---|---|---|
| **Recruits** | Gene-tagging | Absolute abundance 2yo | March 2018<br>March 2019 | $N_2$, 2016<br>$N_2$, 2017 | Fishery independent |
| | *CPUE LL rec | Relative abundance 4yo | June 2018<br>June 2019 | 1969-2017<br>1969-2018 | Fishery dependent |
| **Sub-adults** | CPUE LL | Relative abundance 4-8yo or 4-11yo | June 2018<br>June 2019 | 1969-2017<br>1969-2018 | Fishery dependent |
| **Spawning Adults** | POPs | Abundance/trend of spawners. | May 2018<br>May 2019 | 2002-2013<br>2002-2014 | Fishery independent |
| | HSP | Abundance and trend in mortality of spawners | May 2018<br>May 2019 | 2002-2013<br>2002-2014 | Fishery independent |

[4] The history and characteristics of the candidate series were reviewed at OMMP8 (Anon. 2017) and are summarised in Table 1. Hillary et al. (2016b, c and 2017c) provide detailed specifications and diagnostics for the generation of simulated data for each series using the SBT OMs.

### 2.1.3 Testing MPs for performance and robustness - Management Strategy Evaluation (MSE)

Management Strategy Evaluation (MSE) is used to evaluate the performance and behavior of each MP across a wide range of "known" conditions (i.e. the SBT OMs and robustness tests). For each candidate MP, the MP components (data collection, analysis, decision rules, and implementation) are simulated using the SBT operating models, replicating fishery management into the future. This large simulation process is used to collect performance statistics on each candidate MP. To ensure that MPs are tested against the most up to date information, the SBT operating models will be reconditioned with updated data, including the new gene-tagging and close-kin data, in 2019 (Table 2).

The range of operating models used and the robustness tests that have been specified are intended to test the candidate MPs against the combination of uncertainties in the population and fishery dynamics, model structure and input data sets, and potential future conditions that may occur (both pessimistic and optimistic). A base set of OMs has been specified, as well as a large number of robustness tests to evaluate MP performance under plausible but more extreme scenarios (Anon 2017, ESC report).

The results of the simulation models provide statistics on catches and biomass and other indicators of interest each year, which can be summarized for various performance measures and for performance relative to objectives specified by the ESC and Commission. These summary statistics, grouped into general categories of stock conservation/rebuilding performance, catch, CPUE, and management/TAC stability, are used to compare the relative performance of candidate MPs.

The selection of a final MP is an iterative process. Some candidates will be excluded by the ESC purely on technical grounds. Summary results on the main performance measures for those candidate MPs judged by the ESC to be technically sound and capable of reasonable performance will be presented to the Commission and members through formal and informal consultation processes. In each iteration of consultation, feedback on desired performance from members and the Commission will result in refinements to candidate MPs and performance measures, and further simulation evaluation ("MSE runs") by MP developers. The ESC will review candidate MPs to make a final selection and recommendation to the Commission (See Table 2, work plan).

## 2.2 MP implementation

The current MP work plan aims for the selection of a single MP from the candidate MPs by the Commission in 2019 (and provides a contingency for 2020) based on the MSE results. This MP will fully specify the data, analysis, decision rule and operational constraints.

The MP code will be run to calculate the recommended TAC, using the specified input data series. The ESC will review this TAC in light of the meta-rules process and recommend a TAC to the Commission.

The first TAC, calculated using the new MP, is for the 2021-2023 TAC block. The current work plan has the MP being selected in 2019 and the TAC recommended and decided in 2020. In this case, the current 1 year lag between TAC decision and TAC implementation would be foregone for the first implementation of the new MP only.

The MP is scheduled to run every 3 years: e.g. in 2022 (for 2024-2026 TAC block), 2025 (for the 2027-2029 TAC block), and ongoing 3 year blocks of TAC.

The MP schedule includes a review of the MP after 3 TAC recommendations (i.e. in 2026 under the current schedule).

**Table 2 The CCSBT MSE work plan (Anon 2017, ESC report).**

| Workplan for MP development and consultation | | |
|---|---|---|
| 2017 | | |
| October | CCSBT | Qualitative discussion of rebuilding objectives in the light of the updated projection results. |
| 2018 | | |
| June | OMMP9 | First presentation of candidate MPs (CMPs) evaluated using 2017 OMs. |
| September | ESC + 1 day informal OMMP | Evaluation of refined CMPs. |
| October | EC | Results on CMP performance and trade-offs presented to EC. Consultation with stakeholders. EC confirms or amends broad recovery objectives based on advice from the ESC. |
| 2019 | | |
| June/July | OMMP10 | Recondition the OM and review initial updated versions of CMPs to develop a limited set to put forward to the ESC. |
| September | ESC + 1 day informal OMMP | Review and advice on set of CMPs and a session for interaction with stakeholders. |
| October | EC | Aim to select and adopt MP. |
| 2020 | | |
| June | Special ESC/EC meeting | Contingency placeholder in case more time is needed to complete evaluation |
| September | ESC | Implementation of adopted MP to provide TAC advice for 2021 (i.e., no standard 1-year lag) (note, this MP implementation will include the 2020 data exchange). Updated assessments including projections using adopted MP |
| October | EC | Agrees TAC for 2021-2023. |

# 3 Guidance on objectives and desirable behavior of new MP

The Bali MP was designed for the specific purpose of rebuilding SBT. Given, i) the state of the stock at the time, ii) the rebuilding target, and iii) a desire to maintain a viable commercial fishery, the "operating space" for MPs was quite narrow.

The interim rebuilding target (20% $SSB_0$) was selected as it corresponded to the level of spawning biomass that resulted in stable recruitment, on average, before recruitment declined substantially in the early to mid-1980s. Hence, it was considered an appropriate empirical reference point to aim to rebuild the spawning biomass and improve average recruitment.

The improved status and higher productivity indicated from the recent assessment of stock status (Anon 2017) changes the context for the development of a new CCSBT MP. The assessment

indicates that the status of the spawning stock, while still low, has steadily improved and the estimated higher productivity implies that the interim rebuilding target may be met substantially earlier than expected when the Bali Procedure was agreed and implemented.

In this context, **advice is required from the SFMWG on the following to guide the technical aspects of MP development:**

- Initial direction on potential **objectives for management of the fishery beyond the interim rebuilding target**;
- **Desirable attributes of candidate MPs in addition to achieving (on average) a given rebuilding target** (e.g. short-term and longer-term average catches, low probability of decrease in TAC following increase, low average annual variation in TAC, average SSB at end of simulation period, etc.).

Guidance from the SFMWG will be used by MP developers and OMMP for the initial round of testing of candidate MPs. Results from these initial simulations will be considered by the ESC, initially, and then by the Commission at its 2018 meeting. They will provide the Commission with concrete examples of the likely implications and trade-offs between the different objectives and provide a basis for more specific, refined feedback to the OMMP to conduct a 2nd iteration of MP development process in the first half of 2019.

## 3.1 Objectives

It was recognised in the development of the Bali MP that, as the rebuilding objective was approached, a new MP would be required for management of the fishery.

A strength of the MP development process is that multiple objectives can be considered, e.g. sustainable use and low risk of unintended depletion, noting that these sometimes conflict. MSE allows identification of MPs that are likely to achieve a satisfactory/appropriate balance across multiple objectives, as judged by members and, ultimately, the Commission.

The following are examples of specification of broader objectives beyond the interim rebuilding target. They are offered to provide clarity on the nature of the guidance that is requested from the SFMWG for MP developers and ESC to conduct the next stage of the MSE process. **They are not recommendations.**

- A desirable level to rebuild the stock, beyond the interim rebuilding target, and a time frame for this to be achieved. For example, 0.3 or 0.4 of the unexploited biomass ($SSB_0$), or the spawning biomass likely to achieve Maximum Sustainable Yield (0.28) [5], by some time in the future with a specified probability.
- Low probability of spawning biomass declining below 20% (i.e. the interim rebuilding target) over the evaluation period.

[5] MSY and the corresponding level of depletion of spawning biomass is a function of the number of populaton parameters that vary among the Reference Set of Operating Models, e.g. steepness and natural mortality. This estimate (0.28) of the level of depletion of SSB that corresponds to MSY is the average (median) value across the Reference Set of Operating Models used for the 2017 stock assessmwent (for which there are 432 combinations). The variation in the esitmates of level of depletion of spawning stock biomass that corresponds to MSY across the full 432 Models is given in Table 3).

- Maximise average catch over the evaluation period.
- Low probability of TAC reduction over some period in the short to medium term.

For continuity, the probability of meeting the interim rebuilding target by 2035 will be included as a performance statistic in the MP testing with the aim to have *at least* 70% of the simulated trajectories rebuild to higher than 20%$SSB_0$ by 2035.

**Table 3: The average (median = 50%) and percentiles of the level of depletion of spawning biomass that correspondes to Maximum Sustainable Yield (MSY) for the Reference Set of Operating Models used for the 2017 stock assessment.**

| Percentile | 5% | 25% | 50% | 75% | 95% |
|---|---|---|---|---|---|
| SSB depletion | 0.219 | 0.238 | 0.284 | 0.323 | 0.346 |

## 3.2 Tuning criterion for candidate MPs

As part of the MSE process, all candidate MPs are "tuned" to an agreed performance level (the tuning criterion), so that they all have equal performance for this particular objective. The relative behaviour of candidate MPs can then be compared consistently across all other objectives and performance measures.

The Bali Procedure was tuned to the interim rebuilding target (i.e. rebuilding to 20% $SSB_0$ by 2035 with a probability of 0.7). However the potential for earlier rebuilding causes difficulties in the use of the rebuilding target as the specified tuning criterion for testing of new MPs, because:

- Candidate MPs, if tuned to the existing specification of the interim rebuilding target, will act to keep the SSB at 20% $SSB_0$, i.e. with no rebuilding above this level and likelihood of fluctuations above and below 20% $SSB_0$.
- The SSB may be greater than 20% $SSB_0$ by 2035 in too many of the Operating Model simulations[6] and therefore it may be impossible to tune the MPs to meet the tuning criterion used for the current MP. If a candidate MP has not met this criterion it cannot be compared against others and, as a result, it will be excluded from further testing.

A realistic range of tuning criteria will be considered by the OMMP as part of the initial MP testing phase and reported back to the ESC and Commission in 2018.

## 3.3 Operational constraints

Operational constraints in the magnitude and frequency of TAC adjustments need to be specified to guide the initial MSE process and as part of the final management procedure implementation. It is important to note that these **operational constraints interact with performance of MPs.** Hence,

[6] Given the current estimates of depletion and productivity from the most recent assessment (Anon 2017).

it will be necessary to define an initial set of preferences to be applied to all candidate MPs to ensure that comparisons between candidate MPs is fair. Given the success of the Bali MP and feedback from members and stakeholders, the existing constraints seem appropriate as default settings for this initial round of evaluations. Should members wish to consider potential alternatives, they could be explored as part of the MSE process to determine if any of the proposed alternatives produces demonstrable performance benefits.

The operational constraints in the Bali Procedure include: 3000t maximum TAC change (up or down), 100t minimum TAC change, a one year implementation lag and 3 year TAC blocks. These have served the current Bali procedure well:

- The 3000t maximum TAC change provides for more stability in catches, and less incidence of decreases in TAC after increases, compared with the 5000t TAC limit tested in 2011 (Anon, 2011).
- The minimum TAC change limit is 100t. If the calculated TAC change is less than 100t then no TAC change is made. This is to avoid very small changes in TAC for each member and unnecessary administrative and management cost.
- The implementation lag affects Australia and New Zealand in terms of the period of time between decision and implementation of TAC changes. No lag means that a Commission decision in October will affect the Australian fishery in December of the same year. The New Zealand fishery actually commences 1 October, which is before the Commission meets to set the TAC for the next 3-year block.

We note that having a maximum TAC change limit that is too small or too large, a one year lag before TAC implementation, or a minimum TAC limit that is too large can affect responsiveness of the MP and may give poorer performance under some worst-case scenarios.

The implications of current carry forward provisions and any new or proposed revisions to these should be evaluated as part of the development of new MPs.

## 3.4 Performance measures

Candidate MPs were compared for the following performance measures in 2011. These were added to and refined, through iterations of consultation between scientists, managers and Industry, as part of the MSE process. Some of these reflect desirable states/objectives, while some reflect states of the stock or fishery that are to be avoided. The MSE process involves simulating hundreds of models (432 in current grid) and replicating hundreds of times each; this is to encapsulate the range of uncertainty in the dynamics of the stock and the fishery, and the observation uncertainty in the monitoring series. The performance statistics are then summarized across all of the model runs. A summary of the performance measures used in the previous MSE process is given below.

Catch performance measures:

- Average short-term (10 year) and long-term catch.
- Measure of TAC smoothness: (Average Annual catch variability over 25 years).
- Maximum TAC decrease
- Proportion of occurrence where initial 2 TAC changes are up then down

- Proportion of occurrence where initial 4 TAC changes are up then down
- Proportion of runs with TAC above the current catch at the tuning year
- Lower 10th catch percentile in year t, e.g. in 10 years

SSB performance:

- Spawning biomass in medium term relative to $SSB_0$.
- Spawning biomass in short term relative to current.
- Spawning biomass in medium term relative to current.
- Minimum spawning biomass relative to current
- Proportion of runs above the current biomass at the tuning year
- Appearance that catch continues to increase while SSB stays low (ratio of catch / SSB in 2030 for a) lower $10^{th}$, b) median, c) upper $90^{th}$ percentile).
- SSB lower ($10^{th}$) percentile continuing to increase (no decline in period 2013-2035)
- Lower 10th SSB percentile in year t, e.g. in 10 years

CPUE performance:

- CPUE current relative to CPUE in short term.

See Appendix A for example figures of these types of performance measures.

# 4 Meta-rules for MP implementation

Meta-rules have been central to the orderly implementation of the current MP. The meta-rules include an annual review of MP implementation and process for action to ensure that the MP is operating under the conditions against which it was tested, and that any other indicators or information on changes to the stock or fishery are considered before recommendations on TAC are provided by the ESC.

The meta-rules specifications will likely be reviewed as part of the MP processes, including their rationale, the schedule of activities, processes etc. The review can consider whether the meta-rules adequately specify the process and actions in the event that the data for an input data series to the MP are unavailable in one, or more, year (s).

Un-accounted mortalities (UAM) have been a concern at the ESC for several years and have been dealt with through the meta-rules process. The 2016 ESC agreed that scenarios for UAM would be included in the MSE testing of candidate MPs so that the recommended TAC from the MP would be for member allocations only. The UAM incorporated into the MSE testing needs to be sufficiently large that the MPs are robust to any new information or hypotheses on additional mortality. This will ensure that exceptional circumstances and the meta-rules process do not need to be invoked.

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# Appendix A

**Figure 1. Two examples of the performance statistics examined in 2011: source (Attachment 9, ESC report, Anon 2011). Statistics comparing the performance of MP1 and the Bali Procedure (referred to in this figure as MP3) for procedures tuned to 2035 and 3000 t maximum change in TAC. AAV is average annual variability in catch. "C up down 2" is the probability that the TAC goes up and then down in the first two MP decision years (2013, 2016); "C up down 4" is the probability that the TAC goes up then down in any of the first four MP decision years (2013, 2016, 2019, 2022).**

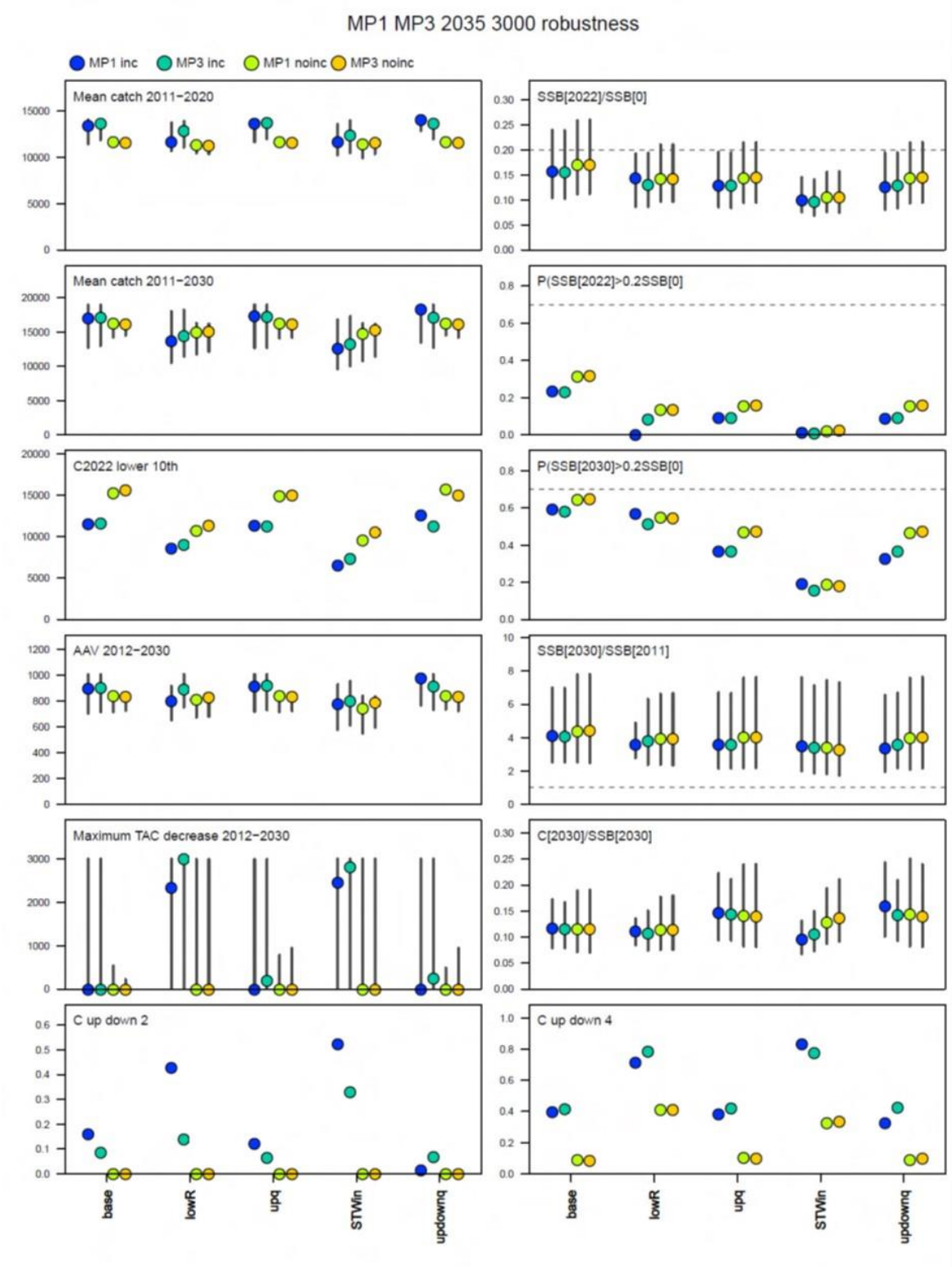
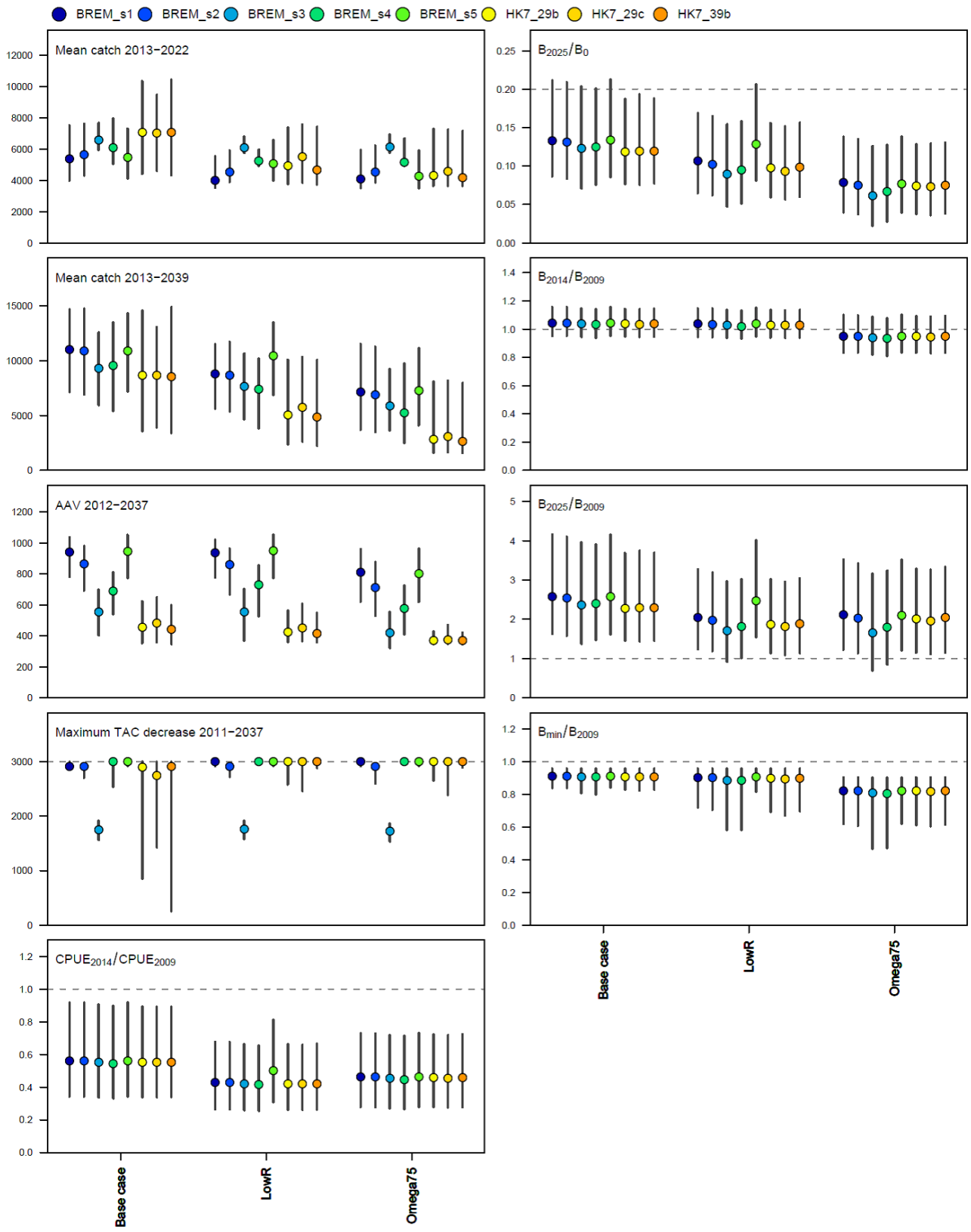


**Figure 1b.**


BREM_s1
BREM_s2
BREM_s3
BREM_s4
BREM_s5
HK7_29b
HK7_29c
HK7_39b
Mean catch 2013−2022
B2025/B0
Mean catch 2013−2039
B2014/B2009
AAV 2012−2037
B2025/B2009
Maximum TAC decrease 2011−2037
Bmin/B2009
CPUE2014/CPUE2009
Base case
LowR
Omega75