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# Evaluation of Candidate Management Procedures for South Pacific Albacore

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## Executive summary

This report presents recent evaluations of candidate management procedures (MPs) for South Pacific albacore (SPA) and updates the paper SPAMWS02-WP-01 based upon outcomes from that workshop.

Following the mixed fishery harvest strategy approach, the SPA MP applies to longline and troll fisheries operating in the region south of 10°S in the WCPFC-CA (excluding the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, following SPAMWS02). In previous evaluations, presented to SMD02 and WCPFC21 in 2024, the MP applied to longline and troll fisheries operating in the WCPFC-CA, south of the equator. As requested by SC21, additional information to support this change, including Commission decisions, are provided in this report.

To run the evaluations it is necessary to make an assumption about future albacore longline fishing levels in the equator to 10°S region of the WCPFC-CA, known as the tropical longline (TLL) fishery, and the EPO (excluding the overlap area). For the TLL fishery, the baseline assumption is that the future catches of albacore are fixed at 9000 mt per annum (approximately the average of 2014-2023 catches). The assumed future catch levels of albacore in the EPO are fixed at 18,000 mt per annum (approximately the average of 2014-2023 catches). In the previous evaluations they were fixed at 22,500 mt per annum. As requested by SC21, information is provided to support these assumptions. SPAMWS02 agreed that fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S are excluded from being managed through the SPA MP. The assumed future catch levels of albacore in these slivers are fixed at 667 mt per annum (approximately the average of 2014-2023 catches).

Following outcomes of SPAMWS02, three candidate MPs are evaluated using these baseline EPO and TLL assumptions. All three are catch-based, i.e. output a catch limit. It should be noted that the allocation of a catch or effort limit output from an MP, and how those allocations are managed in practice (e.g. through effort if the allocation is in terms of catch, or catch if the allocation is in terms of effort) is external to the MP. The candidate MPs are designed to achieve the interim target reference point (iTRP) or the proposed upper or lower TRP range in the long-term. Constraints are applied to how much the output of an MP can change between management periods.

Detailed sensitivity tests are performed for one of the candidate MPs in which the future SPA catches in the EPO and in the equator to 10°S region of the WCPFC-CA are set at 22,500 and 12,000 mt per annum respectively, i.e. higher than the baseline assumptions. As the adoption of a South Pacific albacore MP is conditional upon the assumptions made about future catches in these regions, catches in these regions will need to be monitored as part of the South Pacific albacore MP monitoring strategy to determine if these assumptions are still valid. Additional sensitivity tests relating to how much the output of the MP can change between management periods are also run. The other two candidate MPs are also subjected to a single sensitivity test with the higher than baseline catch assumptions in both the EPO and in the equator to 10°S region of the

WCPFC-CA. Under these higher catch assumptions, the probability of being above the LRP for the catch-based MP with HCR 10 (that achieves the lower TRP range) was 0.8, i.e. at the minimum that is acceptable by the WCPFC, implying a 20% probability of falling below the LRP.

Additional MP evaluations were requested by SC21 and SPAMWS01 which have alternative assumptions about future albacore fishing levels in the equator to 10°S region and EPO (excluding the overlap area) and also explore the exclusion of the WCPFC-CA troll fishery from being managed through the MP. These additional MPs are designed to achieve specific long-term objectives under those different assumptions, so care must be taken when comparing the results. SPAMWS02 agreed to only continue considering a subset of these additional candidate MPs.

The estimation method (EM) of the MPs is an age-structured production model, implemented in Multifan-CL that uses the longline indices in the WCPFC-CA and EPO. The EM outputs a relative indicator of estimated stock status (average $SB/SB_{F=0}$ in the last three years relative to the average $SB/SB_{F=0}$ in 2017-2019). SC21 recommended the continued use of this EM. The EM has been run with the most recently available data (up to 2023) and the result used by each of the candidate MPs to produce the corresponding catch or effort limit that would be defined for the management period 2026-2028.

Performance indicators are calculated to evaluate the relative performance of the candidate MPs, including expected $SB/SB_{F=0}$ (to be compared to candidate TRP levels), expected catch levels, and expected vulnerable biomass (a proxy for catch rates). SPAMWS02 requested an additional performance indicator: total albacore catch of fisheries managed through the MP. This has been calculated and included in the results.

SC21 made additional requests, including:

- Provide sufficient explanation and additional information as necessary (such as historical catch trajectory in the EPO and the area bounded by 0-10°S) to the SPAMWS01 (September 2025) and to WCPFC22 to assist decision makers.
- Three additional MPs be developed for the Commission's consideration that more fully explore EPO (excluding overlap area) catch consequences as well as the use of a fixed effort assumption in the WCPFC-CA from the equator to 10°S.
    1. EPO (excluding the overlap area) set to 22,500 mt (being the approximate average of catches in the years 2021-23), WCPFC-CA 0-10°S set to 9,000 mt (being the approximate average in the period 2014-2023), using a catch control HCR 'tuned' to achieve the adopted iTRP.
    2. EPO (excluding the overlap area) set to 13,500 mt (being the approximate catch in the year 2020), WCPFC-CA 0-10°S set to 9,000 mt (being the approximate average in the period 2014-2023), using a catch control HCR 'tuned' to achieve the adopted iTRP.
    3. EPO (excluding the overlap area) set to 18,000 mt (being the approximate average for the period 2014-2023), WCPFC-CA 0-10°S set to average effort levels in the period

2014-2023, using a catch control HCR 'tuned' to achieve the adopted iTRP.

- The results of this expanded set of candidate MP evaluations and all candidate MP evaluations in WCPFC21-2024-30 (those applied to longline and troll fisheries operating in the WCPFC-CA, south of the equator) be provided to the SPAMWS01 in September 2025 and to the Commission for their consideration and decision.
- Reporting the median time series of vulnerable biomass from the OMs for the historical period and to develop a table with the average nominal CPUE (kg/100 hooks) for the reference period (2020-2022) by CCMs with South Pacific albacore catches.

All of these requests were completed and presented at SPAMWS01 and can be examined in the associated report SPAMWS01-WP-01.

SPAMWS01 made additional requests, including:

- Re-tune all seven candidate MPs (the four original MPs in WCPFC-SC21-2025/MI-WP-04 plus the three MPs requested by SC21) operating south of 10°S with exclusion of Tokelau (TK) and Tuvalu (TV) catches that are south of 10°S.
- Perform sensitivity analyses on the re-tuned MPs (those excluding TK and TV from the SPA MP).
- Run HCR 7 with no constraint as an additional sensitivity test (using the retuned HCR 7 that excludes TK and TV from the SPA MP).
- Develop additional MPs that exclude TK and TV from the SPA MP:
    1. Additional MPs based on HCR 7 and HCR 13, which treat troll catch as an assumed constant 'external catch' in the MP. These MPs would be tuned to achieve the appropriate associated TRP. In developing these MPs, the "external troll catch" could be set at 2000-2004 average troll levels (in line with the baseline referenced in CMM 2015-02)
    2. An additional MP equivalent to HCR 14 (EPO catches at 22,500 mt per annum) but with 0-10°S on fixed effort (2014-2023) instead of catch, and that achieves the iTRP in the long-term.
- Update SPAMPLE to include full suite of considered MPs.

All of these requests were completed and presented at SPAMWS02 and can be examined in the associated report SPAMWS02-WP-01.

SPAMWS02 made additional requests, including:

- From 2000-2023, South Pacific albacore catches, broken down by EEZ and high seas, showing: total catch, catch between the Equator and 10°S, and south of 10°S; and
- From 2000-2023, for the area between the Equator and 10°S, south of 10°S, the number of hooks (or other effort indicator) set on the high seas vs. the number of hooks set within EEZs.
- Calculation of an additional performance indicator that reports the total albacore catch of fisheries directly managed through the MP.

All of these requests have been completed. The first two requests are presented in a separate paper. The third request is presented here.

Following discussions at SPAMWS02 a reduced number of MPs and evaluations are carried forward to WCPFC22 and are focused on in this report.

SPAMWS02 agreed to focus on two distinct 'streams' of evaluations, primarily defined by the area of application of the SPA MP (WCPFC-CA south of 10°S, excluding the slivers of the EEZs of Tokelau and Tuvalau that are south of 10°S; WCPFC-CA south of equator). The candidate MPs from these two 'streams' should not be directly compared given the different assumptions, and spatial range of the MP, underpinning them.

Considering the evaluations presented at SPAMWS02 (the WCPFC-CA south of 10°S 'stream' that excludes the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S), the assumptions about the future EPO and TLL albacore catch levels and the WCPFC-CA troll fishery are different for many of the candidate MPs so care must be taken when comparing them. The differences between their performance are a combination of the different HCR shapes and the underlying assumptions. However, where candidate MPs have been tuned to achieve the iTRP in the long-term, their results indicate how the alternative assumptions can affect the total albacore catch of the fisheries managed through the MP. The MP that achieves the iTRP under baseline assumptions yiels the highest catch for those fisheries controlled by the MP i.e. longline and WCPFC-CA troll. The other candidate MPs are evaluated using assumptions that set higher catches in the EPO (excluding the overlap) and 0-10°S region or exclude the WCPFC-CA troll fishery from being managed through the MP, i.e. only the WCPFC-CA southern longline fishery is managed through the MP. Therefore, to achieve the same iTRP under these different assumptions, less catch is available for fisheries managed through the MP when compared to the MP evaluated with baseline assumptions, i.e. more catch is assumed to be 'locked away' in the EPO or 0-10°S regions of the WCPFC-CA or in the troll fishery.

# 1 Introduction

## 1.1 Background

This report describes the most recent evaluations of candidate management procedures (MPs) for South Pacific albacore following feedback and outcomes from SC20, SMD02, WCPFC21, SC21, SPAMWS01 and SPAMWS02 (WCPFC, 2024a,b,c; SPC-OFP, 2024a; WCPFC, 2025b,c,d). The relative performance of the MPs is summarised through the calculated performance indicators.

The analyses presented within this paper are based on different assumptions from those presented to the Commission in WCPFC21-2024-30 (REV1) (SPC-OFP, 2024a). Primarily, fishing for South Pacific albacore is now being controlled within the southern WCPFC-CA below 10°S, rather than from the equator. This change was highlighted within WCPFC Circular 2025/17, distributed on the 4th April 2025 (WCPFC, 2025a). Following presentation to SC21, the SSP was encouraged to "provide sufficient explanation for the change and additional information as necessary (such as historical catch trajectory in the EPO and the area bounded by 0-10°S) to the SPAMWS01 and to WCPFC22 to assist decision makers". We therefore provide a summary of the decisions made by the Commission and its subsidiary bodies that underpin the changes made.

The mixed fishery framework has had several names and has been discussed over many years. WCPFC-SC14-MI-WP-05 noted the need to develop 'multi-species approaches' to harvest strategies, given many of the fisheries under consideration affect more than one key tuna stock (SPC, 2018). This was expanded upon in WCPFC-SC15-MI-WP-04, and a tentative framework put forward where MPs for skipjack, South Pacific albacore and bigeye interacted to achieve objectives for all four stocks (including yellowfin), and the MP for South Pacific albacore would relate to the southern longline and troll fisheries (operating south of 10°S) (Scott et al., 2019). SC15 endorsed the use of this 'hierarchical approach' based on single species operating models as a way forward and recommended that WCPFC16 note the approaches and associated challenges (SC15 summary report, para 457) (WCPFC, 2019). WCPFC16 duly tasked the SC and SSP with progressing work on the 'multispecies approach' (WCPFC16 summary report, para 195) (WCPFC, 2018). While discussion was limited during the COVID period, SC17 reviewed a proof-of-concept of the 'multi-species modelling framework for mixed fishery interactions', endorsed the proposed work, and recommended the Commission take note of the progress (SC17 summary report, paras 127-128) (WCPFC, 2021). WCPFC18 incorporated the 'the mixed fishery (multispecies) approach' within the agenda for the first Science-Management Dialogue meeting (WCPFC, 2022a). Updates on progress within the mixed fishery framework have subsequently been given to the SC18 and SC19 meetings (Scott et al., 2022c,b,a, 2023).

As noted in WCPFC Circular 2025/17, the adjustments to the area of control for South Pacific albacore arose from WCPFC21 outcomes, to incorporate the request for parallel development and adoption of the South Pacific albacore and bigeye tuna MPs under the mixed fishery framework within the next two years (WCPFC, 2025a). These changes are consistent with the long-term

development of the mixed fishery framework. We note that while the MP for South Pacific albacore may control the level of fishing specifically south of 10°S - and catch levels between the equator and 10°S are assumed - the implementing measure may specify how the total southern Convention Area catch or effort is set and managed.

A reduced number of South Pacific albacore MPs were presented to SC21 compared to the 20 in WCPFC21-2024-30 (REV1) and WCPFC21-2024-30a (19 original MPs plus a supplementary request) (SPC-OFP, 2024a,b). As presented to WCPFC21, the level of constraint (the amount by which effort or catch was allowed to change up or down between management periods) had little impact on the performance of the candidate MPs. To simplify presentation, therefore, MPs with specific constraints are provided herein (+10% -5% for catch-based MPs, +-5% for the effort-based MP), reducing the number of MPs being presented from 20 (WCPFC21) to a main set of four. Following outcomes of SPAMWS02 the main set of candidate MPs has been further reduced to three, after excluding the effort-based MP. These have been complemented by several additional MPs requested at SC21 and SPAMWS01 and discussed at SPAMWS02.

The main differences between the evaluations presented here and at WCPFC21 is that the longline fishery operating between the equator and 10°S within the WCPFC-CA, representing the southern part of the tropical longline (TLL) fishery (20°N-10°S), is not managed through the South Pacific albacore MP. Following outcomes of SPAMWS02 fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S are also excluded from being managed through the MP. This results in two distinct 'streams' of evaluations, primarily defined by the area of application of the SPA MP and also the assumption made about future levels of albacore catch in the EPO (Section 2; Figure 1).

The original 20 MPs presented to WCPFC21, including their results, are described in WCPFC21-2024-30 (REV1) and WCPFC-2024-30a (SPC-OFP, 2024a,b). Only the MPs operating south of 10°S, excluding fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, and their results, are presented in this report.

Under the mixed fishery harvest strategy framework, it is proposed that the TLL fishery will be managed through the bigeye MP, i.e. their fishing levels will not consider the stock status of South Pacific albacore. To run the candidate South Pacific albacore MP evaluations, assumptions need to be made about the future level of albacore catch taken by the TLL, noting those catches would vary dependent upon the bigeye MP output. The impact of alternative catch assumptions are explored in a series of sensitivity tests (Section 5.2). Catch levels of albacore in the equator to 10°S region of the WCPFC-CA make up about 12% of recent (2020-2022) total South Pacific albacore catch in the WCPFC-CA. It is therefore important that any adopted MP is robust to different levels of albacore catch by the TLL. In this way, mixed fishery considerations are included in the evaluations.

Additional MP evaluations address requests made by SC21 and SPAMWS01 (Section 5.3), noting that SPAMWS02 agreed to no longer consider some of these candidate MPs (SPC-OFP, 2025).

Other requests from SC21, SPAMWS01 and SPAMWS02 (see Appendices for details) have also been addressed.

The results from both streams can also be explored in the online app: https://ofp-sam.shinyapps.io/spample. Due to the differences in the underlying assumptions and settings of each stream, the results between them cannot be directly compared. To assist decision making SPAMPLE has an option at the start to select the stream of interest.

# 2 Management strategy evaluation framework

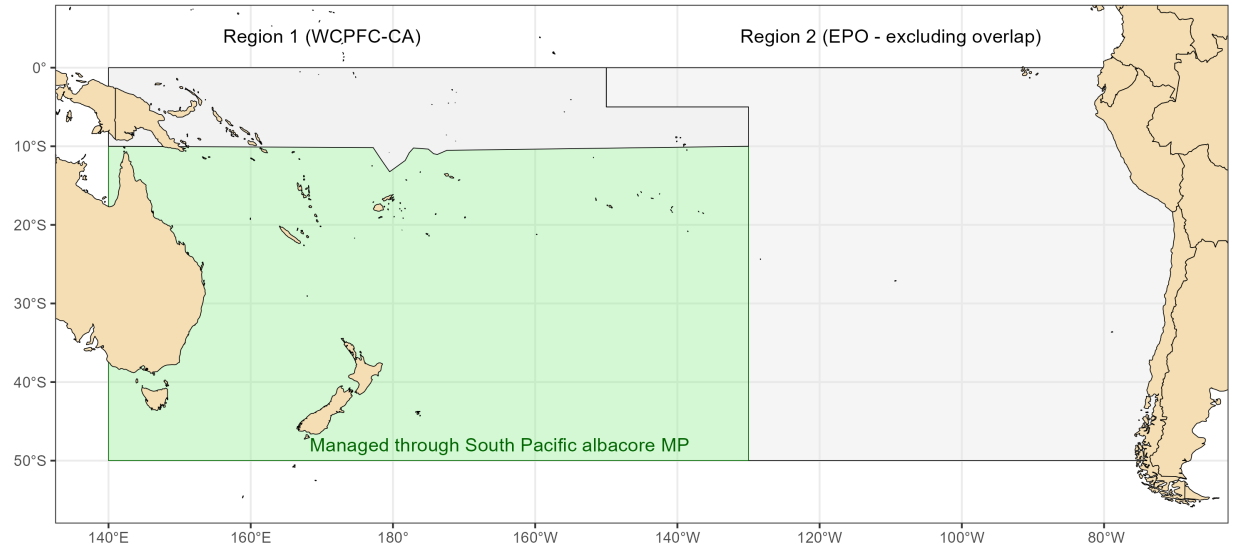
Details of the management strategy evaluation (MSE) framework, including the operating models (OMs) can be found in WCPFC-SMD02-2024/SMD02-BP-02 (Scott et al., 2024b). A summary of the main assumptions, including a description of the OMs can be found in the Appendices.

## 2.1 Two streams of MP evaluations

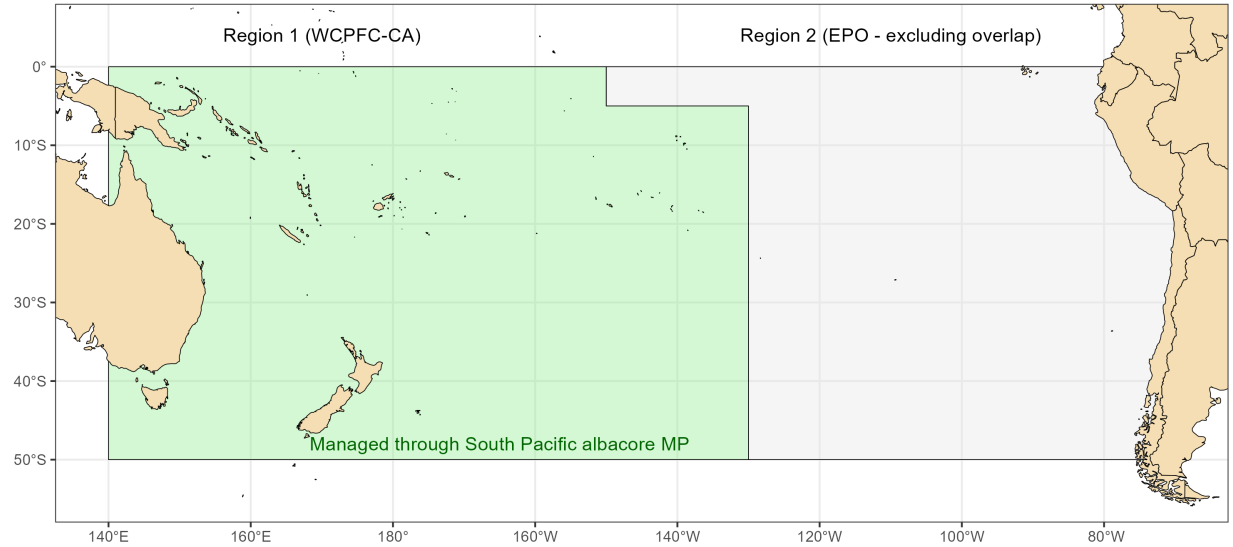
Following requests from SC21, SPAMWS01 and SPAMWS02 there are now two streams of MP evaluations, primarily defined by the area of application of the SPA MP and also the assumption made about future levels of albacore catch in the EPO (Table 1; Figure 1). As mentioned in the introduction, due to the differences in the underlying assumptions and settings of each stream, the results between them should not be directly compared. Instead, a stream should be selected and the performance of the corresponding candidate MPs then examined.

Table 1: The two streams of South Pacific albacore MP evaluations, the spatial extent of their MPs and the baseline assumption about future catches of albacore in the EPO (excluding the overlap area). Additional MP evaluations in each stream may have alternative assumptions about future EPO catches of albacore to that noted in the table.

| Area of MP application | EPO future albacore catch (p.a.) | Number of MPs | Presented |
|---|---|---|---|
| All fisheries operating south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S | 18,000 mt | 7 (3 MPs plus 4 additional MPs requested by SC21, SPAMWS01 and SPAMWS02) | SPAMWS02 and here |
| All fisheries operating in the area south of the equator | 22,500 mt | 20 | WCPFC21 |




(a) The MP applies to all fisheries operating south of 10°S in the WCPFC-CA, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S.




(b) The MP applies to all fisheries operating south of the equator in the WCPFC-CA.

Figure 1: Area of application of the South Pacific albacore MP under the two different streams.

## 2.2 Baseline EPO and 0-10°S assumptions

In the evaluations presented here, fisheries operating in the EPO (excluding the overlap) and WCPFC-CA 0-10°S regions of the OMs are not managed through the South Pacific albacore MP. Following outcomes of SPAMWS02 fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S are also excluded from being managed through the MP.

The South Pacific albacore MP therefore defines the level of fishing by longline and troll fisheries in the WCPFC-CA, south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, and adjusts that level as needed to achieve management objectives (Figure 1a).

To run the South Pacific albacore candidate MP evaluations assumptions are made on the level of future albacore catch by fisheries in regions that are not managed through the MP. For the evaluations presented here, the future catches in these regions are fixed at the approximate average levels in the years 2014-2023:

- Future level of albacore catch in the 0-10°S region of the WCPFC-CA (the TLL fishery) is fixed at 9000 mt per annum.
- Future level of albacore catch in the EPO region (excluding the overlap) is fixed at 18,000 mt per annum.
- Future level of albacore catch in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10° is fixed at 667 mt per annum.

Further assumptions for additional MP evaluations are described in Section 3.

As requested by SC21 and SPAMWS01, the historical catches in the EPO (excluding the overlap), WCPFC-CA 0-10°S and WCPFC south of 10°S regions are shown in Figure 2. Note that the 18,000 mt in the EPO region is less than the level of 22,500 mt used in the evaluations presented to WCPFC21 (SPC-OFP, 2024a).

Sensitivity tests are performed whereby candidate MPs are tested against alternative future catch levels in the EPO (excluding the overlap) and 0-10°S regions. As the adoption of a South Pacific albacore MP is conditional upon the assumptions made about future catches in these regions, catches in these regions will need to be monitored as part of the South Pacific albacore MP monitoring strategy to determine if these assumptions are still valid.

## 2.3 Other assumptions

Another assumption is the catches of albacore by fisheries that are managed through the South Pacific albacore MP in the period 2023-2025, i.e. between the start of the evaluations and when the MP is first applied (the 'transient' period). In these evaluations the catches in the transient period are set to the 2017-2022 average of approximately 57,020 mt, including catches in the slivers of the EEZs of Tokelau and Tuvalu that are below 10°S. Data for 2023 and 2024 show the actual catches

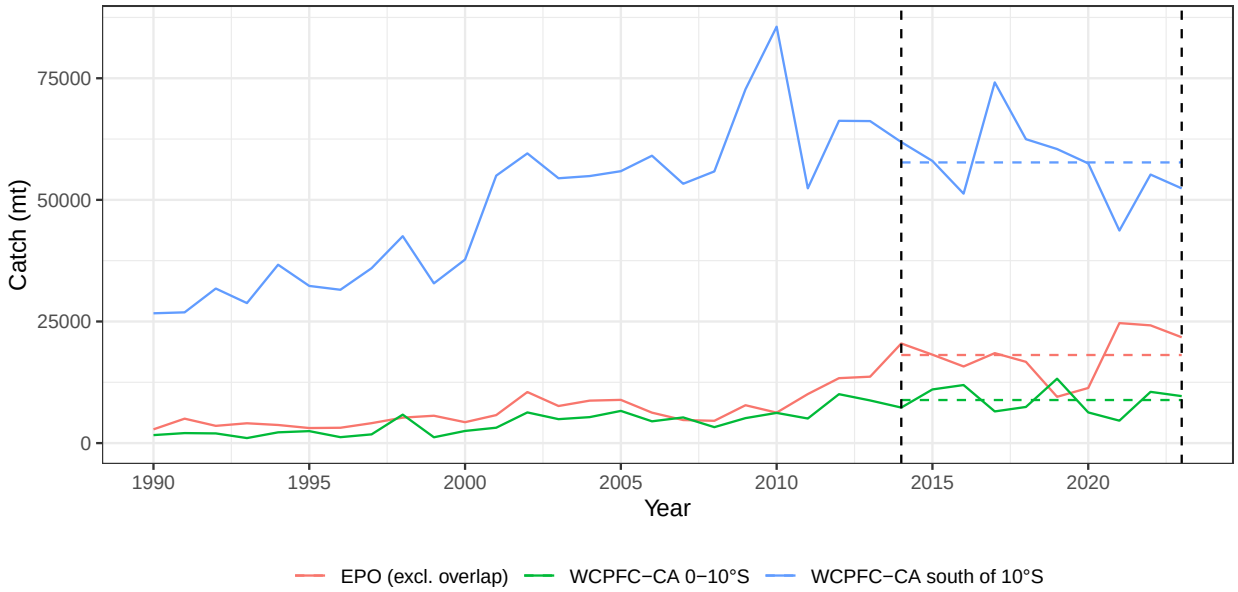



Figure 2: Time series of total albacore catches in the EPO (excluding the overlap), WCPFC-CA 0-10°S and WCPFC-CA south of 10°S regions. The time period used for the EPO and TLL catch assumptions (2014-2023), and corresponding average catch, is shown by the dashed lines.

in the south of 10°S region are approximately 51,500 and 57,300 mt respectively, consistent with this assumption.

Under the WCPFC harvest strategy approach, fisheries operating in archipelagic waters are subject to domestic management arrangements. Using the most recently available data, the proportion of South Pacific albacore catch taken in archipelagic waters in the WCPFC-CA is calculated to be less than 1% of the total South Pacific albacore WCPFC-CA catch. Excluding fisheries operating in archipelagic waters from MP management in the MSE simulations would require some technical work and a number of assumptions to be made. Given the small proportion of catches in archipelagic waters, and the negligible impact they will have on the performance of the candidate MPs, in the current MP evaluations fisheries operating in archipelagic waters are under MP control. Following implementation of an MP for South Pacific albacore, the level of catch in archipelagic waters would be monitored within the monitoring strategy.

# 3 Candidate management procedures

An MP comprises three components:

- Data collection
- Estimation method (EM)
- Harvest control rule (HCR).

For each candidate MP examined in this paper the data collection is the same and is assumed to

be similar to current data collection processes. The EM is also the same for each candidate MP. The HCRs are explored below.

The key assumptions for the MPs are:

- All fisheries managed through the MP are managed through the setting of catch limits.
- The HCR of each MP outputs a scalar that is applied to the baseline catch of the fisheries managed through the MP. Associated catch limits are shown for these catch-based MPs.
- The current baseline for each HCR is the average catch in the period 2020-2022, i.e. an output scalar of 1 sets the catch limit for the next management period to the average of 2020-2022 catches.
- All fisheries managed by the MP are affected equally, e.g. if the MP specifies a 10% increase in catch, all fisheries managed by the MP have their catch limits increased by 10% relative to the baseline for the next management period.

The evaluations assume that the output will be the total annual catch of the longline and troll fisheries that are managed through the MP, for the next 3 year management period. Allocation of that total, and how those allocations are managed in practice (e.g. through effort if the allocation is in terms of catch, or catch if the allocation is in terms of effort), is external to the MP.

The baseline period of 2020-2022 does not affect the output catch limit. It simply provides a baseline level of catch that the scalar output from the HCR can be applied to. If an alternative baseline period were chosen, to achieve the same performance the shape of the HCR would need to change, i.e. be scaled up or down. However, the resulting catch limit would be unaffected.

### 3.1 Estimation method

The estimation method (EM) is an age-structured production model, implemented in Multifan-CL, with two index fisheries: a longline index in the WCPFC-CA model region and a longline index in the EPO model region. This is an update to that presented to SC20 as it has removed the reliance on a WCPFC-CA troll fishery index which helps to 'future proof' the MP (Scott et al., 2024a,b).

Following discussion at SC20 and SMD02, the HCR input is a relative measure of stock status: mean estimated $SB/SB_{F=0}$ in the last three years relative to the mean estimated $SB/SB_{F=0}$ in 2017-2019. The absolute measure of HCR input (mean estimated $SB/SB_{F=0}$ in the last three years) has been dropped.

$SB/SB_{F=0}$ is calculated as $SB_{latest}/SB_{F=0}$, i.e. SB in year y relative to the average $SB_{F=0}$ in years y-10 to y-1, and is averaged over the last three years in the calculations above.

The updated EM performs well and SC21 recommended its continued use (SPC-OFP, 2024a; WCPFC, 2025b).

Following SPAMWS01 a small improvement has been made to the EM model fitting algorithm. The structure and settings of the EM remain unchanged, and it performs exactly as before, but

now there are fewer cases where the model failed to converge leading to an increased number of successful iterations. This has resulted in a small change in the resulting performance indicators.

The estimation method has been run using the most recently available data (upto 2023) and the results presented in the Appendices.

### 3.2 Harvest control rules

As noted in the introduction, this report focuses on the evaluation stream where the MP manages all fisheries operating south of 10°S, excluding those operating in the EEZs of Tokelau and Tuvalu that are south of 10°S. The long-term performance of an MP, in terms of the long-term $SB/SB_{F=0}$, is not strongly affected by whether or not the fisheries in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S are managed through the MP (SPC-OFP, 2025).

Each HCR has a similar shape to the HCR in the adopted interim skipjack MP, with a 'Hillary step' (WCPFC, 2022b).

The candidate MP evaluations are split into two sets:

- A main set of three MPs which have the same basic assumptions, for example about the future fishing level by the TLL and in the EPO.
- Additional candidate MP evaluations in which the basic assumptions differ, as requested at SC21 and SPAMWS01, noting that SPAMWS02 agreed to no longer consider some of these candidate MPs.

The HCRs in each set have been designed to achieve either the interim target reference point (iTRP), or the upper or lower TRP range as proposed by WCPFC20, in terms of long-term median $SB/SB_{F=0}$, e.g. HCR 7 (catch-based) achieves approximately the same long-term median $SB/SB_{F=0}$ as the iTRP, under baseline assumptions for future EPO and TLL catch levels (Table 2).

Each set has different HCR shapes to achieve the desired objectives given the underlying assumptions (Figure 3). A table of the HCR parameters can be seen in the Appendices (Table 6). The results of the main and additional MP evaluations are presented separately because the differences between them are not just because of the HCR shape, but the underlying assumptions too.

#### Main candidate MPs

There are three main candidate MPs, each with a different HCR (Figure 3). All of these MPs are are catch-based. Following discussions at SPAMWS02, the effort-based candidate MP with HCR 9 presented at SC21 and SPAMWS01 is no longer being considered.

#### Additional candidate MPs

Six additional catch-based MPs were requested at SC21 and SPAMWS01 that achieve specified objectives under a range of alternative assumptions. Following discussions at SPAMWS02 this has

been reduced to four. The alternative assumptions include:

- The future level of catch in the EPO (18,000 or 22,500 mt per annum).
- Whether the future fishing levels of the TLL are set to the 2014-2023 levels of catch (9000 mt per annum) or effort (144 million hooks).
- Whether the future catch of the troll fisheries in the WCPFC-CA is managed through the MP or fixed at 2000-2004 average level (4800 mt per annum).

Each of the four additional MPs has a different HCR (HCRs 14 & 17-19, Figure 3). A table of the assumptions behind the evaluations is presented in Table 2.

Table 2: The HCRs, constraints, objectives and assumptions (future annual EPO catch, excluding the overlap area, and TLL fishing level) behind the main and additional candidate MP evaluations. All MPs are catch-based. Where the WCPFC-CA troll fisheries are excluded from the MP the future annual catches of these fisheries is fixed at the 2000-2004 average catch. The target is either the interim TRP, or the upper or lower TRP range as proposed by WCPFC20.

| HCR | Constraint | Target | EPO catch (mt) | TLL metric | TLL (mt or millions of hooks) | WCPFC-CA troll under MP |
|---|---|---|---|---|---|---|
| Main MPs | | | | | | |
| HCR 7 | +10% -5% | iTRP | 18,000 | Catch | 9,000 | Included |
| HCR 10 | +10% -5% | Lower TRP | 18,000 | Catch | 9,000 | Included |
| HCR 13 | +10% -5% | Upper TRP | 18,000 | Catch | 9,000 | Included |
| Additional MPs | | | | | | |
| HCR 14 | +10% -5% | iTRP | 22,500 | Catch | 9,000 | Included |
| HCR 17 | +10% -5% | iTRP | 22,500 | Effort | 144 | Included |
| HCR 18 | +10% -5% | iTRP | 18,000 | Catch | 9,000 | Excluded |
| HCR 19 | +10% -5% | Upper TRP | 18,000 | Catch | 9,000 | Excluded |

### 3.3 Meta-rules and constraints

The candidate MPs have constraints on how much the output of the HCR can change between management periods. Results presented in 2024 suggested that alternative constraint options had only a limited impact on the long-term results. As such, only a specific constraint option is currently evaluated for each HCR (Table 2). Additional constraint options are evaluated as sensitivity tests (Section 5.2).

The first time the MP is used (in 2025), the constraint is applied to the catch in 2023 (assuming a two year data lag), i.e. the catch limit set by the MP for 2026 cannot change by more than X% from the catch level in 2023. The assumed levels of catch in 2023 can therefore impact the performance of an MP with a constraint, particularly in the first few management periods.

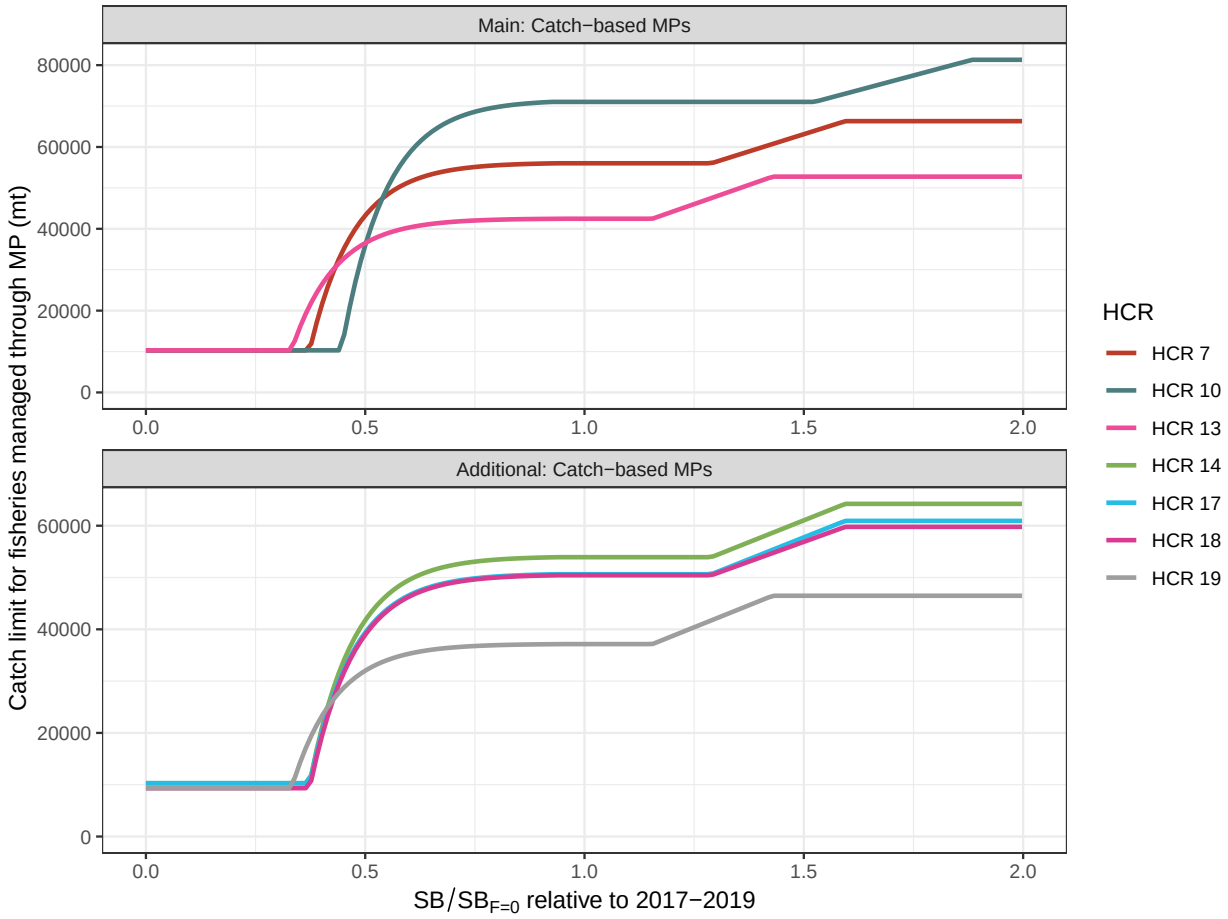



Figure 3: The HCR shapes for the candidate MPs. The input to the HCR is the estimated mean $SB/SB_{F=0}$ of the last three years relative to 2017-2019. The output of an HCR is a scalar applied to average 2020-2022 levels of catch for those fisheries managed through the MP. The associated catch limit for fisheries managed through the MP is shown.

# 4 Performance indicators

Relative performance of the candidate MPs is evaluated by comparing the calculated performance indicators. As requested by SPAMWS02 an additional catch based indicator is calculated that reports the total expected catch of fisheries managed through the MP, giving seven performance indicators.

The biomass indicators ($SB/SB_{F=0}$, probability of being above the LRP) are based on the biomass in the WCPFC-CA, whereas the other indicators are based on fisheries operating south of 10°S.

- $SB/SB_{F=0}$ in the WCPFC-CA (measured as $SB_{latest}/SB_{F=0}$, i.e. SB in year y relative to the average $SB_{F=0}$ in years y-10 to y-1). This can be compared to the interim target reference point (iTRP) and any proposed alternative TRPs.
- Probability of the stock status in the WCPFC-CA being above the limit reference point

(LRP), noting that the WCPFC requires the probability to be greater than 0.8.

- Total albacore catch in the WCPFC-CA, south of 10°S. Note that this indicator includes catches in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S even though fisheries operating in those slivers are not managed through the MP.
- Total albacore catch of fisheries managed through the MP, i.e. those operating south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S, and potentially excluding the catch of the troll fisheries in the WCPFC-CA depending on the MP (i.e. those with HCRs 18 and 19).
- Vulnerable biomass available to longline fisheries in the WCPFC-CA, south of 10°S. This is a proxy for CPUE and is calculated as relative to the average vulnerable biomass in the period 2020-2022.
- Catch variability, calculated as the absolute annual difference in WCPFC-CA catch, south of 10°S (also the same as the variability of catch of fisheries managed through the MP).
- Effort variability, calculated as the absolute annual difference in WCPFC-CA longline effort, south of 10°S, measured in 100s of hooks.

The average values of the performance indicators are calculated over three time periods:

- Short (2026-2034)
- Medium (2035-2043)
- Long (2044-2052)

SC21 requested that the SSP report the median time series of vulnerable biomass from the OMs for the historical period and to develop a table with the average nominal CPUE (kg/100 hooks) for the reference period (2020-2022) by CCMs with SPA catches. These can be seen in the Appendices (Table 7).

# 5 Results

800 stochastic simulations (known as iterations) are performed for each MP. In some of the simulations the projected stock crashes due to a combination of low recruitment, life history parameters implying a less productive stock, and high fishing pressure. In these cases, the expected catch, effort and stock status for the remainder of the simulation are set to zero.

In some of the simulations the estimation method does not produce a valid response (less than 2% of the iterations). This is to be expected given that during the evalutions the estimation method is confronted with a very wide range of possible stock statuses and fishery data. In these cases, the expected catch, effort and stock status for the remainder of the simulation are set to NA, i.e. they are essentially removed from the results.

A brief summary of the results are presented here using box plots in the three different time periods. The box and whiskers show the 60th and 95th percentile ranges respectively. The larger the box

and the longer the whiskers, the greater the uncertainty in the expected values. Summary tables are given in the Appendices.

The results include the main MPs (evaluated when the future EPO and TLL catches are fixed at 18,000 mt and 9000 mt, respectively), and the additional MPs (that have a range of different assumptions, including about the future fishing in the EPO and by the TLL). Sensitivity tests for different EPO and TLL future assumptions are also shown (Section 5.2).

The interactive app, SPAMPLE, is recommended for exploring the results and may assist in selecting preferred MPs: https://ofp-sam.shinyapps.io/spample.

The estimation method has been run with the most recently available data (upto 2023) and the result used by each of the candidate MPs to produce the corresponding catch limit for the management period 2026-2028. These results are presented in the Appendices (note that the results are provisional).

## 5.1 Main MPs

The main MPs all have the same underlying assumption about future fishing levels in the EPO (excluding the overlap area) and the WCPFC-CA equator to 10°S area. Their resulting performance indicators can therefore be directly compared.

### Stock depletion and LRP risk

The range of expected $SB/SB_{F=0}$ for each candidate MP can be seen in Figure 4. WCPFC20 agreed an interim TRP (iTRP) as 0.96 x mean $SB/SB_{F=0}$ in 2017-2019. A TRP range of 0.42 to 0.56 was also proposed at WCPFC20 for examination. These are shown as the top three horizontal dashed lines, the middle line being the iTRP. Note that these values were proposed on the basis of projections based on the 2024 stock assessment grid. The OM grid is different to the stock assessment grid and so the TRP values have been rescaled accordingly. The bottom dashed line is the LRP.

All current candidate MPs have a probability of being above the LRP greater than the WCPFC threshold of 0.8. The MP with HCR 10, which achieves the lower range of the proposed TRP, shows the lowest probability (greatest risk) and has a 15% chance of falling below the LRP.

### Longline vulnerable biomass, south of 10°S

Vulnerable biomass is a proxy for CPUE (catch rates). The relative vulnerable biomass of longline fisheries in the WCPFC-CA, south of 10°S, follows a similar pattern to the $SB/SB_{F=0}$ results (Figure 4). The MP with HCR 13, which achieves the upper TRP range in the long-term, has the highest vulnerable biomass, but in the short- and medium-term it is not much higher than the MP with HCR 7. The MP with HCR 10 implies larger reductions in vulnerable biomass.

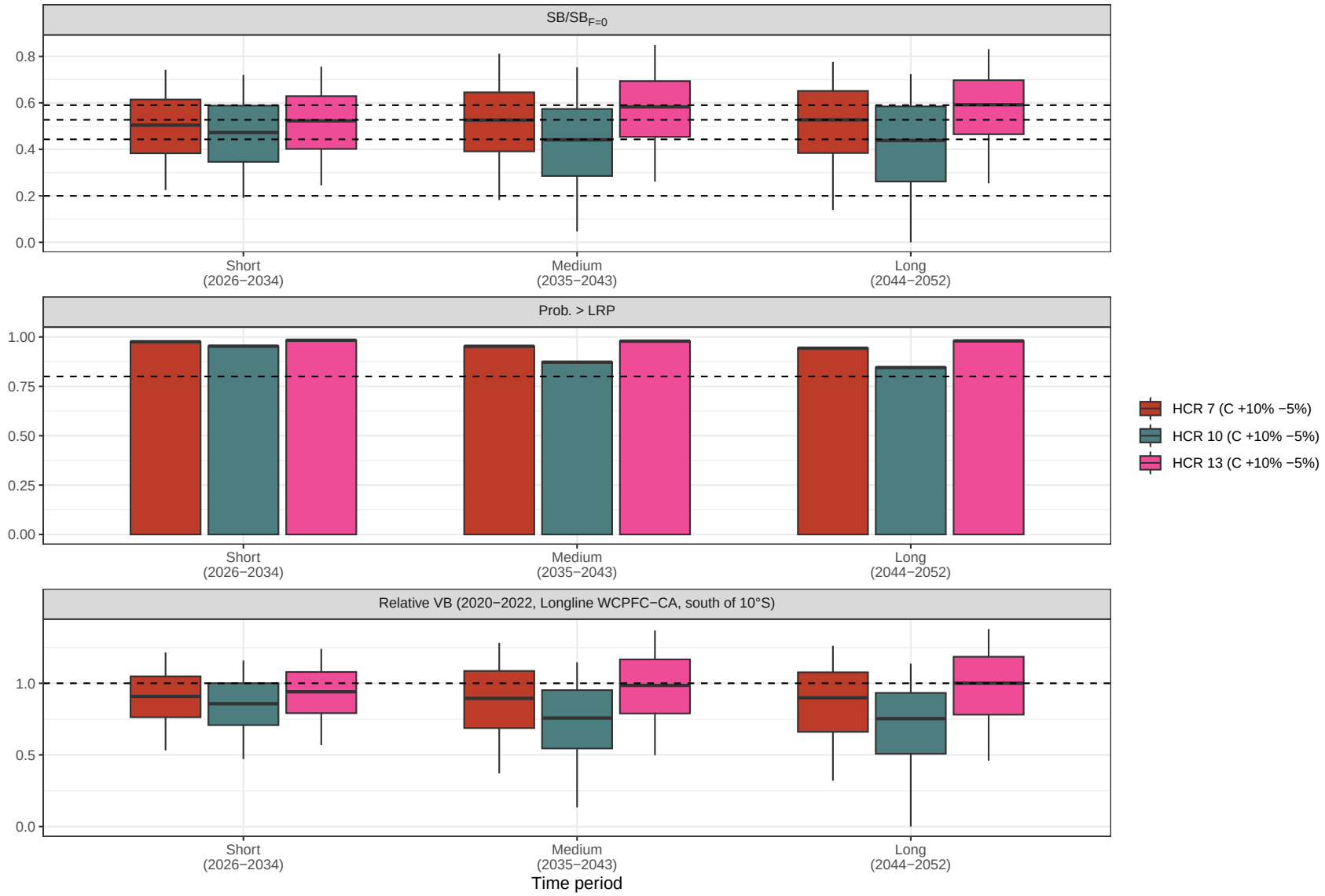



Figure 4: Box plots of $SB/SB_{F=0}$ in the WCPFC-CA and vulnerable biomass (VB) for the longline fisheries in the WCPFC-CA, south of 10°S, relative to the level in 2020-2022, and a bar plot (middle) of probability of being above the LRP. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. Horizontal lines on the $SB/SB_{F=0}$ plot are the iTRP (second from top), proposed TRPs from WCPFC20 and the LRP (bottom). The horizontal line on the Prob. > LRP plot is at 0.8, the minimum required by WCPFC.

### Expected catches and catch variability

The median level of expected albacore catch is conditional on the shape of the HCR (Figure 5). Note only the total catch by fisheries managed through the MP is shown here (the other catch indicator is available in the results tables in the Appendices and in SPAMPLE). This is the same as the total catch in the WCPFC-CA, south of 10°S less the catch in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S (here assumed to be 667 mt per annum).

The candidate MP with HCR 13 has the lowest expected catches, and is the only one which has catches lower than the 2020-2022 average level in the WCPFC-CA, south of 10°S. This MP also achieves the highest level of stock status and vulnerable biomass (Figure 4), an example of the known trade-off choice between high catches and high catch rates.

Some of the advantages of having a catch-based MP setting can be seen in the low uncertainty in future catches, and also low median levels of catch variability (the catch limit is fixed for each three year management period). The catch variability for the catch-based MPs will be partially determined by the constraint (here +10% -5%).

The long whiskers seen for the MP based on HCR 10 in the medium- and long-term are a result of the stock crashing in some iterations, due to a combination of high catches, less productive stock assumptions, and low recruitment (Figure 5). For these iterations the catches are set to 0 for the remainder of the simulation. For this MP, 6% of the 800 iterations resulted in the stock crashing at the end of the time series. However, as the whiskers show the 95th percentile range (almost the full range of results), this is enough to result in the whisker reaching 0.

### Effort variability

The effort needed to take a set catch limit depends on the biomass available to the fishery. This varies over time as biomass levels vary due to natural processes as well as fishing pressure.

The evaluations for a catch-based MP assume that the catch limit is always caught where possible, i.e. when there are enough fish. If the stock is very low it can require unrealistically high levels of fishing effort to take the catch limit. In reality the maximum effort would be limited, and the realised catches resulting from that effort would be lower than the catch limit set by the MP, limiting effort variability.

The output type of the MP is not necessarily how the limit set by the MP will be implemented, e.g. the catch limits specified by a catch-based MP may be implemented through effort limits. To implement a catch limit set by a catch-based MP as an effort limit requires a conversion between catch and effort, likely based on recently observed catch rates. Therefore, the effort limits that would be implemented would be expected to be as stable as the catch limits set by a catch-based MP, and subject to the same constraint on how much the output can change between management periods.

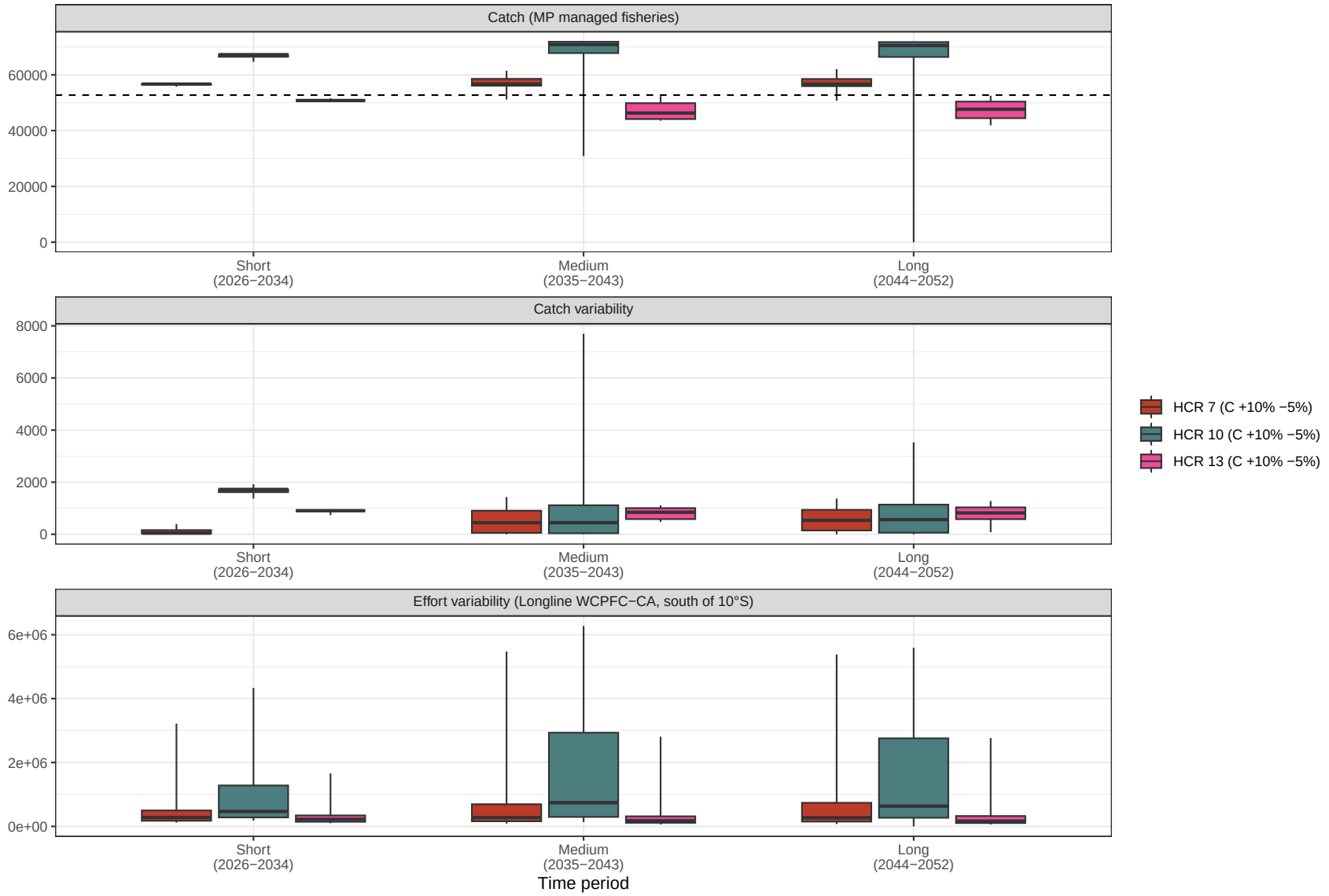



Figure 5: Box plots of total albacore catch by fisheries managed through the MP, the associated average annual catch variability (all in mt) and average annual WCPFC-CA longline effort variability (00s of hooks), south of 10°S.The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The dashed horizontal line on the catch plot is the average catch in 2020-2022 in the WCPFC-CA, south of 10°S (included for reference).

## 5.2 Sensitivity tests

One-off sensitivity tests were performed based on alternative assumptions about the future levels of albacore catches in the EPO and in the region between the equator and 10°S in the WCPFC-CA (the tropical longline, TLL, fisheries). Alternative constraint options of +-10% and no constraint are also included. In these tests the level of albacore catch in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S remains fixed at 667 mt per annum.

These evaluations use a catch-based MP with HCR 7 and a +10% -5% constraint as the base case. The results of a single change are then compared to the results from the base case. The resulting performance indicators are presented as box-plots. Of the catch performance indicators, only the total catch by fisheries managed through the MP is shown. The full results are available in the Appendices.

A single sensitivity test based on the EPO and TLL catch assumptions for the other main candidate MPs is also included below.

### EPO baseline

In the evaluations performed above, the fisheries in the EPO (excluding the overlap area) are not managed through the MP and their future catches are fixed at 18,000 mt per annum. In this sensitivity test the future catches of albacore in the EPO are fixed at the higher level of 22,500 mt per annum, consistent with the assumptions in SPC-OFP (2024a) (Figure 6).

Higher catches in the EPO result in slightly lower expected stock status and vulnerable biomass in the WCPFC-CA. The catch of fisheries managed through the MP is largely unaffected by the increase in catches in the EPO, even though expected biomass is lower, suggesting that the stock status is on the 'Hillary step' part of the HCR, i.e. the stock status is fluctuating but is still on the step so that the output catch limit does not change frequently. This demonstrates that the HCR is working as expected.

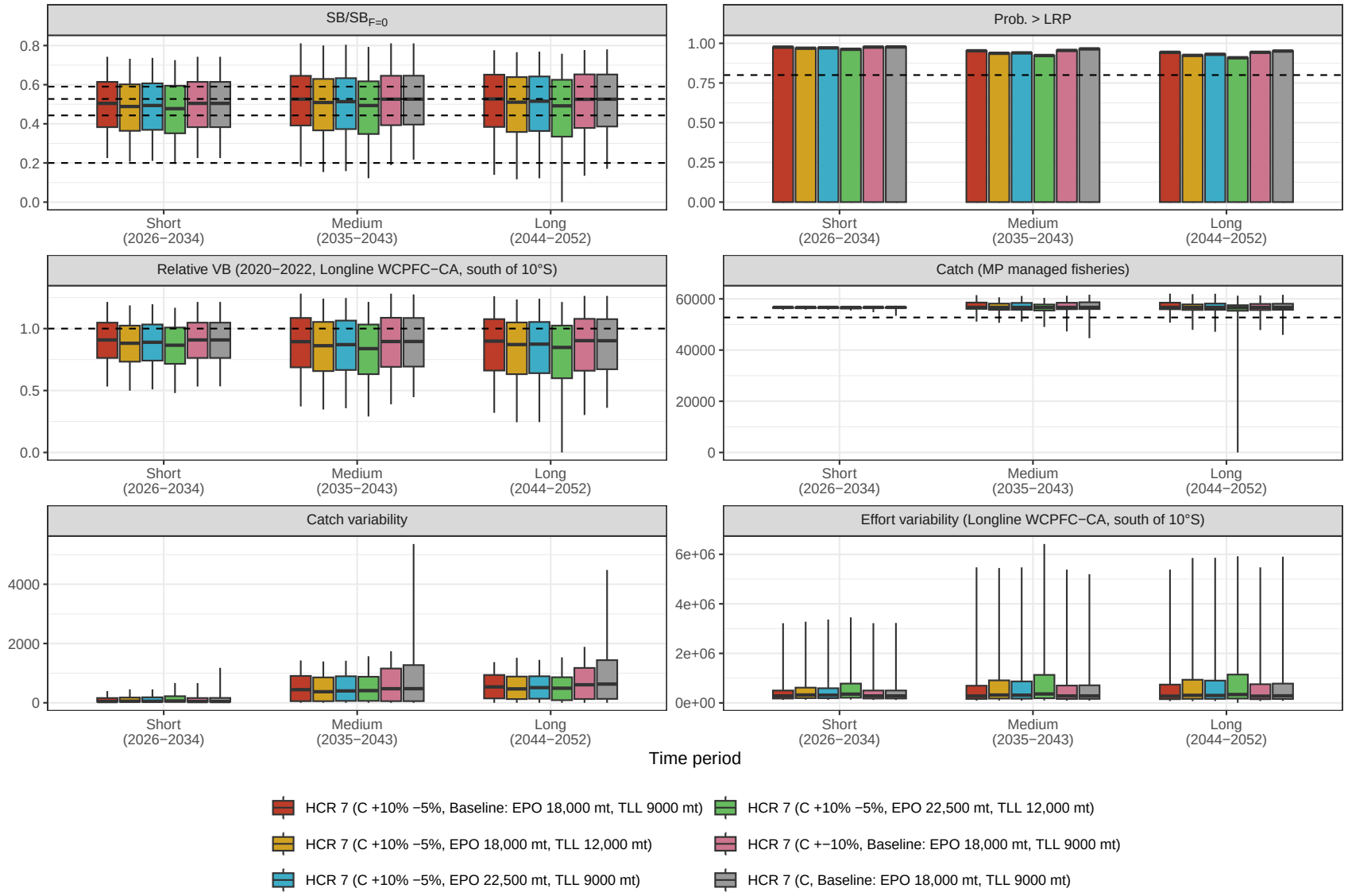



Figure 6: The performance indicators for the same MP with alternative constant annual catch levels in the EPO and in the region between the equator and 10°S in the WCPFC-CA (the TLL fisheries) compared to baseline levels of 18,000 mt and 9000 mt respectively. A catch-based MP with HCR 7 is used, with +10% -5% constraint. Additional constraint options of +-10% and no constraint are also included. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The probability of being above the LRP is shown as a bar plot. The dashed horizontal line on the catch plot is the average catch in 2020-2022 in the WCPFC-CA, south of 10°S (included for reference).

### Tropical longline baseline

In the evaluations performed above the longline fisheries in the WCPFC-CA, equator to 10°S (the TLL fishery), are not managed through the MP and their future catches are fixed at 9,000 mt per annum (excluding the fixed catch of 667 mt per annum from the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). Under the mixed fishery approach it is proposed that these fisheries will be managed through the bigeye MP which will not consider the stock status of South Pacific albacore. It is therefore important that the performance of the South Pacific albacore MP is robust to future South Pacific albacore catch levels by the TLL fishery. In this sensitivity test the future catches of albacore by the TLL fishery are fixed at a higher level of 12,000 mt per annum (approximately the highest one year catch by the TLL fishery in the last ten years) (Figure 6).

As with the alternative EPO catch scenario above, under the higher TLL catch scenario, the average long-term $SB/SB_{F=0}$ and vulnerable biomass are slightly lower. Also as above, the catch of fisheries managed through the MP is largely unaffected by the increase in catches by the TLL fisheries, suggesting that the stock status is on the 'Hillary step' and the HCR is performing as expected.

### EPO and tropical longline baseline

In this sensitivity test, the future South Pacific albacore catches of the EPO (excluding the overlap area) and TLL fisheries are both set at higher levels than the baseline (22,5000 mt and 12,000 mt) (Figure 6).

This scenario represents the biggest change from the baseline assumptions about TLL and EPO future catches. The average long-term $SB/SB_{F=0}$ is lower than the objective of the iTRP, and the vulnerable biomass (CPUE) is also lower. However, the median catch of fisheries managed through the MP are largely unaffected.

### Alternative constraints

In the main results, the MP with HCR 7 has a constraint of +10% -5%. Here the same HCR is tested but with alternative constraints of +-10% and no constraint, as requested by SPAMWS02 (Figure 6). Baseline values for future EPO and TLL catches of albacore are used. The alternative constraints have little impact on the performance of the MP. The main differences are increased catch variability and slightly less uncertainty in the expected catches with the looser or no constraint, in the long-term.

For more detail on the potential impact of constraints, see the relevant section in Scott et al. (2024b).

### Sensitivity tests of the other main MPs

A single sensitivity test is run for the two remaining main MPs (with HCRs 10 and 13), in which the future catches of South Pacific albacore in the EPO are fixed at the higher level of 22,500 mt

per annum and the future catches of albacore by the TLL fishery are fixed at the higher level of 12,000 mt per annum, i.e. the biggest change from the baseline assumptions about TLL and EPO future catches (Figure 7).

The results agree with the comments above for sensitivity tests for the MP with HCR 7, with lower $SB/SB_{F=0}$, catches and vulnerable biomass. The main result of interest is that the probability of being above the LRP for the catch-based MP with HCR 10 is at 0.8, i.e. at the minimum that is acceptable by the WCPFC, implying a 20% probability of falling below the LRP.

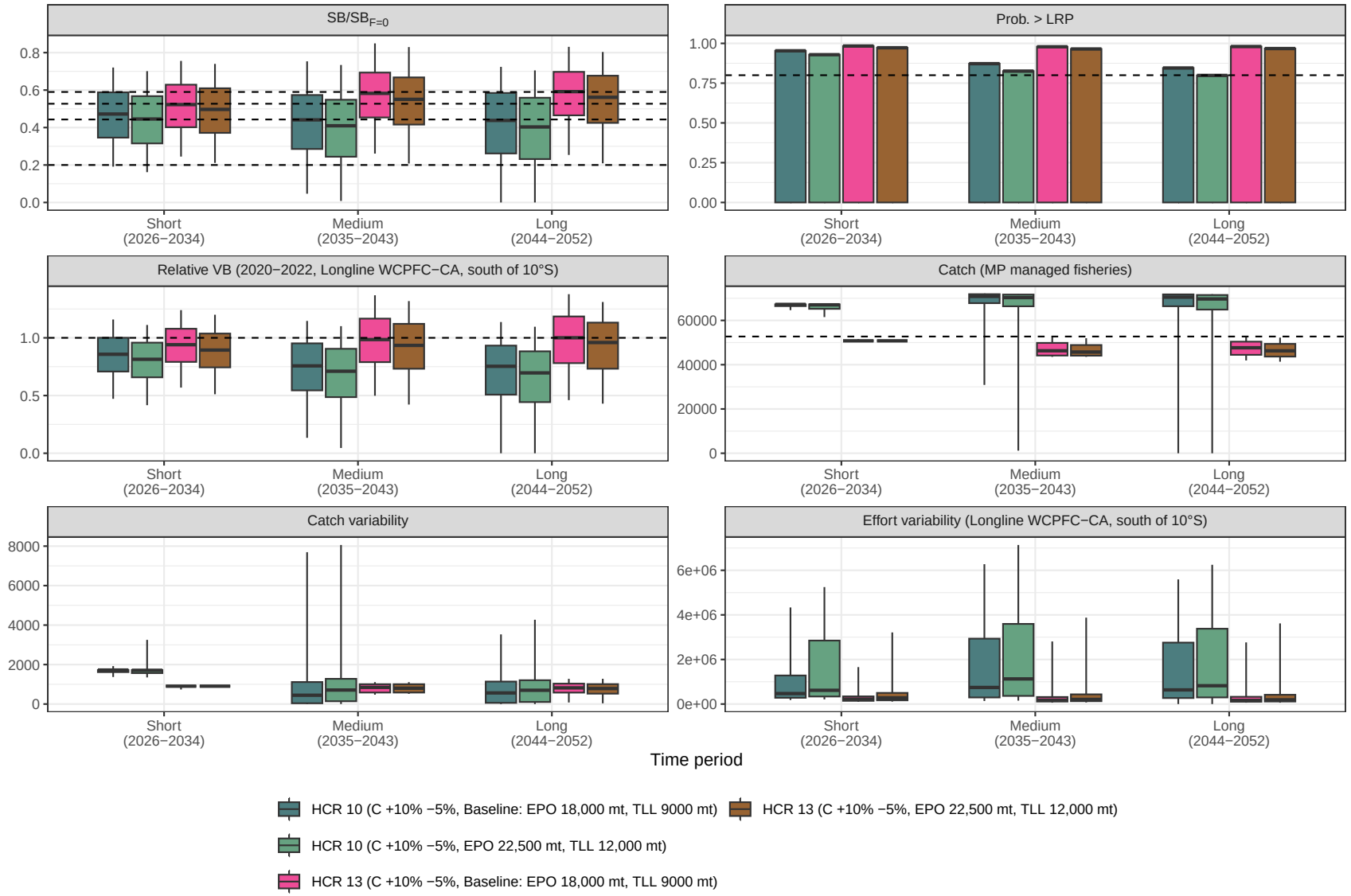



Figure 7: The performance indicators for a single sensitivity test for the main MPs with HCRs 10 and 13 with alternative constant annual catch levels in the EPO of 22,500 mt and in the region between the equator and 10°S in the WCPFC-CA of 12,000 mt (the TLL fisheries) compared to baseline levels of 18,000 mt and 9000 mt respectively. The results with the baseline assumptions are included for reference. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The probability of being above the LRP is shown as a bar plot. The dashed horizontal line on the catch plot is the average catch in 2020-2022 in the WCPFC-CA, south of 10°S (included for reference).

### 5.3 Additional management procedure evaluations

SC21 and SPAMWS01 requested evaluations for additional candidate MPs that more fully explore future EPO (excluding overlap area) catch consequences, the use of a fixed effort assumption in the WCPFC-CA 0-10°S area and the exclusion of the troll fisheries in the WCPFC-CA from being managed through the South Pacific albacore MP (see Table 2 for a summary):

1. Future annual EPO catches (excluding the overlap area) set to 22,500 mt (being the approximate average of catches in the years 2021-23), WCPFC-CA 0-10°S future annual catches set to 9000 mt (being the approximate average in the period 2014-2023), using a catch control HCR 'tuned' to achieve the adopted iTRP.
2. As 1. but with future EPO catches (excluding the overlap area) set to 13,500 mt.
3. Future annual EPO catches (excluding the overlap area) set to 18,000 mt (being the approximate average for the period 2014-2023), WCPFC-CA 0-10°S future annual effort set to average effort levels in the period 2014-2023, using a catch control HCR 'tuned' to achieve the adopted iTRP.
4. As 3. but with future annual EPO catches (excluding the overlap area) set to 22,500 mt.
5. Future annual EPO catches (excluding the overlap area) set to 18,000 mt, WCPFC-CA 0-10°S future annual catches set to 9000 mt, troll fisheries in the WCPFC-CA excluded from the MP and future annual troll catches fixed at average 2000-2004 levels, using a catch control HCR 'tuned' to achieve the adopted iTRP.
6. As 5. but with the HCR 'tuned' to achieve the upper TRP range.

The first two additional MPs use alternative assumptions about future EPO catches (excluding the overlap area) at 22,500 mt and 13,500 mt per annum respectively, while maintaining future TLL catches at baseline levels of 9000 mt per annum. The third and fourth MPs uses alternative assumptions about future EPO catches (excluding the overlap area) at 18,000 mt and 22,500 mt per anuum, while fixing future TLL effort at average 2014-2023 levels (approximately 144 million hooks) instead of fixing future TLL catches at baseline catch levels (Figure 8). The fifth and sixth MPs exclude the WCPFC-CA troll fishery from being managed through the South Pacific albacore MP and fix the future troll catches at the average 2000-2004 levels.

SPAMWS02 agreed to no longer consider the second and third of these additional MP evaluations.

Note these additional evaluations are not equivalent to the sensitivity tests in the previous section. Those sensitivity tests evaluate the robustness of the same MP to alternative EPO and TLL catch assumptions, i.e. they reflect the expected change in performance should the EPO and TLL fishing levels differ to the baseline assumptions. Here, the HCRs are 'tuned' to achieve a specific long-term target performance under alternative EPO, TLL and troll fishery assumptions (the iTRP or upper TRP range), i.e. an HCR shape is found so that the desired objective can be achieved given the underlying assumptions. If the EPO, TLL or troll fishing levels differ to those assumptions, then the expected performance would be different to that reported here.

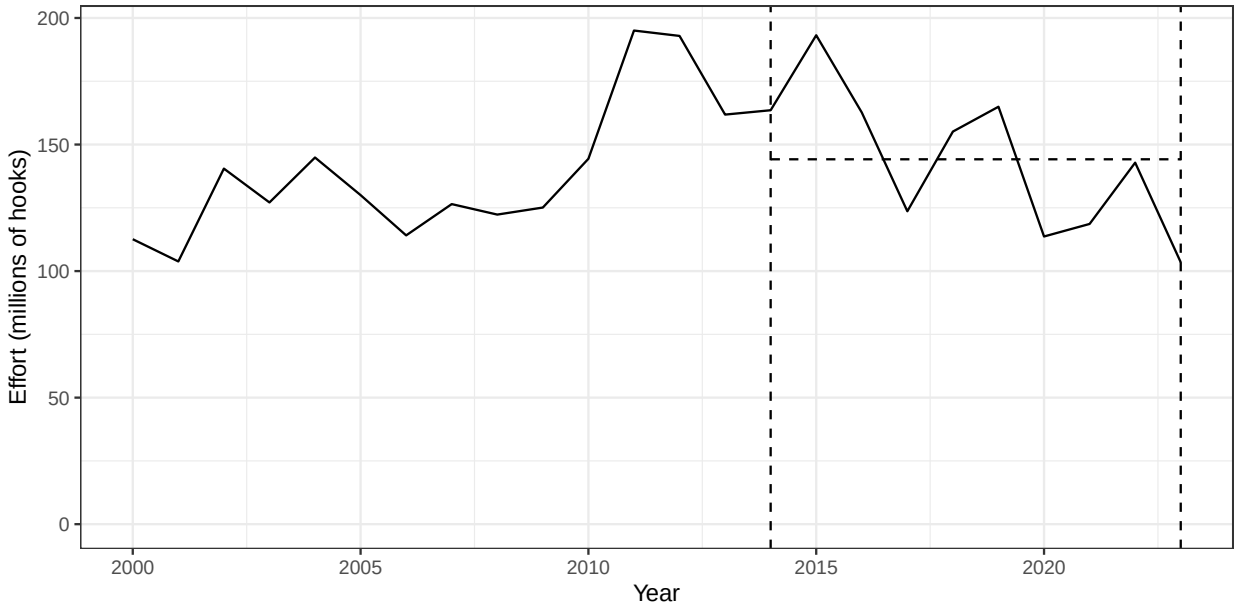



Figure 8: Time series of total longline effort in the WCPFC-CA equator to 10°S model region. The time period of 2014-2023, and the average effort over that time period, are shown as dashed lines.

The additional MPs are catch-based and have new HCRs that have been 'tuned' to achieve either the iTRP or upper TRP range in the long-term. The HCRs are based around HCRs 7 and 13 (which achieve the iTRP or upper TRP range in the long-term under baseline EPO and TLL catch assumptions), with the height of the Hillary step adjusted to achieve the iTRP under the new assumptions (Table 6, Figure 3). A constraint of +10% -5% is applied to each of the new MPs.

**Results**

The performance indicators from the additional MPs are shown in Figure 9. Of the catch performance indicators, only the total catch by fisheries managed through the MP is shown. The full results are available in the Appendices.

The assumptions about the future EPO and TLL albacore catch, fishing effort and the WCPFC-CA troll fishery are different for each of the MPs so care must be taken when comparing them. The differences between their performance are a combination of the different HCR shapes and the underlying assumptions.

Three out of the four additional MPs have HCRs that have been 'tuned' to achieve the iTRP in the long-term. Consequently, the expected $SB/SB_{F=0}$ and the relative vulnerable biomass are very similar across the MPs and underlying assumptions. The probability of being above the LRP is very similar for all MPs, and above the 0.8 minimum required by WCPFC.

The expected catch of the fisheries managed through the MP is different for each of the additional MPs. The lowest is for the MP with HCR 19 which acheives the upper TRP range in the long-term.

The catch of fisheries managed through the MP is affected by the shape of the HCR, the underlying assumptions, and the long-term objective. This is explored in more detail below.

For the MP with HCR 17, future fishing levels of the TLL are fixed at 2014-2023 effort instead of albacore catch, while the EPO catches are set to the baseline level of 18,000 mt. The resulting average catches of albacore in the future period of the evaluations by the TLL for the effort based assumption is approximately 10,500 mt per annum. This is above the 9000 mt baseline assumption, but lower than in the sensitivity test presented in Section 5.2.

In all time periods the median catch variability across all MPs is low for all the additional candidate MPs, but slightly higher for the MP with HCR 19. The differences in the short-term are a result of the evaluations moving from the 'transient period' (2023-2025) to when the MP is first applied. The different MPs attempt to set the catch limit to different levels, as determined by the HCR. The bigger the difference from the catches assumed in the transient period (set to 2017-2022 average levels) to the catch limit first set by the MP, the bigger the catch variability. The difference will be restricted by the constraint applied to the MPs.

The effort variability is similar across MPs and EPO and TLL assumptions. The long whiskers are the result of a small proportion of iterations crashing, leading to catches being set to 0 for the remainder of the iteration.

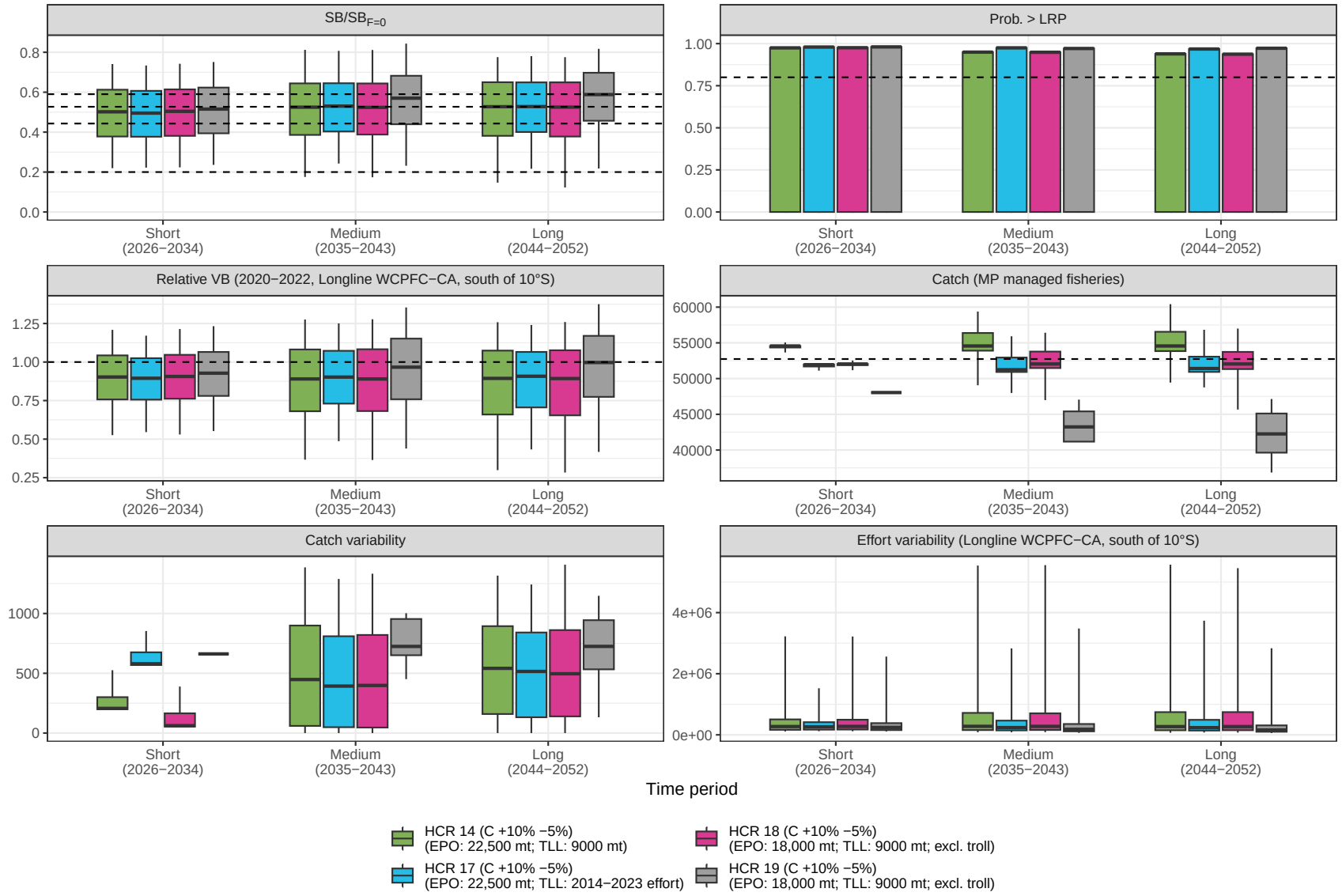



Figure 9: Performance indicators for the additional MPs (with HCRs 14 & 17-19). Each MP has different assumptions about the future EPO and TLL albacore catch or fishing effort, and the WCPFC-CA troll fishery, described in the legend. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The probability of being above the LRP is shown as a bar plot. The dashed horizontal line on the catch plot is the average catch in 2020-2022 in the WCPFC-CA, south of 10°S (included for reference).

**Comparing catch of fisheries managed through the MP**

Although care must be taken when comparing the performance of candidate MPs with different assumptions, several of the main and additional candidate MPs (those with HCRs 7, 14, 17 and 18) have been tuned to achieve the iTRP in the long-term. By comparing the results from these MPs it is possible to examine how the alternative assumptions can affect performance. Most of the indicators are similar across these MPs, including the long-term $SB/SB_{F=0}$, vulnerable biomass (catch rates) and probability of being above the LRP. The key difference is in the total albacore catch of the fisheries managed through the MP, with the MP with HCR 7 yielding the highest catch for those fisheries i.e. longline and WCPFC-CA troll (Figure 10). The other candidate MPs are evaluated using assumptions that set higher catches in the EPO (excluding the overlap area, HCRs 14 and 17) and 0-10°S region or exclude the WCPFC-CA troll fishery from being managed through the MP (HCR 18), i.e. only the longline fishery is managed through the MP. Therefore, to achieve the same iTRP under these different assumptions, less catch is available for fisheries managed through the MP when compared to that under HCR 7, i.e. more catch is assumed to be 'locked away' in the EPO or 0-10°S regions of the WCPFC-CA or in the troll fishery.

As mentioned above, the candidate MPs have been tuned to achieve specific long-term objectives, i.e. a specific median $SB/SB_{F=0}$ in the long-term. This means that the performance of the candidate MPs, and their ability to achieve the specific depletion level in the long-term, is conditional on the underlying assumptions The long-term term objective is only achieved if those assumptions are realised and if the underlying assumptions behind each MP evaluation were not realised then the performance would be different. For example, the MP with HCR 17 makes the assumption that catches in the EPO, excluding the overlap area, will be 22,500 mt each year. If the real catches in the EPO were lower than 22,500 mt then for this HCR the $SB/SB_{F=0}$ would likely be higher than the objective of the iTRP on average. This is because, given the shape of the HCR, the catch limit for the fisheries managed through the MP would not benefit from this increase in biomass while the estimated stock status remained on the Hillary step of the HCR, i.e. no change in catch would be specified by the MP. Similarly, if the stock declined and the HCR called for reductions in catch, the smaller the component of the total fishery that was controlled by the MP the greater the necessary reduction in that component.

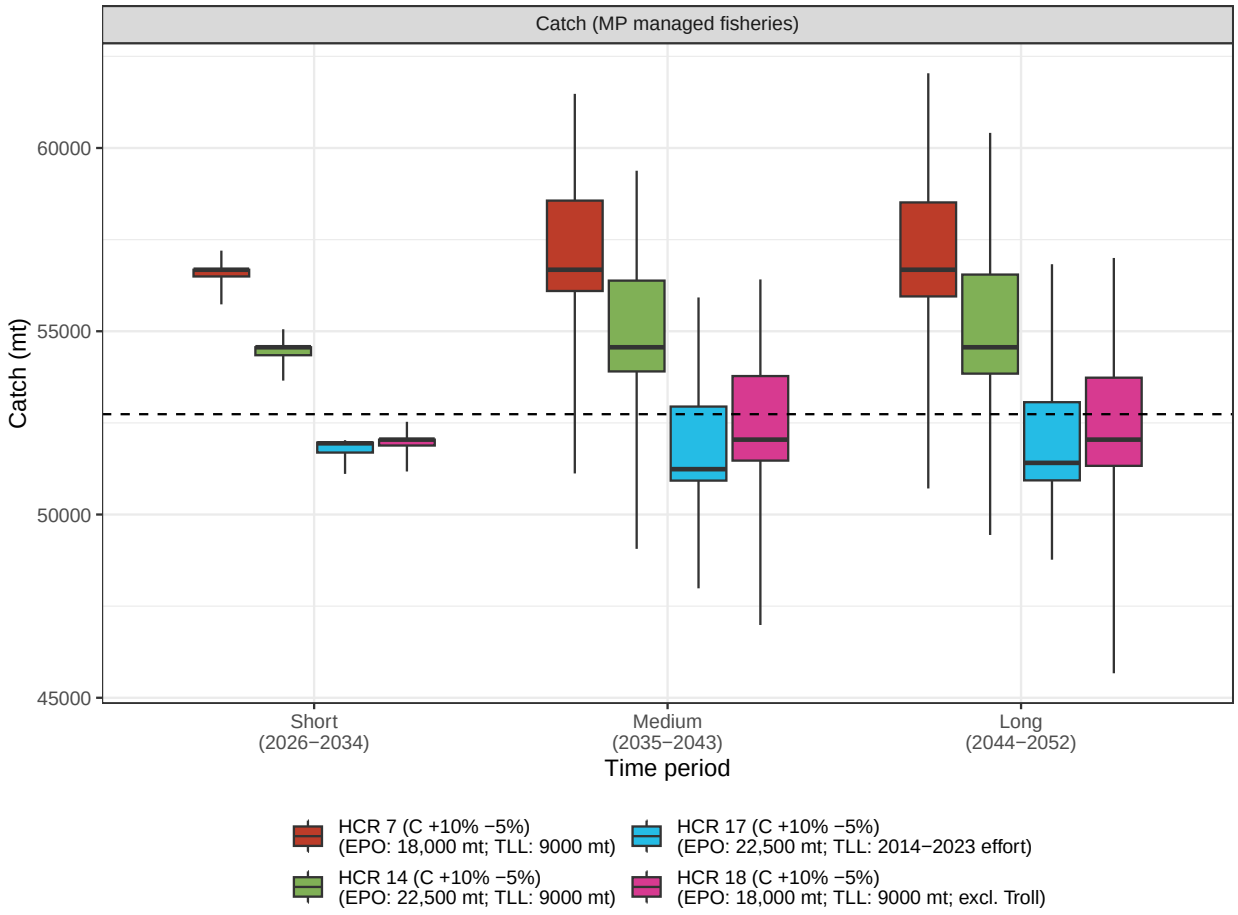



Figure 10: Total expected albacore catch taken by fisheries managed through the MP. Each candidate MP in this figure achieves the iTRP in the long-term and have similar levels of vulnerable biomass (catch rates) and probability of the being above the LRP. The MPs are evaluated with different assumptions on the EPO and TLL albacore fishing level, shown in the legend, or exclude the WCPFC-CA troll fishery from being managed through the MP (HCR 19). The differences in the catch reflect the different assumptions underpinning the evaluations. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The dashed horizontal line on the catch plot is the average catch in 2020-2022 in the WCPFC-CA, south of 10°S (included for reference).

## Acknowledgments

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# Appendix: Additional requests from SC21, SPAMWS01 and SPAMWS02

## Requests from SC21

The following requests are taken from the SC21 Outcomes Document:

- SC21 encouraged the SSP to provide sufficient explanation and additional information as necessary (such as historical catch trajectory in the EPO and the area bounded by 0-10°S) to the SPAMWS01 (Sept 2025) and to WCPFC22 to assist decision makers.
- SC21 noted that it is desirable to constrain the number of candidate MPs evaluated to a manageable level. SC21 recommended that, in addition to the results presented in SC21-MI-WP-04, three additional MPs be developed for the Commission's consideration that more fully explore EPO (excluding overlap area) catch consequences as well as the use of a fixed effort assumption in the WCPFC-CA area equator to 10°S.
  - EPO (excluding the overlap area) set to 22,500 mt (being the approximate average of catches in the years 2021-22), WCPFC-CA 0-10°S set to 9000 mt (being the approximate average in the period 2014-2023), using a catch control HCR 'tuned' to achieve the adopted iTRP.
  - EPO (excluding the overlap area) set to 13,500 mt (being the approximate catch in the year 2020), WCPFC-CA 0-10°S set to 9000 mt (being the approximate average in the period 2014–2023), using a catch control HCR 'tuned' to achieve the adopted iTRP.
  - EPO (excluding the overlap area) set to 18,000 mt (being the approximate average for the period 2014-2023), WCPFC-CA 0-10°S set to average effort levels in the period 2014-2023, using a catch control HCR 'tuned' to achieve the adopted iTRP.
- SC21 recommended that, to the extent possible, the results of this expanded set of seven candidate MP evaluations and all candidate MP evaluations in WCPFC21-2024-30 (those applied to longline and troll fisheries operating in the WCPFC-CA, south of the equator) be provided to the SPAMWS01 in September 2025 and to the Commission for their consideration and decision.
- SC21 also requested that the SSP report the median time series of vulnerable biomass from the OMs for the historical period and to develop a table with the average nominal CPUE (kg/100 hooks) for the reference period (2020–2022) by CCMs with SPA catches.

## Requests from SPAMWS01

The following is the additional work requested at SPAMWS01, taken from the Chairs' Summary Report:

- Re-tune all 7 candidate MPs operating south of 10°S with exclusion of TK and TV catches that are south of 10°S.
- Perform sensitivity analyses on re-tuned MPs, (i.e. those excluding TK and TV catches that

are south of 10°S).

- Develop additional MPs based on the current modified HCR 7 proposal (AU proposal) and HCR 13, which treat troll catch as an assumed and constant 'external catch' in the MP. These MPs would be tuned to achieve the appropriate associated TRP. In developing these MPs, the 'external troll catch' could be set at 2000-2004 average troll levels (in line with the baseline referenced in CMM 2015-02).
  - Although it was agreed at SPAMWS01 that only the additional MP based on HCR 7 would be evaluated, both MPs based on HCRs 7 and 13 have been included in the report.
- Develop an MP equivalent to HCR 14 (EPO at 22,500) but with 0-10°S on fixed effort (2014-2023) instead of catch, and that achieves the iTRP in the long-term.
- Run HCR 7 with no constraint.
- Update SPAMPLE to include full suite of considered MPs.

### Requests from SPAMWS02

SPAMWS02 made additional requests, including:

- From 2000-2023, South Pacific albacore catches, broken down by EEZ and high seas, showing: total catch, catch between the Equator and 10°S, and south of 10°S; and
- From 2000-2023, for the area between the Equator and 10°S, south of 10°S, the number of hooks (or other effort indicator) set on the high seas vs. the number of hooks set within EEZs.
- Calculation of an additional performance indicator that reports the total albacore catch of fisheries directly managed through the MP.

## Appendix: Settings and assumptions for the two candidate MP evaluation streams

Table 3: Settings and assumptions for the two streams of MP evaluations, including the future annual catch of albacore taken in the EPO (excluding the overlap area), and by the tropical longline (TLL) fishery that operates in the WCPFC-CA 0-10°S area. Note that the TLL catch includes catch taken in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S for the relevant stream. The HCR baseline catch for catch-based MPs is the output of the HCR equivalent to a scalar of 1 applied to the baseline period of 2020-2022. An alternative baseline period would require a different HCR shape to achieve the same performance. The transient period catch is the assumed level of catch per annum for the period 2023-2025, i.e. before the MP is first applied.

| Area of MP application | EPO future albacore catch | TLL future albacore catch | HCR baseline catch | Transient period catch |
|---|---|---|---|---|
| All fisheries operating south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S | 18,000 mt | 9,667 mt | 51,689 mt | 56,350 mt |
| All fisheries operating in the area the south of the equator | 22,500 mt | NA | 60,800 mt | 65,500 mt |

# Appendix: Main assumptions behind the South Pacific albacore MSE framework

The MSE framework is described in WCPFC-SMD02-2024/SMD02-BP-02 (Scott et al., 2024b).

The key difference to those assumptions is that the South Pacific albacore MP no longer applies to fisheries operating in the equator to 10°S region of the WCPFC-CA. Instead the future catches of SPA in the equator to 10°S region are fixed at 9000 mt per annum (approximately the average of 2014 to 2023 catches). Following discussions at SPAMWS02, fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S are excluded from being managed through the MP. The future annual catches of albacore in those slivers is fixed at the 2014-2023 average of approximately 667 mt.

Additionally, the future catches of fisheries operating in the EPO region of the model (which excludes the overlap area) are fixed at 18,000 mt per annum (approximately the average of 2014 to 2023 catches) .

## Main MSE assumptions

The key assumptions and settings for the framework are:

- The simulations start in 2023 and run until 2053.
- The MP is first run in 2025 and the output applied in 2026.
- The catches for all fisheries in the WCPFC-CA, south of 10°S, in the period 2023-2025 are set to the average of their 2017-2022 levels.
- The management period is three years, i.e. the catch limits set by the MP are applied for the following three years.
- There is a data lag of two years, e.g. when evaluating the MP in 2025, data for the EM is available up to and including 2023.
- The output of the MP is applied in the following year for the remainder of that management period, e.g. when evaluating the MP in 2025, the output fishing levels are applied in 2026-2028.
- That MP output is applied equally to all fisheries (longline and troll) operating within the WCPFC-CA, south of 10°S with the exception of those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S.
- The catch or effort limits specified by the MP are always fully utilised (if possible), i.e. there is no implementation error.
- The MP does not apply to fisheries operating in the EPO region of the model, unless otherwise specified.
- The total future catches of fisheries operating in the EPO region of the model are fixed at 18,000 mt per annum.
- The MP does not apply to fisheries operating in the equator to 10°S region of the WCPFC-CA.

- The total future catches of fisheries operating in the equator to 10°S region of the WCPFC-CA are fixed at 9000 mt per annum.
- The future annual catches of albacore in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S are fixed at the 2014-2023 average of approximately 667 mt.

### Operating models

The operating model (OM) grid is based on the 2024 South Pacific wide stock assessment, with additional uncertainty scenarios (Scott et al., 2024c; Teears et al., 2024). There are 200 pairs of steepness and natural mortality values, sampled independently from assumed distributions. Two levels of historical recruitment are used on which to base future variability: 1973-2020 and 2000-2020. Two levels of effort creep are applied to the longline fisheries only: 0% and 1% per annum. Note that the inclusion of effort creep in the simulations has been improved since SMD02. A factorial combination of these factors gives 800 OMs.

Stochasticity is included in the projections by applying randomly sampled recruitment deviates to the recruitment calculated by the stock-recruitment relationship. Each OM uses different samples of recruitment deviates so that the projected recruitment for each of the OMs is different.

Observation error with a CV of 20% is applied to the catch and catch-per-unit of effort (CPUE) data used by the EM.

## Appendix: Estimation method settings

Following the update presented in SPC-OFP (2024a), the estimation method uses two index fisheries: the longline indices in the WCPFC-CA and the EPO. The troll index has been removed. This removes the reliance on the troll index and helps to 'future proof' the MP. This change was not found to impact the performance of the esimation method. The estimation method and CPUE standardisation settings can be seen in Table 4 and Table 5.

The estimation method is fit using a number of phases in which some of the key parameters, such as the maximum allowable fishing mortality, are slowly relaxed. A convergence criteria of 1e-5 is used, or when a maximum of 3000 evaluations in the final phase have been completed.

Table 4: Settings for the estimation method

| Model setting | Value |
|---|---|
| Regional structure | 2 regions |
| Number of fisheries | 19 |
| Longline | 13 |
| Troll / Driftnet | 4 |
| Index | 2 (longline only) |
| Steepness | 0.8 |
| Natural mortality | Lorenzen, M12=0.36 |
| Growth | Fixed |
| ML1 | 45.538 |
| ML2 | 100.115 |
| K | 0.3932 |
| Movement rates | Fixed (2024 assessment) |
| Selection patterns | Fixed (2024 assessment) |
| Average recruitment | Last 2 years |
| Recruitment distribution | 0.819, 0.181 |

Table 5: Model settings and post-processing steps used in the CPUE standardisation for south Pacific albacore estimation method.

| Model Setting | Description |
|---|---|
| **Model Type** | Spatiotemporal delta-gamma generalized linear mixed model (delta-GLMM). |
| **Spatial Knot Configuration** | A mesh with 166 spatial knots. |
| **Model Equations** | $$y_i \sim \text{Bernoulli}(p_i)$$ $$\log\left(\frac{p_i}{1-p_i}\right) = \text{Year}_i + \omega_1(s_i) + \phi_1(s_i, t_i) + s(\text{HBF}_i) + \text{Flag}_i + \varepsilon_1$$ $$c_i \sim \Gamma(\log \mu_i, \sigma^{-2}, \eta_i \sigma^2)$$ $$\log \eta_i = \text{Year}_i + \omega_2(s_i) + \phi_2(s_i, t_i) + s(\text{HBF}_i) + \text{Flag}_i + \varepsilon_2$$ where $\sigma$ is the coefficient of variation for positive catch rate measurement errors, $y$ is the encounter probability, $c$ is the CPUE, and $i$ indexes individual records. *Year* is the year effect; $\omega$ is the spatial random effect at location $x$; $\phi$ is the spatiotemporal random effect at location $x$ and time $t$; $s(HBF)$ is a spline function for hook-based fishing effort; and *Flag* is the additive effect of the flag group. The spatial variation terms $\omega_2(x_i)$ are modeled as a Gaussian random field with a Matérn covariance function to account for spatial autocorrelation. |
| **HBF Imputation** | Missing HBF values are predicted using a random forest approach (Breiman, 2001) implemented via the `randomForest` R package (Liaw and Wiener, 2002). The model uses predictors including year, month, latitude, longitude, number of hooks fished, vessel flag, the proportional catch of the four main species (albacore, yellowfin, bigeye, swordfish), and total catch value, with 500 trees. |
| **Implementation Platform** | `sdmTMB` version 0.3.0 (R package). |
| **Normalisation Method** | CPUE values are mean-centered using absolute values. |
| **Penalty Term Calculation** | Penalty terms are applied as the coefficient of variation (CV) for the catch-conditioned model. |

# Appendix: Harvest control rule parameters

Table 6: Parameter values of the HCR shapes.

| HCR | | Limit | Step start | Step end | Maximum |
|---|---|---|---|---|---|
| Main set: Catch-based MPs | | | | | |
| HCR 7 | Relative $SB/SB_{F=0}$ | 0.37 | 0.94 | 1.29 | 1.59 |
| | HCR output | 0.2 | 1.09 | 1.09 | 1.29 |
| | Catch output (mt) | 10,293 | 56,096 | 56,096 | 66,389 |
| HCR 10 | Relative $SB/SB_{F=0}$ | 0.45 | 0.93 | 1.52 | 1.88 |
| | HCR output | 0.2 | 1.38 | 1.38 | 1.58 |
| | Catch output (mt) | 10,293 | 71,020 | 71,020 | 81,313 |
| HCR 13 | Relative $SB/SB_{F=0}$ | 0.33 | 0.95 | 1.15 | 1.43 |
| | HCR output | 0.2 | 0.82 | 0.82 | 1.02 |
| | Catch output (mt) | 10,293 | 42,200 | 42,200 | 52,493 |
| Additional set: Catch-based MPs | | | | | |
| HCR 14 | Relative $SB/SB_{F=0}$ | 0.37 | 0.94 | 1.29 | 1.59 |
| | HCR output | 0.2 | 1.05 | 1.05 | 1.25 |
| | Catch output (mt) | 10,293 | 54,037 | 54,037 | 64,330 |
| HCR 17 | Relative $SB/SB_{F=0}$ | 0.37 | 0.94 | 1.29 | 1.59 |
| | HCR output | 0.2 | 0.98 | 0.98 | 1.18 |
| | Catch output (mt) | 10,293 | 50,435 | 50,435 | 60,728 |
| HCR 18 | Relative $SB/SB_{F=0}$ | 0.37 | 0.94 | 1.29 | 1.59 |
| | HCR output | 0.2 | 1.08 | 1.08 | 1.28 |
| | Catch output (mt) | 9,333 | 50,397 | 50,397 | 59,730 |
| HCR 19 | Relative $SB/SB_{F=0}$ | 0.33 | 0.95 | 1.15 | 1.43 |
| | HCR output | 0.2 | 0.8 | 0.8 | 1 |
| | Catch output (mt) | 9,333 | 37,331 | 37,331 | 46,664 |

## Appendix: Nominal catch rates and historical vulnerable biomass

SC21 requested that the SSP report the median time series of vulnerable biomass from the OMs for the historical period and to develop a table with the average nominal CPUE (kg/100 hooks) for the reference period (2020-2022) by CCMs with South Pacific albacore catches. These are presented in Figure 11 and Table 7. Note that these consider the area WCPFC-CA, south of 10°S, only.

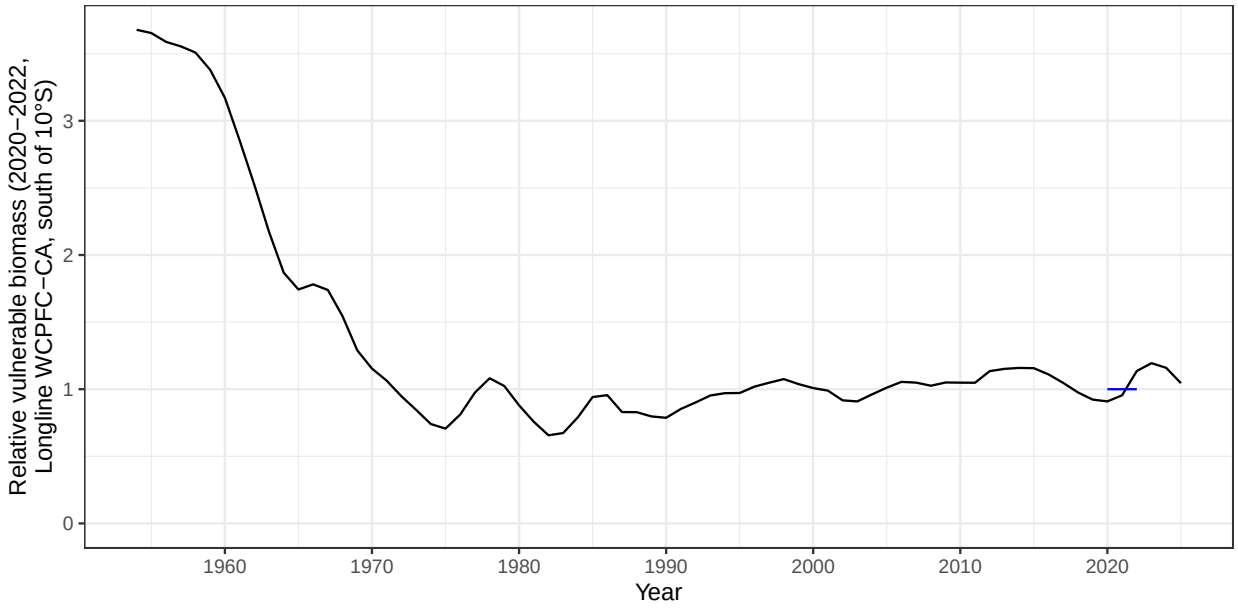


Figure 11: Median historical vulnerable biomass across the operating models, relative to the corresponding average in the period 2020-2022, of the longline fisheries in the WCPFC-CA, south of 10°S. The solid blue line highlights the average in the 2020-2022 period.

Table 7: Average nominal albacore catch-per-unit-effort (CPUE, kg / 100 hooks) for the period 2020-2022 in the WCPFC-CA, south of 10°S by flag.

| Flag | CPUE (kg / 100 hooks) |
|---|---|
| AU | 13.97 |
| CK | 14.94 |
| CN | 18.16 |
| ES | 2.56 |
| FJ | 19.48 |
| FM | 17.49 |
| JP | 16.11 |
| KI | 21.23 |
| KR | 7.30 |
| NC | 32.36 |
| NZ | 9.36 |
| PF | 17.13 |
| PG | 15.69 |
| SB | 17.75 |
| TO | 3.38 |
| TV | 32.25 |
| TW | 21.17 |
| US | 20.90 |
| VU | 31.68 |
| WS | 15.61 |

## Appendix: Tables of results (MP applies south of 10°S, excluding Tokelau and Tuvalu)

This appendix contains the summary tables for when the MP applies to south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. Median results for the short-, medium- and long-term can be seen Table 8, Table 9 and Table 10. The results are separated into the main results, sensitivity results and the additional MP requests from SC21 and SPAMWS01. Only the candidate MPs that SPAMWS02 agreed to continue considering are presented here.

Table 8: Results in the short-term (2026-2034) for when the MP applies to all longline and troll fisheries south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. The value shown is the median. Values in parenthesis are the 95th percentile range. $SB/SB_{F=0}$ is shown as relative to the mean $SB/SB_{F=0}$ in 2017-2019, noting that the iTRP is defined as the 0.96 x mean $SB/SB_{F=0}$ in 2017-2019. Relative vulnerable biomass (VB) and effort variability are for the longline fisheries in the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S).

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| **Main results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 9,000 | 0.92 (0.41-1.35) | 0.98 | 0.91 (0.53-1.22) | 57,300 (56,400-57,900) | 56,700 (55,700-57,200) | 44.4 (35.9-396) | 28.1 (11.9-322) |
| HCR 10 (C +10% -5%) | 18,000 | 9,000 | 0.86 (0.35-1.31) | 0.95 | 0.86 (0.47-1.16) | 67,900 (65,300-67,900) | 67,200 (64,700-67,200) | 1,720 (1,370-1,920) | 47 (18.2-433) |
| HCR 13 (C +10% -5%) | 18,000 | 9,000 | 0.95 (0.45-1.38) | 0.98 | 0.94 (0.57-1.24) | 51,500 (51,500-52,300) | 50,800 (50,800-51,600) | 906 (737-906) | 22.2 (10.1-166) |
| **Sensitivity results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 12,000 | 0.89 (0.38-1.33) | 0.97 | 0.88 (0.5-1.19) | 57,300 (56,400-57,700) | 56,700 (55,700-57,000) | 52.3 (35.9-455) | 32 (12.7-328) |
| HCR 7 (C +10% -5%) | 22,500 | 9,000 | 0.9 (0.38-1.34) | 0.97 | 0.89 (0.51-1.2) | 57,300 (56,400-57,700) | 56,700 (55,700-57,100) | 50.2 (35.9-454) | 31.1 (12.4-337) |
| HCR 7 (C +10% -5%) | 22,500 | 12,000 | 0.87 (0.36-1.32) | 0.96 | 0.87 (0.48-1.17) | 57,300 (56,100-57,600) | 56,600 (55,400-57,000) | 61 (35.9-668) | 35.4 (13.3-345) |
| HCR 7 (C +-10%) | 18,000 | 9,000 | 0.92 (0.41-1.35) | 0.98 | 0.91 (0.53-1.22) | 57,300 (55,500-57,900) | 56,700 (54,800-57,200) | 44.4 (35.9-666) | 28.1 (11.9-322) |
| HCR 7 (C) | 18,000 | 9,000 | 0.92 (0.41-1.35) | 0.98 | 0.91 (0.53-1.22) | 57,300 (54,100-57,900) | 56,700 (53,400-57,200) | 44.4 (35.9-1,180) | 28.1 (11.9-323) |

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| HCR 10 (C +10% -5%) | 22,500 | 12,000 | 0.81 (0.29-1.28) | 0.93 | 0.81 (0.42-1.11) | 67,700 (62,200-67,900) | 67,000 (61,500-67,200) | 1,710 (1,350-3,250) | 61.7 (21-525) |
| HCR 13 (C +10% -5%) | 22,500 | 12,000 | 0.91 (0.38-1.35) | 0.97 | 0.89 (0.51-1.2) | 51,500 (51,400-51,700) | 50,800 (50,800-51,000) | 906 (858-916) | 27.7 (11-321) |
| **Additional MP requests** | | | | | | | | | |
| HCR 14 (C +10% -5%) | 22,500 | 9,000 | 0.91 (0.4-1.35) | 0.97 | 0.9 (0.53-1.21) | 55,200 (54,300-55,700) | 54,600 (53,700-55,100) | 206 (199-526) | 27.2 (10.9-322) |
| HCR 17 (C +10% -5%) | 22,500 | 1,440,000[a] | 0.9 (0.4-1.34) | 0.98 | 0.89 (0.55-1.17) | 52,600 (51,800-52,700) | 51,900 (51,100-52,000) | 580 (569-853) | 26.3 (11.8-152) |
| HCR 18 (C +10% -5%)[b] | 18,000 | 9,000 | 0.92 (0.41-1.35) | 0.98 | 0.91 (0.53-1.21) | 57,500 (56,600-58,000) | 52,000 (51,200-52,500) | 61.9 (54.2-389) | 27.6 (11.7-322) |
| HCR 19 (C +10% -5%)[b] | 18,000 | 9,000 | 0.94 (0.43-1.37) | 0.98 | 0.93 (0.55-1.23) | 53,500 (53,500-53,500) | 48,000 (48,000-48,000) | 662 (662-662) | 24.3 (11-256) |

[a] The TLL assumption for HCR 17 is effort in 00s hooks, not catch.

[b] For HCRs 18 and 19 the WCPFC-CA troll fisheries are not managed through the SPA MP but have future catch fixed at average 2000-2004 levels.

Table 9: Results in the medium-term (2035-2043) for when the MP applies to all longline and troll fisheries south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. The value shown is the median. Values in parenthesis are the 95th percentile range. $SB/SB_{F=0}$ is shown as relative to the mean $SB/SB_{F=0}$ in 2017-2019, noting that the iTRP is defined as the 0.96 x mean $SB/SB_{F=0}$ in 2017-2019. Relative vulnerable biomass (VB) and effort variability are for the longline fisheries in the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S).

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| **Main results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 9,000 | 0.96 (0.33-1.48) | 0.95 | 0.89 (0.37-1.28) | 57,300 (51,800-62,100) | 56,700 (51,100-61,500) | 443 (0-1,430) | 27.6 (8.93-547) |
| HCR 10 (C +10% -5%) | 18,000 | 9,000 | 0.8 (0.09-1.37) | 0.87 | 0.76 (0.13-1.15) | 71,500 (31,200-72,500) | 70,800 (30,900-71,900) | 446 (0-7,690) | 74.4 (13.7-627) |
| HCR 13 (C +10% -5%) | 18,000 | 9,000 | 1.06 (0.48-1.55) | 0.98 | 0.99 (0.5-1.37) | 47,000 (44,200-53,000) | 46,300 (43,500-52,400) | 846 (474-1,110) | 17.7 (6.14-281) |
| **Sensitivity results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 12,000 | 0.93 (0.28-1.46) | 0.94 | 0.86 (0.35-1.24) | 57,300 (51,300-61,300) | 56,700 (50,600-60,600) | 374 (0-1,390) | 31.8 (9.52-545) |
| HCR 7 (C +10% -5%) | 22,500 | 9,000 | 0.93 (0.29-1.46) | 0.94 | 0.87 (0.36-1.25) | 57,300 (51,800-61,800) | 56,700 (51,100-61,100) | 400 (0-1,420) | 31.3 (9.19-547) |
| HCR 7 (C +10% -5%) | 22,500 | 12,000 | 0.9 (0.22-1.44) | 0.92 | 0.84 (0.29-1.22) | 57,300 (49,700-61,100) | 56,600 (49,000-60,400) | 411 (0-1,570) | 36.1 (9.94-642) |
| HCR 7 (C +-10%) | 18,000 | 9,000 | 0.96 (0.34-1.48) | 0.96 | 0.9 (0.39-1.28) | 57,300 (48,000-61,900) | 56,700 (47,300-61,200) | 475 (0-1,740) | 27.9 (9.09-538) |
| HCR 7 (C) | 18,000 | 9,000 | 0.96 (0.4-1.48) | 0.96 | 0.9 (0.45-1.28) | 57,300 (45,300-62,300) | 56,700 (44,600-61,600) | 477 (0-5,360) | 28.2 (9.17-520) |

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| HCR 10 (C +10% -5%) | 22,500 | 12,000 | 0.75 (0.01-1.34) | 0.83 | 0.71 (0.05-1.1) | 71,000 (1,220-72,500) | 70,300 (1,170-71,900) | 709 (0-8,060) | 113 (15.3-714) |
| HCR 13 (C +10% -5%) | 22,500 | 12,000 | 1 (0.38-1.51) | 0.96 | 0.93 (0.42-1.32) | 46,400 (44,200-52,600) | 45,700 (43,500-52,000) | 802 (517-1,110) | 20.8 (7.12-388) |
| **Additional MP requests** | | | | | | | | | |
| HCR 14 (C +10% -5%) | 22,500 | 9,000 | 0.96 (0.32-1.48) | 0.95 | 0.89 (0.37-1.28) | 55,200 (49,700-60,000) | 54,600 (49,100-59,400) | 448 (0-1,390) | 27.8 (8.49-554) |
| HCR 17 (C +10% -5%) | 22,500 | 1,440,000[a] | 0.97 (0.44-1.47) | 0.97 | 0.9 (0.49-1.25) | 51,900 (48,700-56,600) | 51,200 (48,000-55,900) | 393 (0-1,290) | 23.7 (8.48-283) |
| HCR 18 (C +10% -5%)[b] | 18,000 | 9,000 | 0.95 (0.32-1.48) | 0.95 | 0.89 (0.36-1.28) | 57,500 (52,500-61,900) | 52,000 (47,000-56,400) | 398 (0-1,330) | 27.7 (8.84-555) |
| HCR 19 (C +10% -5%)[b] | 18,000 | 9,000 | 1.04 (0.42-1.54) | 0.97 | 0.97 (0.44-1.35) | 48,700 (46,600-52,500) | 43,200 (41,200-47,100) | 725 (451-1,000) | 18.1 (6.34-348) |

[a] The TLL assumption for HCR 17 is effort in 00s hooks, not catch.

[b] For HCRs 18 and 19 the WCPFC-CA troll fisheries are not managed through the SPA MP but have future catch fixed at average 2000-2004 levels.

Table 10: Results in the long-term (2044-2053) for when the MP applies to all longline and troll fisheries south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. The value shown is the median. Values in parenthesis are the 95th percentile range. $SB/SB_{F=0}$ is shown as relative to the mean $SB/SB_{F=0}$ in 2017-2019, noting that the iTRP is defined as the 0.96 x mean $SB/SB_{F=0}$ in 2017-2019. Relative vulnerable biomass (VB) and effort variability are for the longline fisheries in the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S).

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| **Main results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 9,000 | 0.96 (0.25-1.41) | 0.94 | 0.9 (0.32-1.26) | 57,300 (51,400-62,700) | 56,700 (50,700-62,000) | 537 (0-1,370) | 27.2 (7.38-538) |
| HCR 10 (C +10% -5%) | 18,000 | 9,000 | 0.8 (0-1.32) | 0.85 | 0.75 (0-1.14) | 71,200 (0-72,500) | 70,500 (0-71,900) | 563 (0-3,530) | 63.5 (0-559) |
| HCR 13 (C +10% -5%) | 18,000 | 9,000 | 1.08 (0.46-1.51) | 0.98 | 1 (0.46-1.38) | 48,300 (42,600-53,100) | 47,700 (41,900-52,500) | 820 (79.5-1,280) | 16.5 (6.09-277) |
| **Sensitivity results** | | | | | | | | | |
| HCR 7 (C +10% -5%) | 18,000 | 12,000 | 0.93 (0.21-1.4) | 0.92 | 0.87 (0.24-1.24) | 57,300 (48,600-62,500) | 56,700 (47,900-61,900) | 470 (0-1,520) | 30.6 (7.13-585) |
| HCR 7 (C +10% -5%) | 22,500 | 9,000 | 0.94 (0.22-1.4) | 0.93 | 0.87 (0.25-1.24) | 57,300 (47,800-62,700) | 56,700 (47,100-62,000) | 511 (0-1,450) | 30 (7.28-586) |
| HCR 7 (C +10% -5%) | 22,500 | 12,000 | 0.9 (0-1.38) | 0.91 | 0.85 (0-1.21) | 57,200 (0-61,900) | 56,600 (0-61,300) | 492 (0-1,530) | 33.8 (0.37-592) |
| HCR 7 (C +-10%) | 18,000 | 9,000 | 0.96 (0.25-1.42) | 0.94 | 0.9 (0.3-1.26) | 57,300 (48,500-62,000) | 56,700 (47,800-61,400) | 608 (0-1,890) | 27.1 (7.51-547) |
| HCR 7 (C) | 18,000 | 9,000 | 0.96 (0.31-1.42) | 0.95 | 0.9 (0.36-1.26) | 57,300 (46,600-62,300) | 56,700 (45,900-61,600) | 632 (0-4,480) | 28.5 (8.24-590) |

| HCR | EPO catch (mt) | TLL catch (mt) | Relative $SB/SB_{F=0}$ | Prob. > LRP | Relative VB | Catch (WCPFC-CA, S of 10°S) (mt) | Catch (MP) (mt) | Catch var. (mt) | Effort var. (millions of hooks) |
|---|---|---|---|---|---|---|---|---|---|
| HCR 10 (C +10% -5%) | 22,500 | 12,000 | 0.73 (0-1.28) | 0.8 | 0.7 (0-1.1) | 70,400 (0-72,500) | 69,700 (0-71,900) | 699 (0-4,270) | 82.2 (0-625) |
| HCR 13 (C +10% -5%) | 22,500 | 12,000 | 1.02 (0.38-1.46) | 0.97 | 0.96 (0.43-1.31) | 46,900 (42,000-52,900) | 46,300 (41,400-52,200) | 786 (38.1-1,280) | 19 (6.08-362) |
| **Additional MP requests** | | | | | | | | | |
| HCR 14 (C +10% -5%) | 22,500 | 9,000 | 0.96 (0.27-1.41) | 0.94 | 0.89 (0.3-1.26) | 55,200 (50,100-61,100) | 54,600 (49,400-60,400) | 541 (0-1,320) | 27 (6.98-557) |
| HCR 17 (C +10% -5%) | 22,500 | 1,440,000[a] | 0.96 (0.39-1.42) | 0.97 | 0.91 (0.43-1.24) | 52,100 (49,400-57,500) | 51,400 (48,800-56,800) | 516 (0-1,240) | 23.5 (7.7-374) |
| HCR 18 (C +10% -5%)[b] | 18,000 | 9,000 | 0.96 (0.22-1.41) | 0.94 | 0.89 (0.28-1.26) | 57,500 (51,100-62,500) | 52,000 (45,700-57,000) | 496 (0-1,410) | 27 (7.18-545) |
| HCR 19 (C +10% -5%)[b] | 18,000 | 9,000 | 1.07 (0.4-1.49) | 0.97 | 1 (0.42-1.38) | 47,700 (42,300-52,600) | 42,300 (36,900-47,100) | 725 (132-1,150) | 15.9 (5.76-283) |

[a] The TLL assumption for HCR 17 is effort in 00s hooks, not catch.

[b] For HCRs 18 and 19 the WCPFC-CA troll fisheries are not managed through the SPA MP but have future catch fixed at average 2000-2004 levels.

## Appendix: Running the candidate MPs

The estimation method was run using the most recently available data, up to 2023, i.e. there is a two year data lag, as specified in the MSE framework settings.

Note that the figures contained in this Appendix are provisional.

The EM ran successfully to convergence with a maximum gradient of $5.0e^{-7}$. The predicted CPUE of the two index fisheries tracks the observed CPUE (Figure 12).

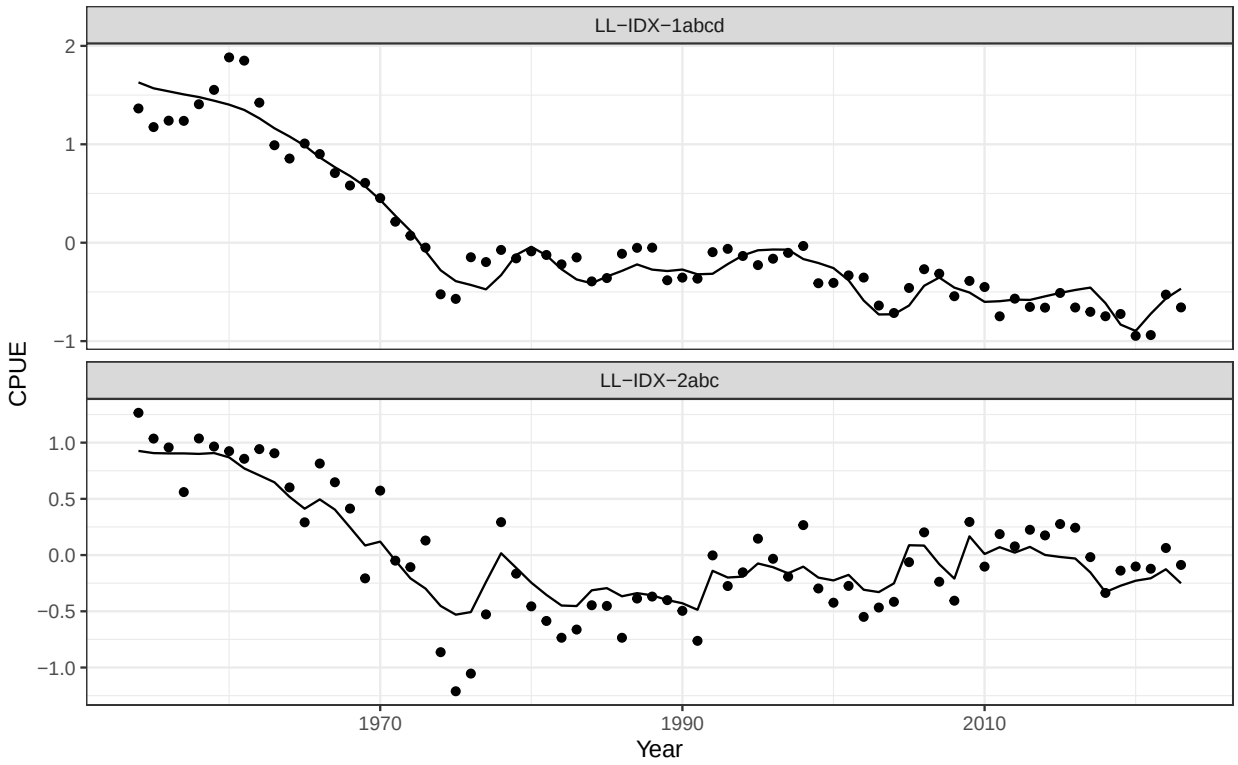


Figure 12: Observed (points) and predicted (lines) CPUE for the index fisheries (top panel is in the WCPFC-CA, bottom panel is in the EPO) from the EM fit.

The input to the HCR is the estimated mean $SB/SB_{F=0}$ of the last three years relative to the estimated mean $SB/SB_{F=0}$ in 2017-2019. From the EM fit, the value is 1.180 This value is used by each HCR of the candidate MPs to set the proposed new catch or longline effort limit.

The candidate MPs have constraints (+10% -5%) on how much the output of the MP can change between management periods. The first time the MP is called in 2025 the constraint is applied to the most recent catch (in 2023) relative to the HCR baseline catch (the average of 2020-2022) to give an effective 'original HCR scalar'. The new HCR scalar cannot change from this original scalar by more than the constraint.

The baseline (2020-2022 average) and latest (2023) catch values, and corresponding original HCR scalers can be seen in Table 11. These values are different if the WCPFC-CA troll fisheries are

excluded from being managed through South Pacific albacore MP (MPs with HCRs 18 and 19). The candidate MP outputs, excluding the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, are shown in Table 12.

Table 11: Baseline (2020-2022 average) and latest (2023) albacore catch (mt) in the WCPFC-CA south of 10°S and the associated 'original HCR scalar', excluding the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. The baseline and recent catches are different if the WCPFC-CA troll fisheries are excluded from being managed through the MP.

| MP type | WCPC-CA troll managed through SPA MP | Baseline (2020-2022) | Latest (2023) | Original HCR scalar |
|---|---|---|---|---|
| Catch-based | Included | 51,464 | 51,953 | 1.01 |
| Catch-based | Excluded | 46,664 | 49,689 | 1.065 |

Table 12: Output of the candidate MPs for the WCPFC-CA south of 10°S, without and with the application of the constraint (excluding the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). Output of all MPs is catch (mt). Note that the constraint is not applied to the 'unconstrained' columns, but to the 2023 (latest) level of catch or effort.

| HCR | New scaler (unconstrained) | New output (unconstrained) | New scaler (constrained) | New output (constrained) |
|---|---|---|---|---|
| HCR 7 (C +10% -5%) | 1.088 | 56,019 | 1.088 | 56,019 |
| HCR 10 (C +10% -5%) | 1.380 | 71,020 | 1.110 | 57,148 |
| HCR 13 (C +10% -5%) | 0.843 | 43,400 | 0.959 | 49,355 |
| HCR 14 (C +10% -5%) | 1.048 | 53,928 | 1.048 | 53,928 |
| HCR 17 (C +10% -5%) | 0.984 | 50,641 | 0.984 | 50,641 |
| HCR 18 (C +10% -5%) | 1.081 | 50,444 | 1.081 | 50,444 |
| HCR 19 (C +10% -5%) | 0.814 | 37,999 | 1.012 | 47,205 |