Western and Central Pacific Fisheries Commission

SOUTH PACIFIC ALBACORE MANAGEMENT WORKSHOP (SPAMWS)
SECOND SESSION

Electronic Meeting
Wednesday, 5 November 2025

Evaluation of Candidate Management Procedures for South Pacific Albacore

SPAMWS02-WP-01
30 October 2025

SPC-OFP

Executive summary

This report presents recent evaluations of candidate management procedures (MPs) for South Pacific albacore (SPA) and updates the papers WCPFC-SC21-2025/MI-WP-04 REV1 and SPAMWS01-WP-01.

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. 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.

Four candidate MPs are evaluated using these baseline EPO and TLL assumptions. Three are catch-based, i.e. output a catch limit, and the other is effort-based, i.e. outputs an effort limit. It should be noted that the allocation of the catch or effort limit, 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. Additional sensitivity tests relating to how much the output of the MP can change between management periods are also run. The other three MP candidate MPs are also subjected to a single sensitivity test with the higher than baseline catch assumptions.

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 detailed below and are designed to achieve specific long-term objectives under those different assumptions, so care must be taken when comparing the results. SPAMWS01 requested an additional set of evaluations where 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 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 is 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 for the management period 2026-2028.

Six 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).

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 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.
- 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.

SPAMWS01 made additional requests, including:

- Re-tune all 7 candidate MPs (the four original MPs 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 have been completed and are presented in this report.

The requests lead to three distinct 'streams' of evaluations, primarily defined by the area of application of the SPA MP, between which candidate MPs should not be directly compared given the different assumptions underpinning them. A key finding was that the exclusion of fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S did not strongly impact the performance of the four main MPs.

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 and SPAMWS01 (WCPFC, 2024a,b,c; SPC-OFP, 2024a; WCPFC, 2025b,c). 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 4. These have been complemented by several additional MPs requested at SC21 and SPAMWS01 (see below).

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, with an option to also exclude fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, as requested at SPAMWS01. This results in three 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, 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 SPAMWA01 (Section 5.3). Other requests from SC21 and SPAMWS01 (see Appendices for details) have also been addressed.

The results from all three 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

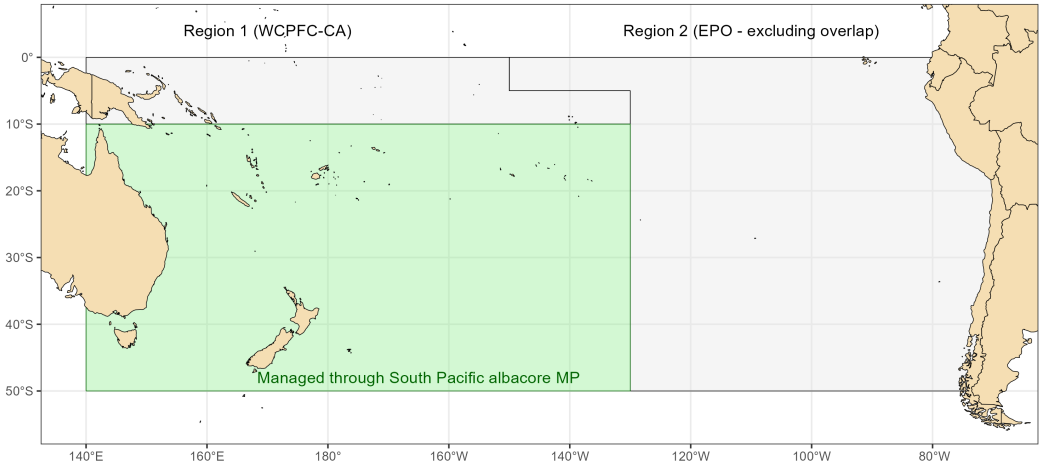
Details of the management strategy evaluation (MSE) framework, including the operating models (OMs) can be found in WCPFC-SMD02-2024/SMD02-BP-02 (Scott et al., 2024b). A summary of the main assumptions, including a description of the OMs can be found in the Appendices.

2.1 Three streams of MP evaluations

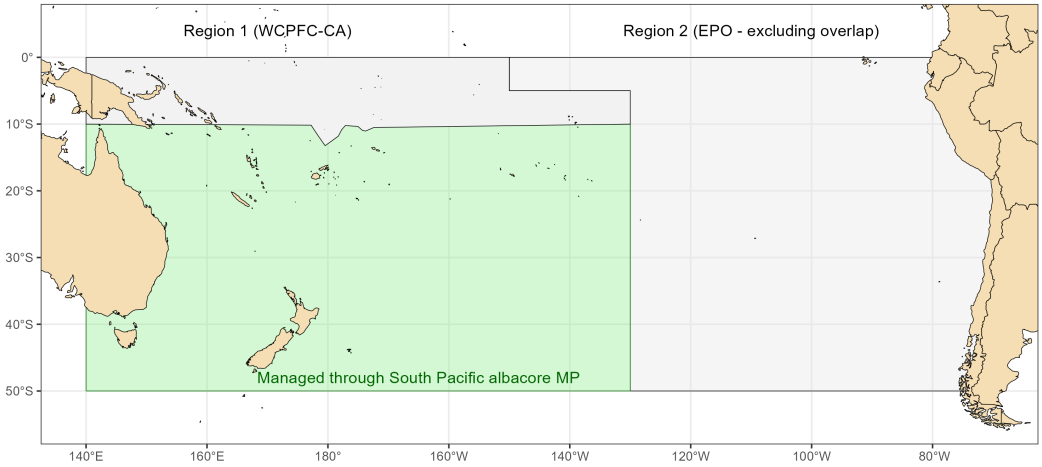
Following requests from SC21 and SPAMWS01 there are now three streams of MP evaluations, primarily defined by the area of application of the SPA MP and also the assumption made about future levels of albacore catch in the EPO (Table 1; Figure 1). As mentioned in the introduction, due to the differences 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 three 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.

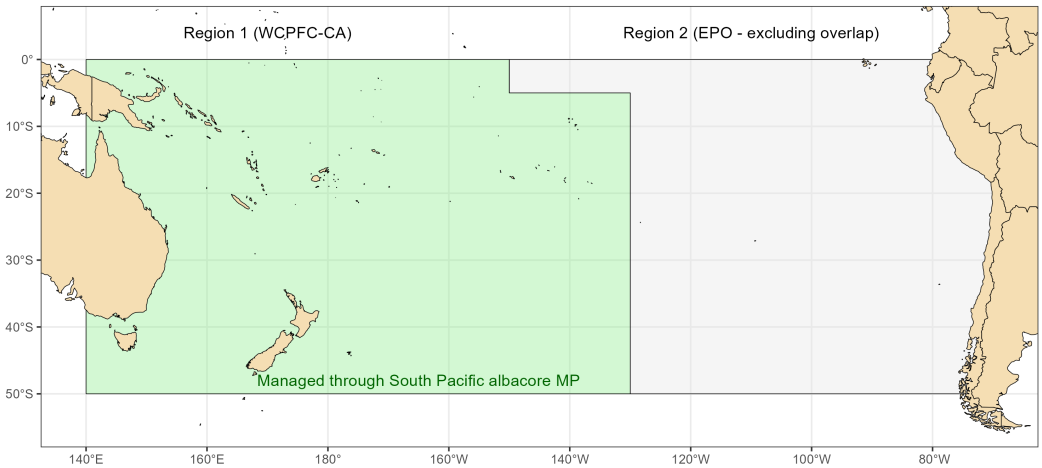
Area of MP application	EPO future albacore catch (p.a.)	Number of MPs	Presented
All fisheries operating south of 10°S	18,000 mt	7 (4 MPs plus 3 additional MPs requested by SC21)	SPAMWS01 and here
All fisheries operating south of 10°S, excluding those operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S	18,000 mt	10 (4 MPs plus 6 additional MPs requested by SC21 and SPAMWS01)	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.



(b) 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.



(c) 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 three 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. The South Pacific albacore MP therefore defines the level of fishing by longline and troll fisheries in the WCPFC-CA, south of 10°S, and adjusts that level as needed to achieve management objectives. In a separate set of evaluations, fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10° are also excluded from being managed through the MP (Figure 1b).

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.
- When the fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10° are also excluded from being managed throught the MP, the future level of albacore catch in these regions is fixed at 667 mt per annum.

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

As requested by SC21 and SPAM WS01, 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 or 56,350 mt per annum, depending on whether the slivers of the EEZs of Tokelau and Tuvalu are included or excluded respectively. Data for 2023 and 2024 show the actual catches in the south of 10°S region are approximately 51,500

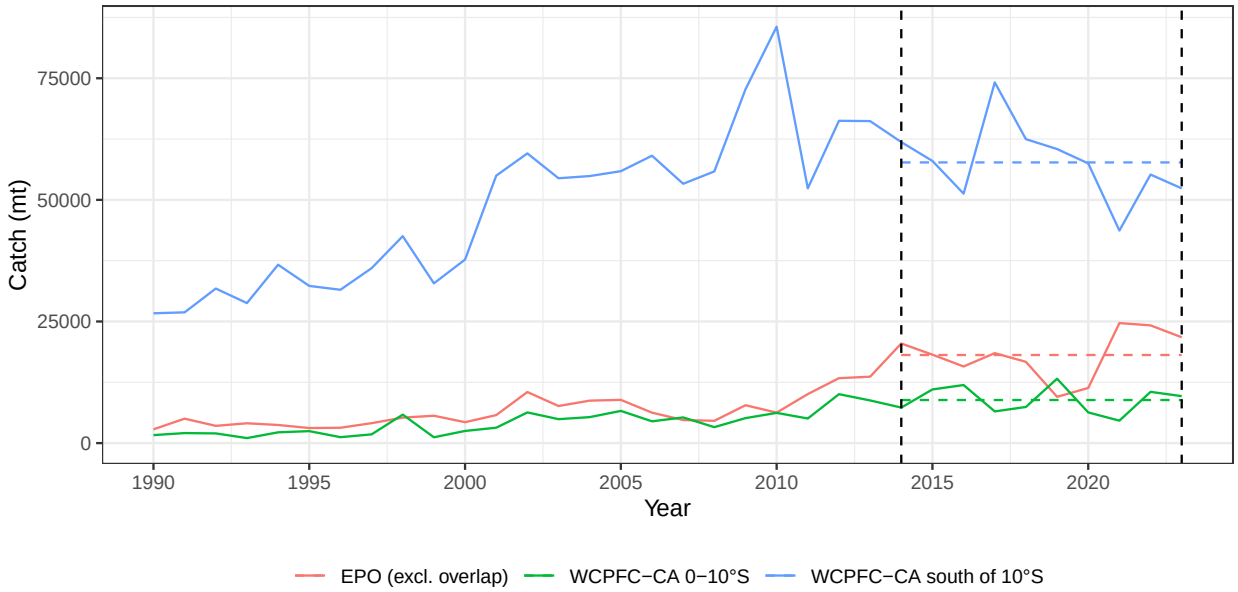


Figure 2: Time series of total albacore catches in the EPO (excluding the overlap), WCPFC-CA 0-10°S and WCPFC-CA south of 10°S regions. The time period used for the EPO and TLL catch assumptions (2014-2023), and corresponding average catch, is shown by the dashed lines.

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 either through the setting of catch or effort limits, depending on the candidate MP, i.e. all are managed through catch limits, or all are managed through effort limits.
- The HCR of each MP outputs a scalar that is applied to the baseline catch or effort of the fisheries managed through the MP. Associated catch limits are shown for the catch-based MPs.
- The current baseline for each HCR is the average catch or effort in the period 2020-2022, i.e. an output scalar of 1 sets the catch or effort limit for the next management period to the average of 2020-2022 catches or effort.
- 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, dependent on the MP, the output will be either the total annual catch or total annual effort 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 or effort limits. It simply provides a baseline level of catch or effort 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. scaled up or down. However, the resulting effort or catch limits 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). The results are presented in the Appendices.

3.2 Harvest control rules

As noted in the introduction, this report focuses on the evaluation streams where the MP manages all fisheries operating south of 10°S, including or excluding the EEZs of Tokelau and Tuvalu.

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 (see Section 5). The same HCR shapes are therefore appropriate for both evaluation streams, noting that the catch limit set by the catch-based MPs is slightly lower when the EEZs of Tokelau and Tuvalu are excluded. There are some small differences in the performance indicators between these two streams and so are presented separately.

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 4 MPs which have the same basic assumptions, for example about the future fishing level by the TLL and in the EPO.
- Additional evaluations in which the basic assumptions differ, as requested at SC21 and SPAMWS01.

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 $SB/SB_{F=0}$ 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.

The HCRs were 'tuned' using the evaluations in which fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S were not managed through the MP. The same tuned

HCRs were then used again for the evaluations in which those fisheries were managed through the MP. Consequently, some of the HCR shapes are slightly different to those presented at SPAMWS01, but the overall performance is the same.

Even though the additional MPs requested at SPAMWS01 were only for the evaluations in which the fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S are not managed through the MP, for completeness they have also been run for the evaluations in which those fisheries are managed through the MP.

Main MPs

There are four main MPs, each with a different HCR (Figure 3). There are three catch-based candidate MPs (HCRs 7, 10 and 13) and an effort-based candidate MP (HCR 9). The parameters for HCRs 9 and 10, that both achieve the lower TRP range, are different as the performance is affected by the management method.

Additional MPs

There are six additional MPs, as requested at SC21 and SPAMWS01, that achieve specified objectives under a range of different assumptions:

- The future level of catch in the EPO (13,5000, 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 (as requested by SPAMWS01).

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

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

Table 2: The HCRs, constraints, objectives, management type and assumptions (future annual EPO catch, excluding the overlap area, and TLL fishing level) behind the main and additional candidate MP evaluations. The MP is either catch or effort 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	Management	EPO catch (mt)	TLL metric	TLL (mt or millions of hooks)	WCPFC-CA troll in MP
Main MPs							
HCR 7	+10% -5%	iTRP	Catch	18,000	Catch	9,000	Included
HCR 9	+-5%	Lower TRP	Effort	18,000	Catch	9,000	Included
HCR 10	+10% -5%	Lower TRP	Catch	18,000	Catch	9,000	Included
HCR 13	+10% -5%	Upper TRP	Catch	18,000	Catch	9,000	Included
Additional MPs							
HCR 14	+10% -5%	iTRP	Catch	22,500	Catch	9,000	Included
HCR 15	+10% -5%	iTRP	Catch	13,500	Catch	9,000	Included
HCR 16	+10% -5%	iTRP	Catch	18,000	Effort	144	Included
HCR 17	+10% -5%	iTRP	Catch	22,500	Effort	144	Included
HCR 18	+10% -5%	iTRP	Catch	18,000	Catch	9,000	Excluded
HCR 19	+10% -5%	Upper TRP	Catch	18,000	Catch	9,000	Excluded

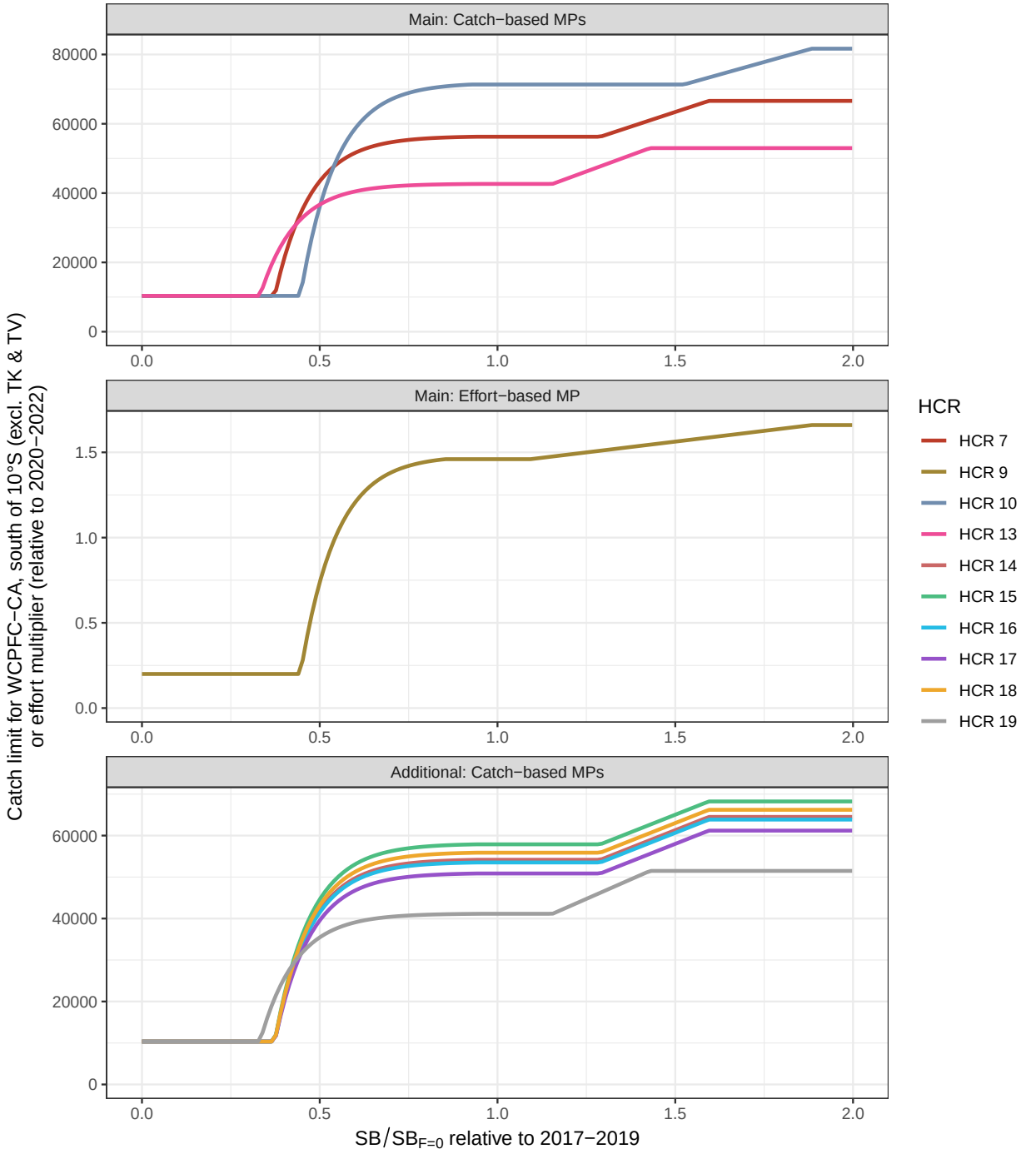


Figure 3: The HCR shapes for the candidate MPs. The effort-based MP is plotted in a different panel as the y-axis is different. The input to the HCR is the estimated mean SB/SB$_{F=0}$ of the last three years relative to 2017-2019. The output is a scalar applied to average 2020-2022 levels of catch or effort, depending on the MP. For catch-based MPs, the associated catch limit for WCPFC-CA, south of 10°S, without the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S, are also shown in mt.

4 Performance indicators

Six performance indicators are calculated. Note that the biomass indicators ($SB/SB_{F=0}$, probability of being above the LRP) are based on the biomass in the WCPFC-CA, whereas the catch and effort indicators are based on the area in which the SPA MP operates, i.e. the WCPFC-CA, 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 catch in the WCPFC-CA, south of 10°S. Note that this indicator include catches in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S even when fisheries in those slivers are not managed through the MP.
- 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.
- 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

As mentioned in Section 3, the same HCR shapes are used for both streams of evaluations where fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S are included or excluded from being managed through the MP. This is because the results are not strongly affected by the inclusion or exclusion of the EEZs of Tokelau and Tuvalu. Therefore, to achieve the same performance in terms of long-term median $SB/SB_{F=0}$ in either stream the same MP can be used. For example, the MP with HCR 7 reaches the iTRP in the long-term with similar catch levels for both streams. However, there are some differences between the performance indicators

and therefore results from both streams are presented separately.

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 for when fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S are excluded from being managed through the MP 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 for both streams of results 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 assuptions, including about the future fishing in the EPO and by the TLL). Sensitivity tests for different EPO and TLL future assumptions for a single MP from the main set 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 or effort 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 based on 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 based on 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 based on HCR 7. The effort based MP with HCR 9 has the narrowest range of anticipated outcomes, and like it's catch-based equivalent (the MP with HCR 10), implies larger reductions in vulnerable biomass.

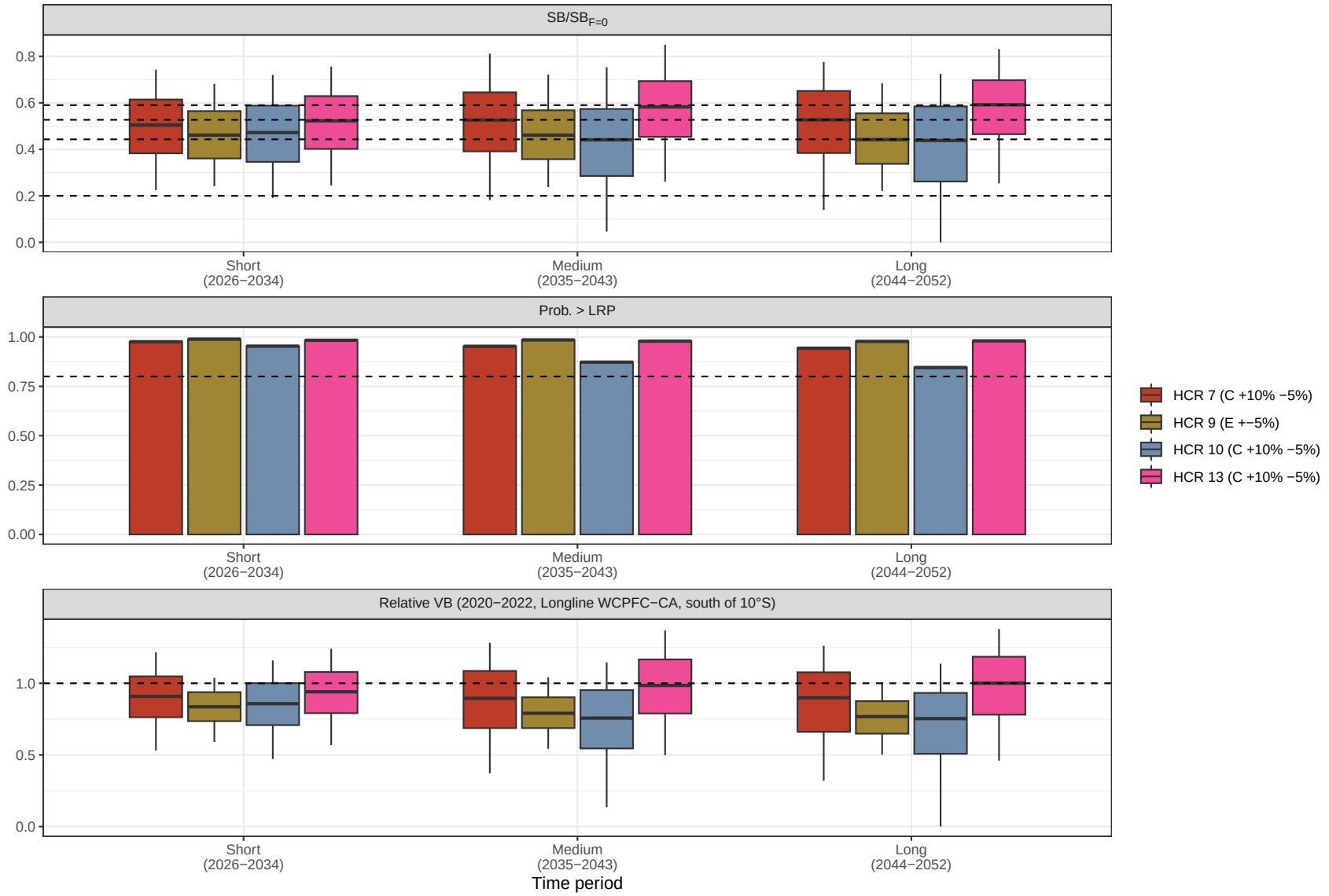


Figure 4: Box plots of SB/SB$_{F=0}$ in the WCPFC-CA and vulnerable biomass (VB) for the longline fisheries in the WCPFC-CA, south of 10°S, relative to the level in 2020-2022, and a bar plot (middle) of probability of being above the LRP. The whiskers show the 95th percentile range, the box shows the 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. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

Expected catches and catch variability

The median level of expected catches is conditional on the shape of the HCR (Figure 5). Only catches in the WCPFC-CA, south of 10°S are considered here. Note that in the figure the MP does not apply to fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S. In these evaluations the future annual catches in these slivers is fixed at 667 mt.

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. 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 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.

The effort-based MP with HCR 9 shows high levels of catch variability. This is because the level of realised catches is a product of the fishing effort and the vulnerable biomass. As biomass levels can vary due to natural processes (here modelled through recruitment variability) as well as fishing pressure, an effort-based MP can therefore result in variable catches, with a high level of uncertainty.

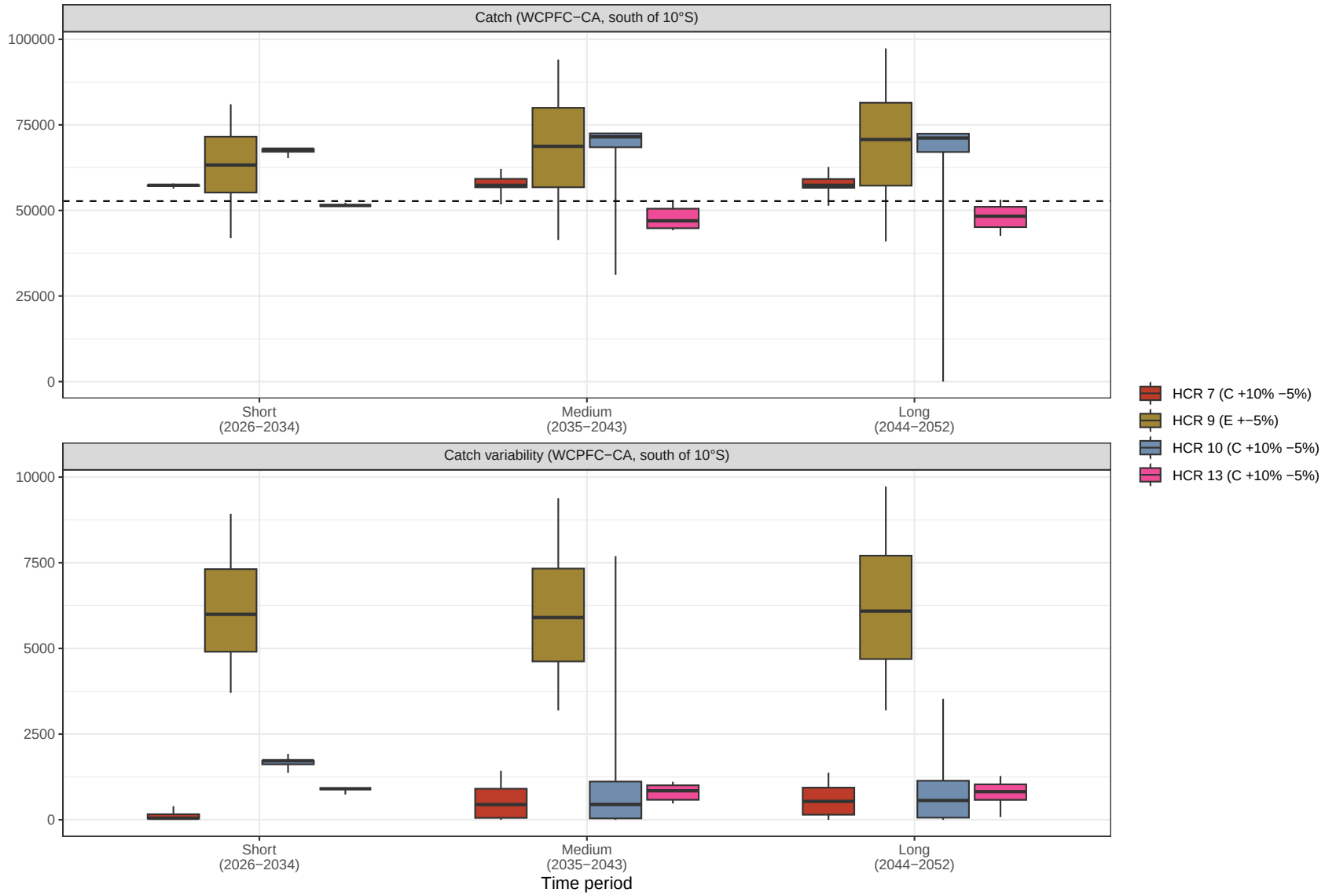


Figure 5: Box plots of total catch in the WCPFC-CA, south of 10°S, and associated average annual catch variability (both in mt). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The dashed horizontal line on the catch plot is the HCR baseline, the average catch in 2020-2022 in the WCPFC-CA, south of 10°S. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

Effort variability

As seen for catch variability, longline effort variability is strongly affected by the management method (Figure 6).

Catch-based MPs have higher effort variability than effort-based MPs. The amount of effort needed to take a set catch limit depends on the biomass available to the fishery. As noted above, biomass levels vary due to natural processes as well as fishing pressure. Therefore, the amount of effort needed to take a set catch limit varies over time, resulting in higher effort variability for the catch-based MPs.

The whiskers seen in Figure 6 are long for the catch-based MPs. The evaluations for the catch-based MPs assumed 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. This would greatly limit the effort variability.

As noted above, 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. This conversion will likely be 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 the catch-based MP, and subject to the same constraint on how much the output can change between management periods.

The average long-term effort variability for the effort-based MP with HCR 9 is lower than in the other two periods. The level of variability in that period is, however, less certain, i.e. there is more uncertainty in the expected effort variability. However, the change in effort between management periods is still constrained by the +-5% constraint.

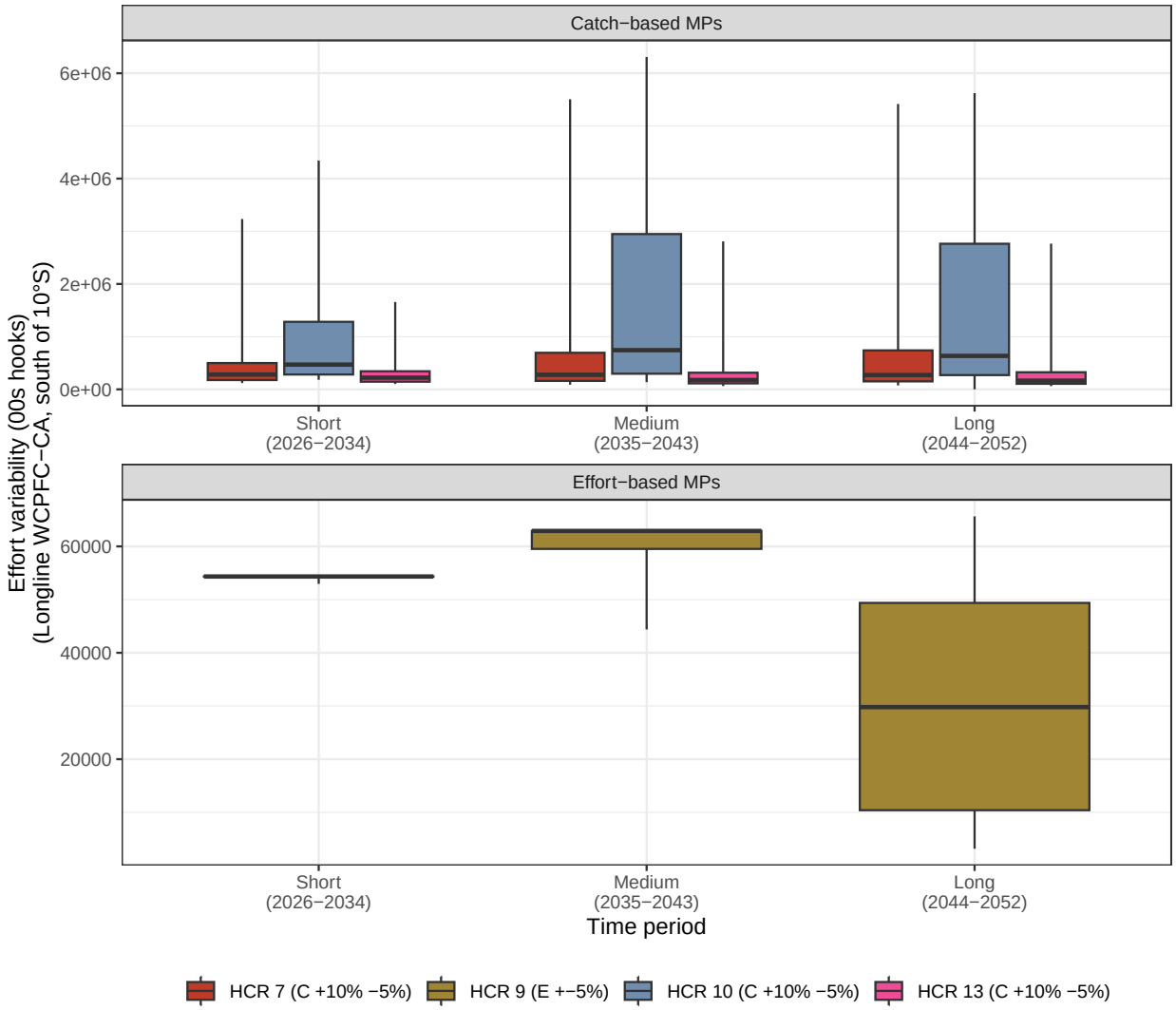


Figure 6: Box plots of average annual WCPFC-CA longline effort variability (00s of hooks), south of 10°S. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The plot is presented in two windows as the results from catch- and effort-based MPs have different scales. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

5.2 Sensitivity tests

One-off sensitivity tests were performed, including 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.

These evaluations use a catch-based MP with HCR 7 and a +10% -5% constraint as the base case. The results of the single change are then compared to the results from the base case.

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

Note that these results are for when fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S are excluded from being managed through the MP and are presented using box plots in the three different time periods.

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 7).

Higher catches in the EPO result in slightly lower expected stock status and vulnerable biomass in the WCPFC-CA. Catches in the WCPFC-CA, south of 10°S, are 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.

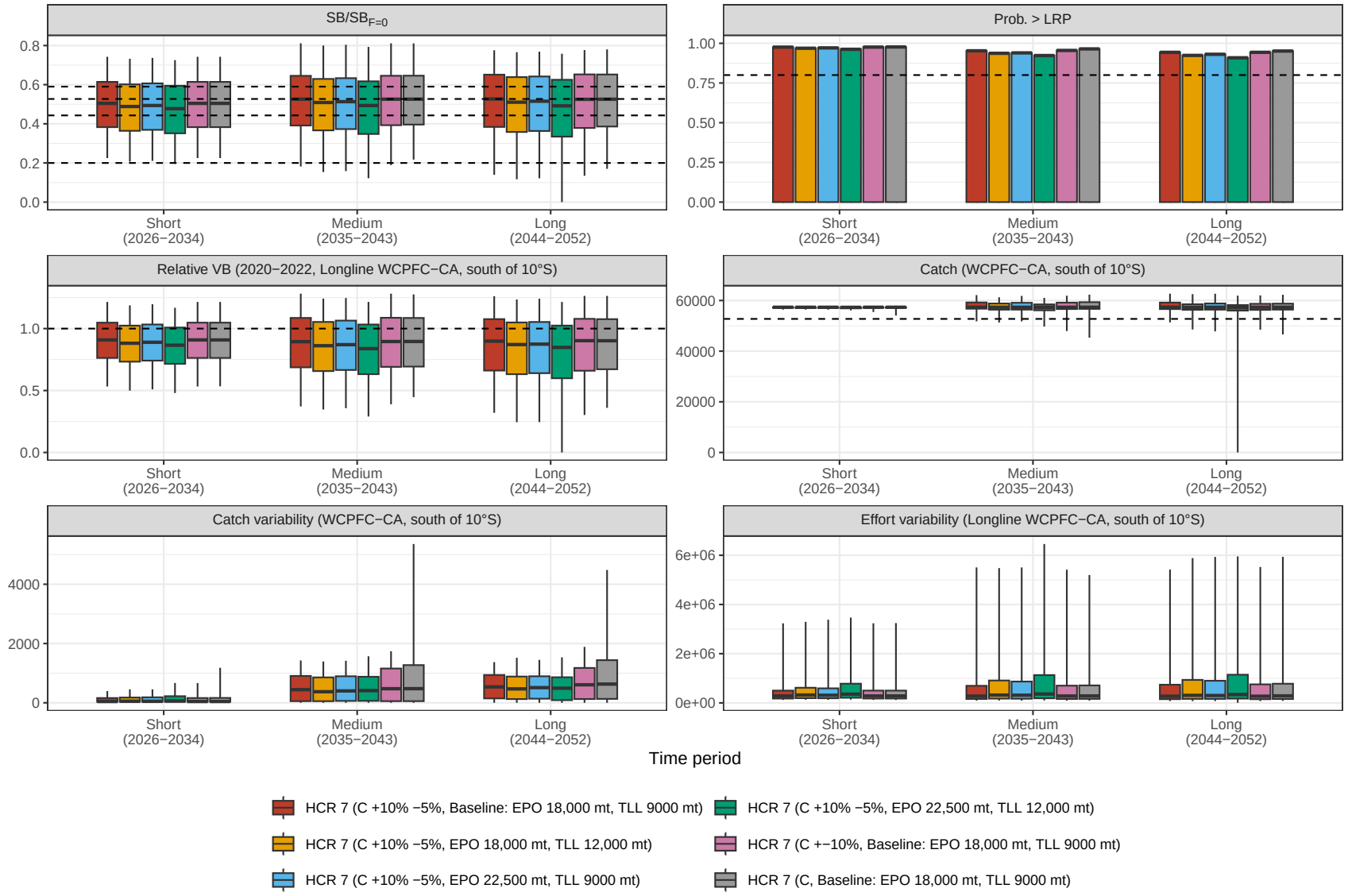


Figure 7: The performance indicators for the same MP with alternative constant annual catch levels in the EPO and in the region between the equator and 10°S in the WCPFC-CA (the TLL fisheries) compared to baseline levels of 18,000 mt and 9000 mt respectively. A catch-based MP with HCR 7 is used, with +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. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

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 7).

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 catches in the WCPFC-CA, south of 10°S, are 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 long line 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 7).

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, median catches in the WCPFC-CA, south of 10°S, are largely unaffected and are still higher than the 2020-2022 average.

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 (Figure 7). 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 main HCRs

A single sensitivity test is run for the remaining main MPs (with HCRs 9, 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 8).

The results track 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. It is worth noting that under the higher EPO and TLL assumptions, this implies a 20% probability of falling below the LRP.

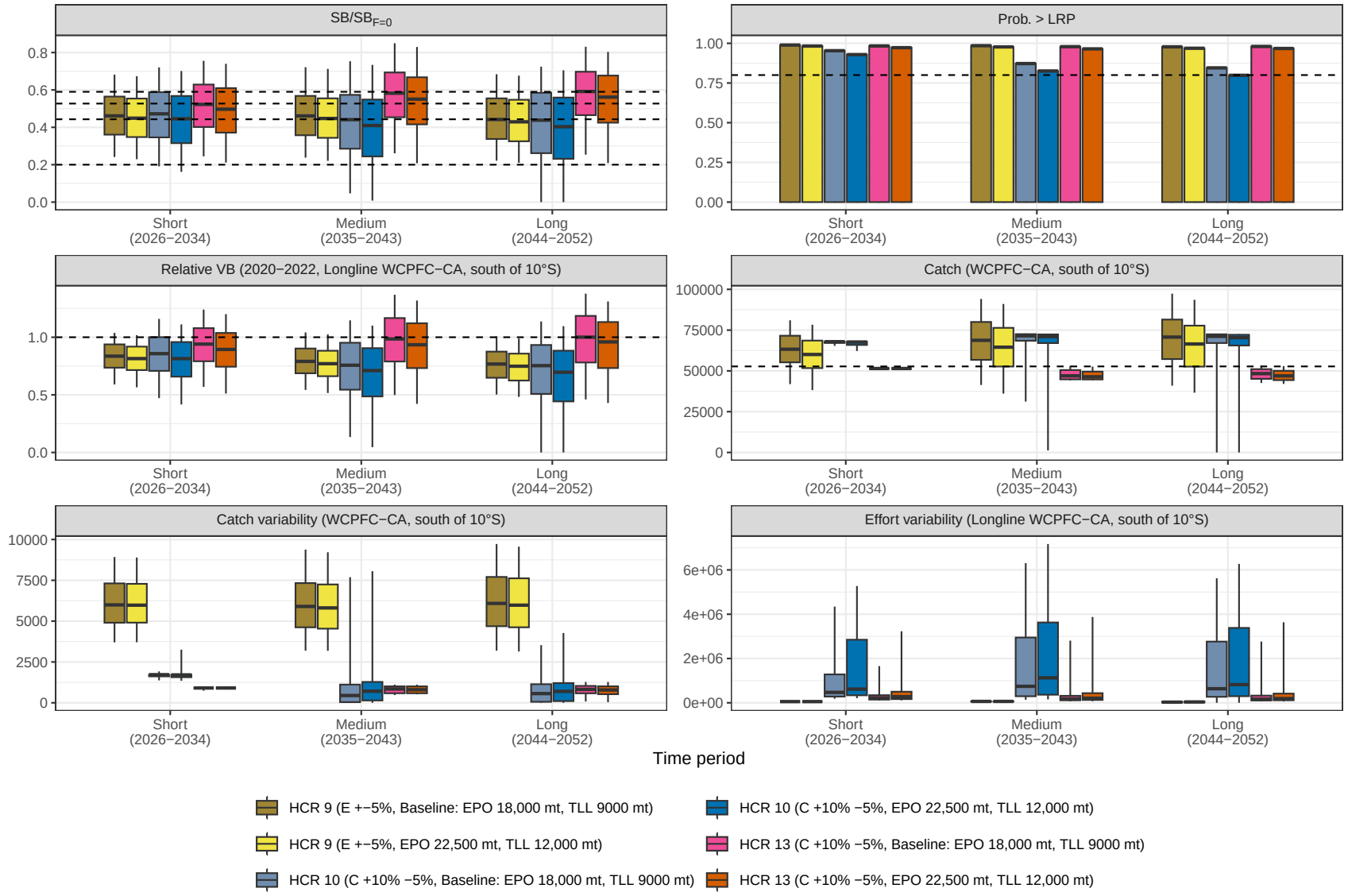


Figure 8: The performance indicators for a single sensitivity test for the main MPs with HCRs 9, 10 ad 13 with alternative constant annual catch levels in the EPO of 22,500 mt and in the region between the equator and 10°S in the WCPFC-CA of 12,000 mt (the TLL fisheries) compared to baseline levels of 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. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

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 9,000t (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 9,000t, 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 9). 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.

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). If the EPO, TLL or troll fishing levels differ to those assumptions, then the expected performance would be different to that reported here.

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

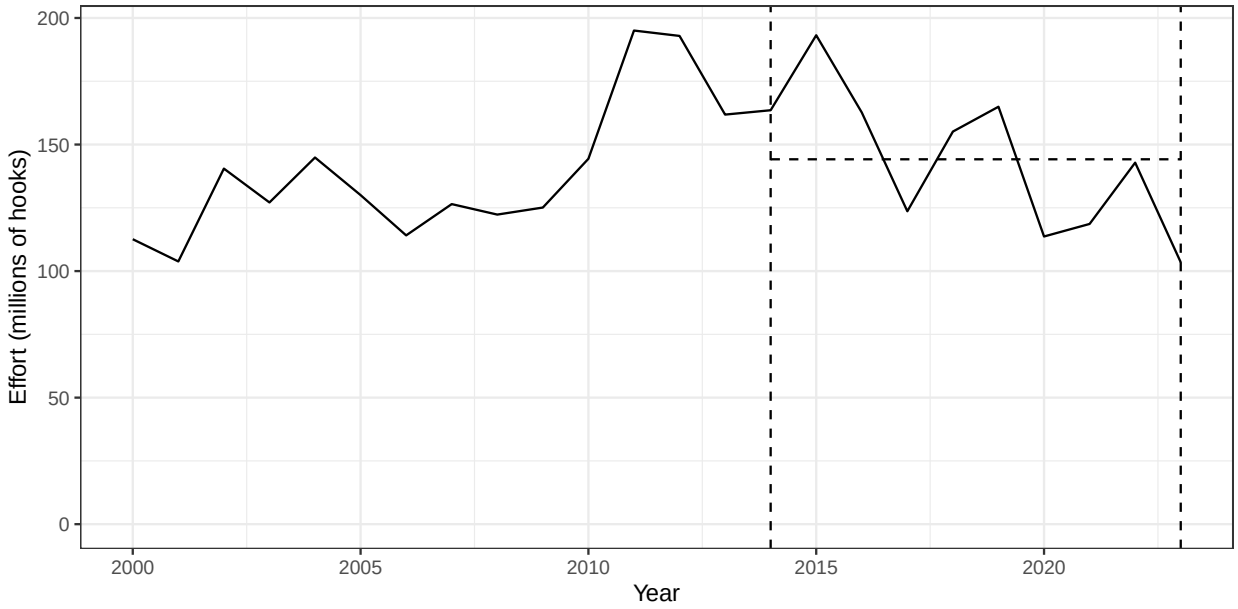


Figure 9: Time series of total longline effort in the WCPFC-CA equator to 10°S model region. The time period of 2014-2023, and the average effort over that time period, are shown as dashed lines.

(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 -5% +10% is applied to each of the new MPs.

Results

The performance indicators from the additional MPs are shown in Figure 10. 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 performance are a combination of the different HCR shapes and the underlying assumptions.

Note that these results are for when fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu, south of 10°S, are excluded from being managed through the MP. Summary tables for both streams of results are given in the Appendices.

Five out of the six 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 catches in the WCPFC-CA, south of 10°S, are affected by the underlying assumptions, as well as the long-term objective. For example, MPs with HCRs 14 and 15 differ in terms of the level of future EPO catches of albacore (22,500 and 13,500 mt per annum respectively). To achieve the same level of long-term $SB/SB_{F=0}$, the resulting catches in WCPFC-CA, south of 10°S, are

therefore different. The median level of catches is above the recent level (average of 2020-2022 period) for all MPs and time periods except for the MP with HCR 19 which achieves a higher $SB/SB_{F=0}$ level in the long-term.

For the MP with HCR 16, 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.

Median catch variability across all MPs is similar in the medium- and long-term. 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. In all time periods the catch variability is relatively small for all MPs and EPO and TLL assumptions.

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.

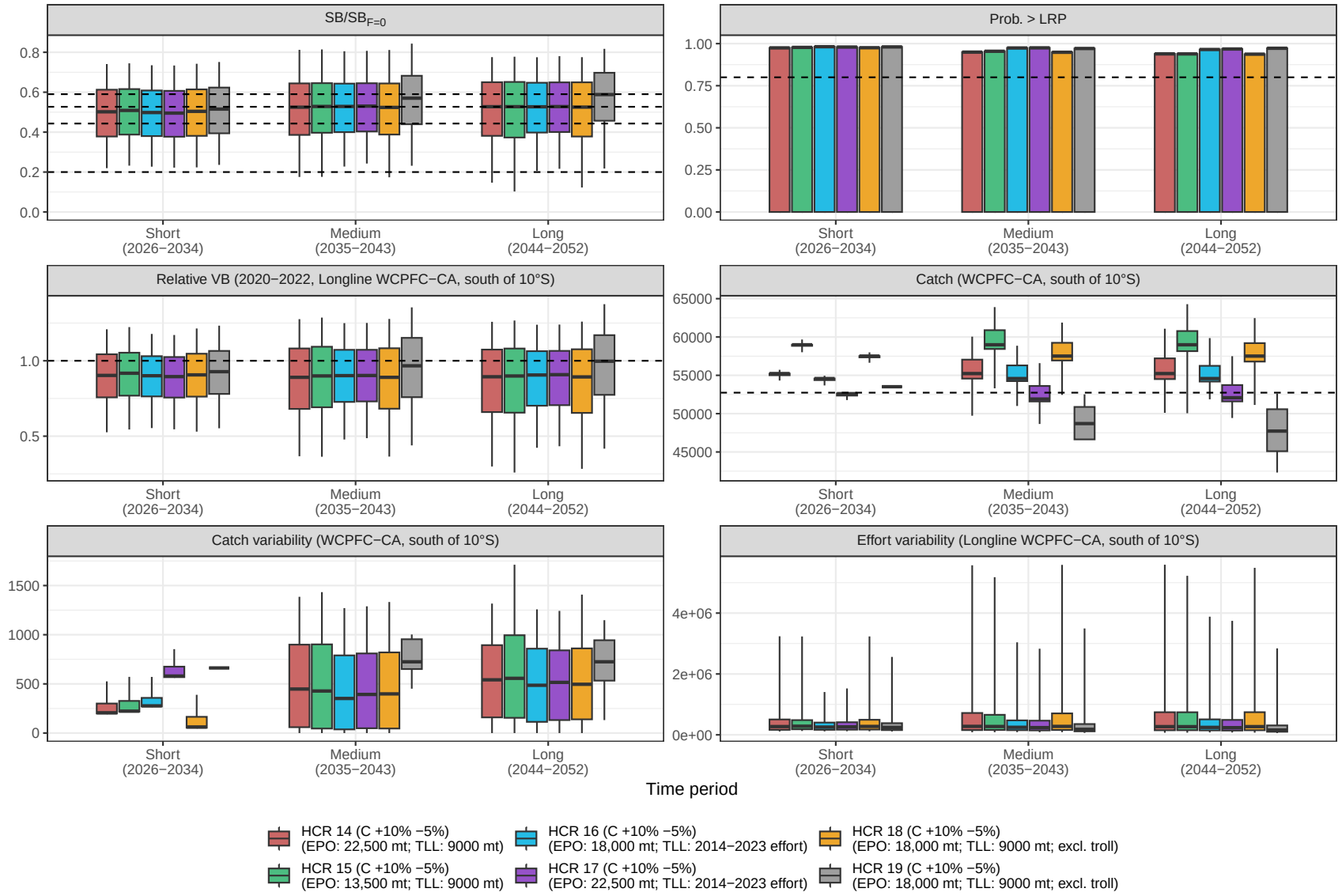


Figure 10: Performance indicators for the additional MPs (with HCRs 14-19). Each MP has different assumptions about the future EPO and TLL albacore catch or fishing effort, and the WCPFC-CA troll fishery, described in the legend. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the horizontal line is the median value. The probability of being above LRP is shown as a bar plot. The horizonal dashed line on the catch plot is the average catch in the 2020-2022 period. In this figure fisheries operating in the Tokelau and Tuvalu EEZs are not managed through the MP.

Acknowledgments

We gratefully acknowledge funding for this work from the New Zealand Ministry of Foreign Affairs and Trade (MFAT) funded project "Sustainable Pacific Fisheries".

References

Breiman, L. (2001). Random forests. *Machine learning*, 45:5–32.

Liaw, A. and Wiener, M. (2002). Classification and regression by randomforest. *Forest*, 23.

Scott, F., Scott, R., and Yao, N. (2024a). Testing and developing an estimation method for South Pacific albacore. Technical Report WCPFC-SC20-2024/MI-WP-05, Manila, Philippines, 14–21 August 2024.

Scott, F., Scott, R., Yao, N., Natadra, R., and Pilling, G. M. (2023). Mixed-fishery harvest strategy update. Technical Report WCPFC-SC19-2023/MI-WP-07-rev01, Koror, Palau, 16–24 August 2023.

Scott, F., Scott, R., Yao, N., and Pilling, G. (2024b). Evaluation of candidate management procedures for South Pacific albacore. Technical Report WCPFC-SMD02-2024/SMD02-BP-02 rev1, Online, 10–12 September 2024.

Scott, F., Scott, R., Yao, N., Pilling, G., and Hamer, P. (2022a). Including South Pacific albacore in the mixed-fishery harvest strategy framework. Technical Report WCPFC-SC18-2021/MI-IP-05, 10–18 August 2022.

Scott, F., Scott, R., Yao, N., Pilling, G., and Hamer, P. (2022b). Mixed-fishery harvest strategy performance indicators. Technical Report WCPFC-SC18-2021/MI-WP-07, 10–18 August 2022.

Scott, F., Scott, R., Yao, N., Pilling, G., and Hamer, P. (2022c). Mixed-fishery harvest strategy update. Technical Report WCPFC-SC18-2021/MI-WP-06, 10–18 August 2022.

Scott, F., Scott, R. D., Yao, N., Pilling, G., and Hampton, S. (2019). Mixed Fishery and Multi-Species Issues in Harvest Strategy Evaluations. Technical Report WCPFC-SC15-2019/MI-WP-04, Pohnpei, Federated States of Micronesia, 12–20 August 2019.

Scott, R., Scott, F., Yao, N., Hamer, P., and Pilling, G. (2024c). Selecting and Conditioning Operating Models for South Pacific Albacore Rev.01. Technical Report WCPFC-SC20-2024/MI-WP-04, Manila, Philippines, 14–21 August 2024.

SPC (2018). Key decisions for managers and scientists under the harvest strategy approach for WCPO tuna stocks and fisheries. Technical Report WCPFC-SC14-2018/MI-WP-05, Busan, South Korea, 5–13 August 2018.

SPC-OFP (2024a). Evaluation of Candidate Management Procedure for South Pacific Albacore Rev01. Technical Report WCPFC21-2024-30 (Rev.01), Suva, Fiji, 28 November - 3 December 2024.

SPC-OFP (2024b). Supplementary Management Procedure Evaluations for South Pacific Albacore. Technical Report WCPFC21-2024-30a, Suva, Fiji, 28 November - 3 December 2024.

Teears, T., Castillo-Jordan, C., Davies, N., Day, J., Hampton, J., Magnusson, A., Peatman, T., Pilling, G., Xu, H., Vidal, T., Williams, P., and Hamer, P. (2024). Stock assessment of South Pacific albacore: 2024. Technical Report WCPFC-SC20-2024/SA-WP-02-Rev 3, Manila, Philippines, 14–21 August 2024.

WCPFC (2018). Fifteenth Regular Session of the Commission - Summary Report. Technical report, Honolulu, Hawaii, USA, 9-14 December 2018.

WCPFC (2019). Summary Report of the Scientific Committee Fifteenth Regular Session. Technical report, Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, Pohnpei, Federated States of Micronesia, 12–20 August 2019.

WCPFC (2021). Summary Report of the Scientific Committee Seventeenth Regular Session. Technical report, Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, Online, 11–19 August 2021.

WCPFC (2022a). Commission Science-Management Dialogue First Meeting - Summary Report. Technical report, 19 and 22 August 2022.

WCPFC (2022b). Conservation and management measure on a management procedure for WCPO skipjack tuna. Technical Report CMM 2022-01, Da Nang, Vietnam, 27 November - 3 December 2023.

WCPFC (2024a). Science-Management Dialogue The Second Session (SMD02) - Summary Report. Technical Report WCPFC21-2024-SMD02-00, Online, 10–12 September 2024.

WCPFC (2024b). Second Science-Management Dialogue (SMD02) - Outcomes Document. Technical Report WCPFC21-2024-SMD02-01, Online, 10–12 September 2024.

WCPFC (2024c). Twenty First Regular Session of the Commission - Summary Report. Technical report, Suva, Fiji, 28 November - 3 December 2024.

WCPFC (2025a). Note from SPC on 2025 modelling approach for South Pacific Albacore Harvest Strategies. Technical Report Circular No.: 2025/17, 4 April 2025.

WCPFC (2025b). Scientific Committee Twenty-First Regular Session - Summary Report - Outcomes Document. Technical Report WCPFC22-2025-SC21-00, Nuku'alofa, Tonga, 13–21 August 2025.

WCPFC (2025c). South Pacific Albacore Management Workshop (SPAMWS) First Session - Chairs' Summary Report. Technical Report WCPFC22-2025-SPAMWS01, Electronic meeting, 11–12 September 2025.

Appendix: Additional requests from SC21 and SPAMWS01

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 9,000 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 9,000 t (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.

Appendix: Settings and assumptions for the three MP evaluation streams

Table 3: Settings and assumptions for the three 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	18,000 mt	9,000 mt	52,131 mt	57,020 mt
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). Fisheries operating in the slivers of the EEZs of Tokelau and Tuvalu south of 10°S may also be excluded from being managed through the MP. In this case 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 (approximate 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.
- For the evaluations where the MP sets catch limits, 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.
- For the evaluations where the MP sets effort limits, the effort 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 or effort 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 possible 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.
- If the 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.

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 now only 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 σ 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; ω is the spatial random effect at location x; ϕ 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)	10,338	56,341	56,341	66,679
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)	10,338	71,331	71,331	81,669
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)	10,338	42,385	42,385	52,723
Main set: Effort-based MPs					
HCR 9	Relative $SB/SB_{F=0}$	0.45	0.85	1.09	1.88
	HCR output	0.2	1.46	1.46	1.66
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)	10,338	54,273	54,273	64,611
HCR 15	Relative $SB/SB_{F=0}$	0.37	0.94	1.29	1.59
	HCR output	0.2	1.12	1.12	1.32
	Catch output (mt)	10,338	57,892	57,892	68,229
HCR 16	Relative $SB/SB_{F=0}$	0.37	0.94	1.29	1.59
	HCR output	0.2	1.04	1.04	1.24
	Catch output (mt)	10,338	53,757	53,757	64,094
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)	10,338	50,655	50,655	60,993
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)	10,338	55,824	55,824	66,162
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)	10,338	41,351	41,351	51,689

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, i.e. the area of application of the South Pacific albacore MP.

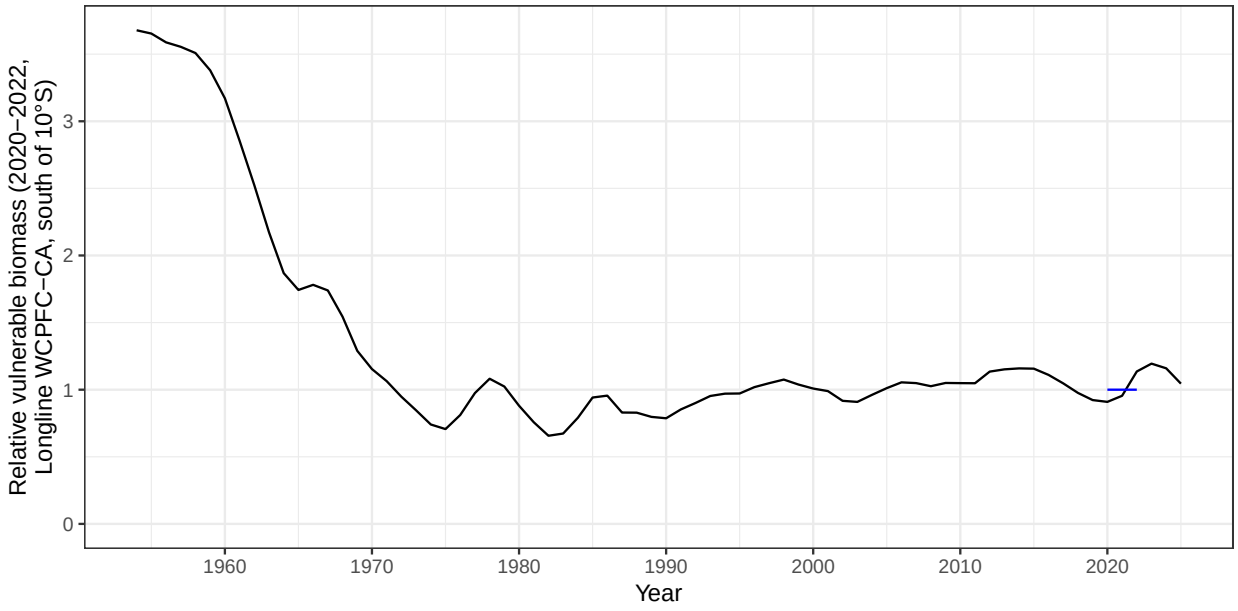


Figure 11: Median historical vulnerable biomass across the operating models, relative to the corresponding average in the period 2020-2022, of the longline fisheries in the WCPFC-CA, south of 10°S. The solid blue line highlights the average in the 2020-2022 period.

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 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. 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.

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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s 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)	44.4 (35.9-396)	281,000 (119,000-3,230,000)
HCR 9 (E +-5%)	18,000	9,000	0.84 (0.44-1.24)	0.99	0.84 (0.59-1.04)	63,300 (41,900-81,000)	5,990 (3,700-8,930)	54,300 (52,900-54,300)
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)	1,720 (1,370-1,920)	470,000 (182,000-4,340,000)
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)	906 (737-906)	222,000 (101,000-1,660,000)
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)	52.3 (35.9-455)	320,000 (127,000-3,290,000)
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)	50.2 (35.9-454)	311,000 (124,000-3,380,000)
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)	61 (35.9-668)	354,000 (133,000-3,470,000)
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)	44.4 (35.9-666)	281,000 (119,000-3,230,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	44.4 (35.9-1,180)	281,000 (119,000-3,240,000)
HCR 9 (E +-5%)	22,500	12,000	0.82 (0.42-1.23)	0.98	0.81 (0.57-1.02)	60,100 (38,200-78,300)	5,980 (3,710-8,900)	54,300 (53,400-54,300)
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)	1,710 (1,350-3,250)	617,000 (210,000-5,270,000)
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)	906 (858-916)	277,000 (110,000-3,230,000)
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)	206 (199-526)	272,000 (109,000-3,240,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.93 (0.42-1.36)	0.98	0.92 (0.54-1.22)	59,000 (58,000-59,700)	223 (218-572)	283,000 (127,000-3,230,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.91 (0.41-1.34)	0.98	0.9 (0.55-1.18)	54,600 (53,700-54,900)	277 (271-571)	255,000 (113,000-1,410,000)
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)	580 (569-853)	263,000 (118,000-1,520,000)
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)	61.9 (54.2-389)	276,000 (117,000-3,230,000)
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)	662 (662-662)	243,000 (110,000-2,560,000)

[a]The TLL assumption for HCRs 16 and 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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s 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)	443 (0-1,430)	276,000 (89,300-5,510,000)
HCR 9 (E +-5%)	18,000	9,000	0.84 (0.43-1.31)	0.99	0.79 (0.54-1.04)	68,700 (41,400-94,100)	5,900 (3,190-9,380)	62,900 (44,400-62,900)
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)	446 (0-7,690)	744,000 (137,000-6,310,000)
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)	846 (474-1,110)	177,000 (61,400-2,810,000)
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)	374 (0-1,390)	318,000 (95,200-5,480,000)
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)	400 (0-1,420)	313,000 (91,900-5,500,000)
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)	411 (0-1,570)	361,000 (99,400-6,460,000)
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)	475 (0-1,740)	279,000 (90,900-5,410,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	477 (0-5,360)	282,000 (91,700-5,200,000)
HCR 9 (E +-5%)	22,500	12,000	0.81 (0.4-1.3)	0.98	0.77 (0.52-1.03)	64,500 (36,100-91,000)	5,810 (3,180-9,220)	62,900 (42,500-62,900)
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)	709 (0-8,060)	1,130,000 (153,000-7,170,000)
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)	802 (517-1,110)	208,000 (71,200-3,880,000)
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)	448 (0-1,390)	278,000 (84,900-5,570,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.96 (0.32-1.48)	0.95	0.9 (0.36-1.29)	59,000 (53,300-63,900)	428 (0-1,430)	274,000 (86,400-5,180,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.96 (0.41-1.47)	0.97	0.9 (0.48-1.25)	54,600 (51,000-58,900)	352 (0-1,270)	248,000 (88,000-3,040,000)
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)	393 (0-1,290)	237,000 (84,800-2,830,000)
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)	398 (0-1,330)	277,000 (88,400-5,580,000)
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)	725 (451-1,000)	181,000 (63,400-3,500,000)

[a]The TLL assumption for HCRs 16 and 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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S (including in the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s 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)	537 (0-1,370)	272,000 (73,800-5,420,000)
HCR 9 (E +-5%)	18,000	9,000	0.8 (0.4-1.25)	0.98	0.77 (0.5-1.01)	70,700 (40,900-97,300)	6,090 (3,190-9,720)	29,800 (3,170-65,600)
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)	563 (0-3,530)	635,000 (0-5,620,000)
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)	820 (79.5-1,280)	165,000 (60,900-2,770,000)
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)	470 (0-1,520)	306,000 (71,300-5,890,000)
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)	511 (0-1,450)	300,000 (72,800-5,930,000)
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)	492 (0-1,530)	338,000 (3,700-5,950,000)
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)	608 (0-1,890)	271,000 (75,100-5,520,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	632 (0-4,480)	285,000 (82,400-5,940,000)
HCR 9 (E +-5%)	22,500	12,000	0.78 (0.38-1.23)	0.97	0.75 (0.48-0.99)	66,500 (36,600-93,600)	5,980 (3,140-9,560)	38,900 (3,180-65,900)
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)	699 (0-4,270)	822,000 (0-6,270,000)
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)	786 (38.1-1,280)	190,000 (60,800-3,630,000)
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)	541 (0-1,320)	270,000 (69,800-5,590,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.96 (0.19-1.42)	0.94	0.9 (0.26-1.27)	59,000 (50,100-64,300)	557 (0-1,710)	268,000 (70,800-5,230,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.96 (0.38-1.41)	0.97	0.91 (0.42-1.24)	54,600 (51,900-59,900)	486 (0-1,260)	245,000 (78,900-3,880,000)
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)	516 (0-1,240)	235,000 (77,000-3,750,000)
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)	496 (0-1,410)	270,000 (71,800-5,490,000)
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)	725 (132-1,150)	159,000 (57,600-2,840,000)

[a]The TLL assumption for HCRs 16 and 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: Tables of results (MP applies south of 10°S, including Tokelau and Tuvalu)

This appendix contains the summary tables for when the MP applies to all longline and troll fisheries south of 10°S, including fisheries 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 11, Table 12 and Table 13. The results are separated into the main results, sensitivity results and the additional MP requests from SC21 and SPAMWS01.

Table 11: Results in the short-term (2026-2034) for when the MP applies to all longline and troll fisheries south of 10°S, including 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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S. Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
Main results								
HCR 7 (C +10% -5%)	18,000	9,000	0.92 (0.41-1.35)	0.98	0.91 (0.53-1.21)	57,400 (56,400-57,900)	51.2 (42.4-405)	282,000 (120,000-3,230,000)
HCR 9 (E +-5%)	18,000	9,000	0.84 (0.44-1.24)	0.99	0.84 (0.59-1.04)	63,400 (41,900-80,900)	6,000 (3,700-8,940)	55,200 (53,400-55,200)
HCR 10 (C +10% -5%)	18,000	9,000	0.86 (0.35-1.31)	0.95	0.86 (0.47-1.16)	68,000 (65,500-68,100)	1,750 (1,390-1,880)	476,000 (184,000-4,340,000)
HCR 13 (C +10% -5%)	18,000	9,000	0.95 (0.45-1.38)	0.98	0.94 (0.57-1.24)	51,400 (51,400-52,200)	916 (751-916)	221,000 (100,000-1,620,000)
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)	52.3 (35.9-455)	320,000 (127,000-3,290,000)
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)	50.2 (35.9-454)	311,000 (124,000-3,380,000)
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)	61 (35.9-668)	354,000 (133,000-3,470,000)
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)	44.4 (35.9-666)	281,000 (119,000-3,230,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	44.4 (35.9-1,180)	281,000 (119,000-3,240,000)
HCR 9 (E +-5%)	22,500	12,000	0.82 (0.42-1.23)	0.98	0.81 (0.57-1.02)	60,100 (38,200-78,300)	5,980 (3,710-8,900)	54,300 (53,400-54,300)
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)	1,710 (1,350-3,250)	617,000 (210,000-5,270,000)
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)	906 (858-916)	277,000 (110,000-3,230,000)
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)	55,300 (54,300-55,800)	203 (196-522)	273,000 (109,000-3,240,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.93 (0.42-1.36)	0.98	0.92 (0.54-1.22)	59,100 (58,100-59,800)	232 (227-593)	284,000 (127,000-3,230,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.91 (0.41-1.34)	0.98	0.9 (0.55-1.18)	54,600 (53,700-55,000)	274 (269-572)	255,000 (113,000-1,410,000)
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 (51,700-52,700)	581 (570-858)	262,000 (118,000-1,520,000)
HCR 18 (C +10% -5%)[b]	18,000	9,000	0.92 (0.41-1.35)	0.98	0.91 (0.53-1.21)	57,600 (56,700-58,100)	68.1 (60.2-391)	277,000 (117,000-3,230,000)
HCR 19 (C +10% -5%)[b]	18,000	9,000	0.94 (0.43-1.37)	0.98	0.93 (0.55-1.23)	53,400 (53,400-53,400)	673 (673-673)	242,000 (109,000-2,550,000)

[a] The TLL assumption for HCRs 16 and 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 12: Results in the medium-term (2035-2043) for when the MP applies to all longline and troll fisheries south of 10°S, including 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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S. Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
Main results								
HCR 7 (C +10% -5%)	18,000	9,000	0.96 (0.32-1.48)	0.95	0.89 (0.36-1.28)	57,400 (51,700-62,200)	448 (0-1,470)	281,000 (89,800-5,530,000)
HCR 9 (E +-5%)	18,000	9,000	0.84 (0.43-1.31)	0.98	0.79 (0.54-1.04)	68,800 (41,400-94,200)	5,920 (3,230-9,410)	63,900 (45,300-63,900)
HCR 10 (C +10% -5%)	18,000	9,000	0.8 (0.08-1.38)	0.87	0.76 (0.12-1.14)	71,700 (39,800-72,800)	463 (0-7,830)	760,000 (139,000-6,280,000)
HCR 13 (C +10% -5%)	18,000	9,000	1.06 (0.47-1.55)	0.98	0.98 (0.49-1.37)	46,900 (44,100-53,000)	851 (488-1,130)	177,000 (61,900-2,830,000)
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)	374 (0-1,390)	318,000 (95,200-5,480,000)
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)	400 (0-1,420)	313,000 (91,900-5,500,000)
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)	411 (0-1,570)	361,000 (99,400-6,460,000)
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)	475 (0-1,740)	279,000 (90,900-5,410,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	477 (0-5,360)	282,000 (91,700-5,200,000)
HCR 9 (E +-5%)	22,500	12,000	0.81 (0.4-1.3)	0.98	0.77 (0.52-1.03)	64,500 (36,100-91,000)	5,810 (3,180-9,220)	62,900 (42,500-62,900)
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)	709 (0-8,060)	1,130,000 (153,000-7,170,000)
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)	802 (517-1,110)	208,000 (71,200-3,880,000)
Additional MP requests								
HCR 14 (C +10% -5%)	22,500	9,000	0.95 (0.32-1.48)	0.95	0.89 (0.37-1.28)	55,300 (49,800-60,100)	450 (0-1,390)	280,000 (85,000-5,570,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.96 (0.32-1.48)	0.95	0.9 (0.36-1.29)	59,100 (53,300-63,900)	430 (0-1,450)	276,000 (86,700-5,260,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.96 (0.41-1.47)	0.97	0.9 (0.48-1.25)	54,600 (51,000-58,900)	354 (0-1,290)	248,000 (90,500-3,050,000)
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 (48,600-56,600)	399 (0-1,310)	237,000 (84,900-2,820,000)
HCR 18 (C +10% -5%)[b]	18,000	9,000	0.95 (0.32-1.48)	0.95	0.89 (0.36-1.28)	57,600 (52,400-62,000)	402 (0-1,350)	278,000 (90,400-5,580,000)
HCR 19 (C +10% -5%)[b]	18,000	9,000	1.04 (0.42-1.54)	0.97	0.97 (0.44-1.35)	48,600 (46,500-52,600)	734 (451-1,010)	179,000 (63,400-3,480,000)

[a] The TLL assumption for HCRs 16 and 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 13: Results in the long-term (2044-2052) for when the MP applies to all longline and troll fisheries south of 10°S, including 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), catch, catch variability and effort variability are for the WCPFC-CA, south of 10°S. Relative VB and effort variability are for longline fisheries only.

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
Main results								
HCR 7 (C +10% -5%)	18,000	9,000	0.96 (0.24-1.41)	0.94	0.9 (0.31-1.26)	57,400 (51,200-62,800)	548 (0-1,390)	272,000 (72,600-5,420,000)
HCR 9 (E +-5%)	18,000	9,000	0.8 (0.4-1.25)	0.98	0.77 (0.51-1.01)	70,800 (41,100-97,500)	6,100 (3,210-9,740)	30,500 (3,810-66,600)
HCR 10 (C +10% -5%)	18,000	9,000	0.79 (0-1.32)	0.84	0.75 (0-1.14)	71,400 (0-72,800)	586 (0-3,740)	649,000 (0-5,670,000)
HCR 13 (C +10% -5%)	18,000	9,000	1.08 (0.44-1.5)	0.98	1 (0.44-1.38)	48,300 (42,400-53,200)	832 (82-1,300)	164,000 (60,600-2,620,000)
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)	470 (0-1,520)	306,000 (71,300-5,890,000)
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)	511 (0-1,450)	300,000 (72,800-5,930,000)
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)	492 (0-1,530)	338,000 (3,700-5,950,000)
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)	608 (0-1,890)	271,000 (75,100-5,520,000)

HCR	EPO catch (mt)	TLL catch (mt)	$SB/SB_{F=0}$ relative to 2017-2019	Prob. > LRP	Relative VB	Catch (mt)	Catch variability (mt)	Effort variability (00s hooks)
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)	632 (0-4,480)	285,000 (82,400-5,940,000)
HCR 9 (E +-5%)	22,500	12,000	0.78 (0.38-1.23)	0.97	0.75 (0.48-0.99)	66,500 (36,600-93,600)	5,980 (3,140-9,560)	38,900 (3,180-65,900)
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)	699 (0-4,270)	822,000 (0-6,270,000)
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)	786 (38.1-1,280)	190,000 (60,800-3,630,000)
Additional MP requests								
HCR 14 (C +10% -5%)	22,500	9,000	0.96 (0.24-1.41)	0.94	0.89 (0.29-1.25)	55,300 (50,100-61,200)	549 (0-1,340)	270,000 (70,100-5,600,000)
HCR 15 (C +10% -5%)	13,500	9,000	0.96 (0.19-1.42)	0.94	0.9 (0.26-1.26)	59,100 (50,000-64,400)	554 (0-1,620)	271,000 (72,400-5,200,000)
HCR 16 (C +10% -5%)	18,000	1,440,000[a]	0.96 (0.38-1.42)	0.97	0.91 (0.43-1.24)	54,600 (51,900-59,900)	486 (0-1,280)	246,000 (78,900-3,870,000)
HCR 17 (C +10% -5%)	22,500	1,440,000[a]	0.96 (0.4-1.42)	0.97	0.91 (0.43-1.24)	52,100 (49,400-57,600)	522 (0-1,250)	235,000 (77,100-3,750,000)
HCR 18 (C +10% -5%)[b]	18,000	9,000	0.96 (0.22-1.41)	0.94	0.9 (0.28-1.26)	57,600 (51,100-62,600)	500 (0-1,400)	270,000 (71,700-5,370,000)
HCR 19 (C +10% -5%)[b]	18,000	9,000	1.07 (0.4-1.49)	0.97	1 (0.42-1.37)	47,600 (42,100-52,600)	736 (130-1,170)	157,000 (56,800-2,860,000)

[a]The TLL assumption for HCRs 16 and 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).

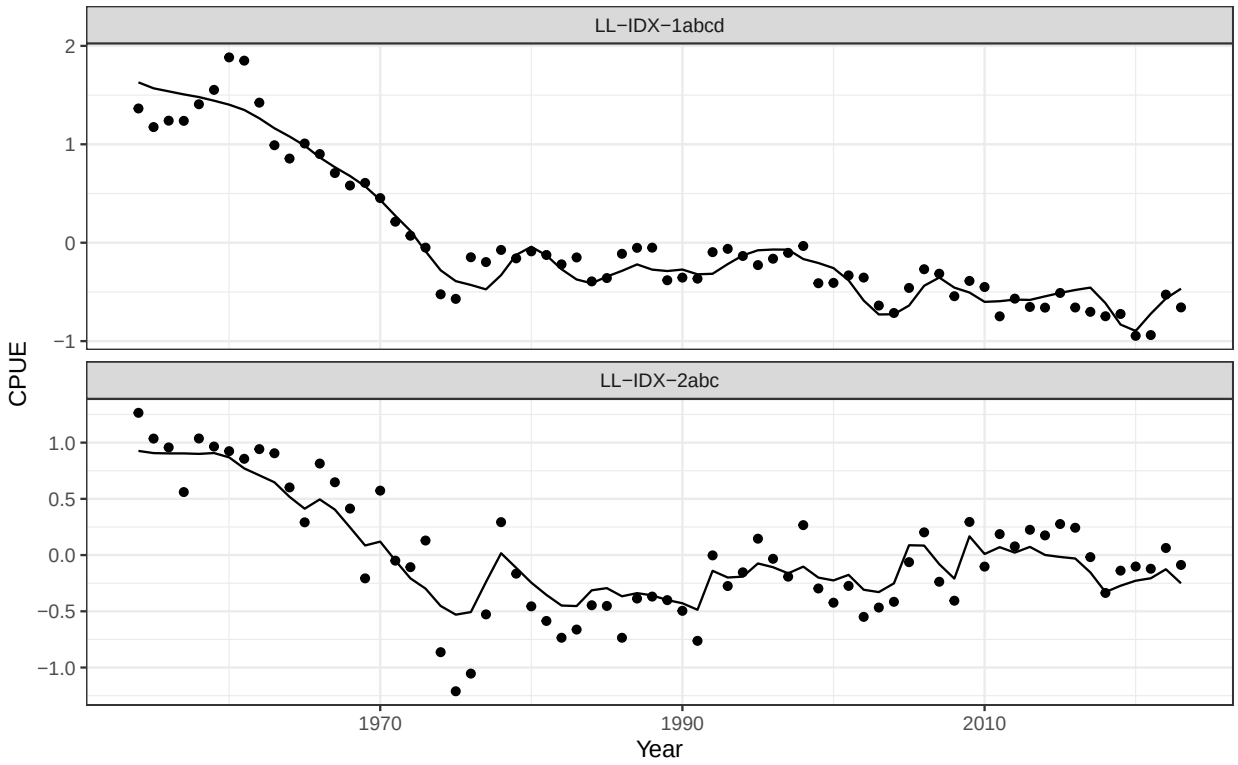


Figure 12: Observed (points) and predicted (lines) CPUE for the index fisheries (top panel is in the WCPFC-CA, bottom panel is in the EPO) from the EM fit.

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%; +-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 or effort (in 2023) relative to the HCR baseline catch or effort (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 and effort values, and corresponding original HCR scalers can be seen in Table 14. The HCR outputs including or excluding the slivers

of the EEZs of Tokelau and Tuvalu that are south of 10°S are shown in Table 16 and Table 15.

Table 14: Baseline (2020-2022 average) and latest (2023) albacore catch (mt) and longline effort (hundreds of hooks) in the WCPFC-CA south of 10°S and the associated 'original HCR scalar', including or excluding the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S.

MP type	TK & TK EEZ slivers	Baseline (2020-2022)	Latest (2023)	Original HCR scalar
Catch-based	Include	52,131	52,358	1.004
	Exclude	51,689	51,953	1.005
Effort-based	Include	2,511,967	2,028,260	0.807
	Exclude	2,475,334	2,011,103	0.812

Table 15: MP output for the WCPFC 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). HCR 9 output is effort (hundreds of hooks), output of all other HCRs 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	56,263	1.088	56,263
HCR 9 (E +-5%)	1.482	3,668,352	0.853	2,111,658
HCR 10 (C +10% -5%)	1.380	71,331	1.106	57,148
HCR 13 (C +10% -5%)	0.843	43,590	0.955	49,355
HCR 14 (C +10% -5%)	1.048	54,164	1.048	54,164
HCR 15 (C +10% -5%)	1.120	57,892	1.106	57,148
HCR 16 (C +10% -5%)	1.035	53,518	1.035	53,518
HCR 17 (C +10% -5%)	0.984	50,862	0.984	50,862
HCR 18 (C +10% -5%)	1.081	55,876	1.081	55,876
HCR 19 (C +10% -5%)	0.814	42,091	0.955	49,355

Table 16: MP output for the WCPFC-CA south of 10°S, without and with the application of the constraint (including the slivers of the EEZs of Tokelau and Tuvalu that are south of 10°S). HCR 9 output is effort (hundreds of hooks), output of all other HCRs 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	56,745	1.088	56,745
HCR 9 (E +-5%)	1.482	3,722,640	0.848	2,129,673
HCR 10 (C +10% -5%)	1.380	71,941	1.105	57,594
HCR 13 (C +10% -5%)	0.843	43,963	0.954	49,740
HCR 14 (C +10% -5%)	1.048	54,627	1.048	54,627
HCR 15 (C +10% -5%)	1.120	58,387	1.105	57,594
HCR 16 (C +10% -5%)	1.035	53,976	1.035	53,976
HCR 17 (C +10% -5%)	0.984	51,297	0.984	51,297
HCR 18 (C +10% -5%)	1.081	56,354	1.081	56,354
HCR 19 (C +10% -5%)	0.814	42,451	0.954	49,740