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BIGEYE TUNA MANAGEMENT PROCEDURE EVALUATIONS FOR BMW02

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SPC-OFP¹

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Executive summary

The WCPFC harvest strategy workplan schedules the adoption of the bigeye tuna management procedure (MP) by the end of 2026. Before an MP is adopted a range of candidate MPs should be evaluated using Management Strategy Evaluation (MSE). This report presents the evaluations of candidate bigeye MPs. Performance indicators are calculated and used to compare the relative performance of the candidate MPs.

The proposed bigeye MP, presented at the first WCPFC Bigeye Management Workshop (BMW01) and SC22, comprises a continuum of pairs of HCRs: one that sets the fishing opportunities of the longline fishery, and one for the FAD associated purse seine fishery. Each pair of HCRs aims to achieve the same outcomes in terms of long-term bigeye stock status, but under an alternative FAD closure scenario. Some pairs of HCRs would allow for more or less longline fishing depending on the associated FAD open period, i.e. the shorter the FAD open period, the higher the longline catch of bigeye to achieve the same long-term stock outcome. Under this approach the pair of HCRs used to set the FAD open period and the longline catch/effort limit, in each management period would be negotiated by the Commission.

As requested by BMW01 and SC22, four bigeye MP spatial/fishery scenarios are evaluated, each of which specifies different longline fisheries that would be managed through the bigeye MP.

BMW01 specified four different candidate Target Reference Points (TRPs) to be evaluated, around which the MPs are designed. These TRPs are based around long-term spawning biomass depletion being above the ‘lower’ TRP ($0.94 \times 2012\text{-}2015$ average spawning biomass depletion) and ‘upper’ TRP ($1.06 \times 2012\text{-}2015$ average spawning biomass depletion) with probabilities of 50% and additional probabilities of 60% and 70% for the lower TRP.

As the outcomes of future MP negotiations are currently unknown it is not possible to know which pairs of HCRs will actually be used in the future. To simulate the continuum of pairs of HCRs possible within the guidance provided by WCPFC22, three pairs of HCRs are designed within a single MP: ‘FAD favoured’, ‘intermediate’ and ‘longline favoured’, where each attempts to achieve the same stock outcomes while distributing management responsibility differently between longline and purse seine fisheries. Each candidate MP is then evaluated using three HCR pair selection scenarios:

- Only using the ‘FAD favoured’ pair;
- Only using the ‘longline favoured’ pair;
- Randomly selecting between the ‘FAD favoured’, ‘intermediate’ or ‘longline favoured’ pair each time the MP is evaluated.

Only using the ‘FAD favoured’ or ‘longline favoured’ pair can be considered as ‘edge’ cases which simulate the possible limits of the MP. Randomly selecting between three pairs offers the greatest potential variability in catch limits and FAD closure periods. That variability may be viewed as the

more extreme case noting the anticipated intention to negotiate the HCR pair every management period.

To facilitate comparison of results between spatial/fishery scenarios and TRP options, only the results from the ‘random’ HCR pair scenario are included here. The results from the ‘FAD favoured only’ and ‘longline favoured only’ scenarios are included in the supporting information.

In practice, the HCR pair that is used in each management period may be a negotiated outcome and may include HCR pairs not evaluated here, but exist on the continuum of possible HCRs. As such, the expected results presented here are illustrative only and the real results will ultimately depend on the HCR pairs that are selected.

All three HCR pair selection scenarios achieve the same objective in terms of long-term stock status but have different fishery outcomes, e.g. the distribution of catches of bigeye between the longline and purse seine fisheries.

Brief summary of results

TRP objectives

The selection of the TRP objective impacts several performance indicators.

The lower the TRP objective, the lower the probability of being above the Limit Reference Point (LRP). However, for all MPs evaluated the probability of being above the LRP was above 80%, the WCPFC’s requirement.

The TRP objective also affects the expected bigeye catch levels of the longline fisheries managed through the bigeye MP, with the more depleted the TRP objective the higher the catch level, within a spatial/fishery scenario. There is also a small impact on purse seine catches where more depleted TRP objectives result in slightly lower levels of catch, within a spatial/fishery scenario.

The expected relative vulnerable biomass increases with less depleted TRP objectives, most notably for the longline fisheries, i.e. the lowest vulnerable biomass occurs under the lower TRP (50%) objective.

Spatial/fishery scenario

The choice of spatial/fishery scenario has little impact on the biological indicators (the expected spawning biomass depletion, and probability of being above the LRP). However, the choice does affect the fishery based indicators.

Care must be taken when comparing fishery based indicators between the four bigeye MP spatial/fishery scenarios as they manage different groups of longline fisheries. The results will also be partly driven by the impact of assumptions made about fisheries not managed through MP.

1 Introduction

The WCPFC harvest strategy workplan schedules the adoption of the bigeye tuna management procedure (MP) by the end of 2026 (WCPFC, 2025). An important consideration when developing harvest strategies for tuna stocks in the WCPO is to account for mixed fishery interactions as management measures aimed at one stock can also affect other stocks.

Discussions on the bigeye MP at WCPFC22 focussed on the possibility of including the FAD closure period as part of the bigeye MP design (WCPFC, 2025).

At WCPFC22 the Scientific Services Provider was asked to evaluate a range of harvest control rules (HCRs, a key component of an MP) controlling the tropical longline (TLL) and tropical purse seine fleets, at different levels of TLL catch and/or effort and FAD open period, that form the basis of a continuum of MPs all tuned to achieve the same stock status in the long-term, i.e. it would be possible to achieve the same target reference point (TRP) under different combinations of TLL catch and/or effort and FAD open periods. This approach is described in detail in WCPFC-SC22-2026/MI-WP-03 (Scott et al., 2026a).

Before an MP is adopted a range of candidate MPs should be evaluated using Management Strategy Evaluation (MSE). This report presents the evaluations of proposed candidate bigeye MPs based on an updated operating model (OM) grid. Performance indicators are calculated and used to compare the relative performance of the candidate MPs.

1.1 Spatial range of the bigeye management procedure

Three scenarios for the spatial/fishery range of longline fisheries managed through the bigeye MP were proposed at BMW01 for evaluation (Table 1). An additional spatial/fishery scenario was subsequently requested in which the bigeye MP applied to longline fisheries across the WCPO, but was consistent with the existing Tropical Tuna Measure (TTM). Here, this scenario has been evaluated as the bigeye MP applying to longline fisheries across the WCPO, excluding SIDS flagged vessels.

Table 1: Spatial range and fishery scenarios of the bigeye management procedure.

Scenario	Fisheries managed through the bigeye MP
TLL excluding Hawaiian longline fleet	MP manages TLL (20°N to 10°S), excluding the portion of the Hawaiian longline fleet operating south of 20°N.
TLL including Hawaiian longline fleet	MP manages TLL (20°N to 10°S), including the portion of the Hawaiian longline fleet operating south of 20°N.
WCPO wide excluding SIDS	All longline fisheries in the WCPO, excluding catches of bigeye taken by SIDS flagged vessels.
WCPO wide	All longline fisheries in the WCPO, including Hawaiian longline fleet.

For the scenarios in which all longline fisheries in the WCPO are managed through the bigeye MP, including and excluding SIDS flagged vessels, the output of the MP has to be a catch limit, rather than an effort limit, to avoid potential interactions with the South Pacific albacore MP (which sets a catch limit of South Pacific albacore for longline fisheries operating south of 20°S).

1.2 Target Reference Points

Typically, candidate MPs are designed to maintain the biological stock around a TRP on average. Three candidate TRPs for bigeye were specified at WCPFC21 at 1x, 0.94x and 1.06x the 2012-2015 average spawning biomass depletion noting that these candidate TRPs may be specified as threshold targets for which associated probabilities of being ‘at or above’ would need to be specified ([WCPFC, 2024](#)).

BMW01 agreed to evaluate two of the three WCPFC21 candidate TRP levels as target TRPs using a 50% probability formulation, i.e. treating the TRP as a typical point target. Additionally the ‘lower’ TRP (0.94 x 2012-2015) can be considered with thresholds of 60% and 70%. The four agreed candidate TRPs are therefore:

- 0.94 x 2012-2015 average spawning biomass depletion (referred to here as the lower TRP).
- 0.94 x 2012-2015 average spawning biomass depletion with a threshold of 60% and 70%.
- 1.06 x 2012-2015 average spawning biomass depletion (referred to here as the upper TRP).

In this report MPs are evaluated across the four TRPs and all four spatial/fishery bigeye MP scenarios.

2 Management Strategy Evaluation framework

2.1 Operating models

The evaluations use the candidate operating model (OM) grid of 1152 models, with 36 extraction fisheries (purse seine, longline, pole and line and the domestic fisheries of Vietnam, Indonesia and the Phillipines) operating in 9 model regions ([SPC-OFP, 2026b](#)).

The projections are stochastic through the inclusion of recruitment variability, implemented as the application of randomly selected historical recruitment deviates. Observation error is included on the estimation method input data through the addition of lognormally distributed noise, with a CV of 20% on catch data and 10% on CPUE data ([Wickens et al., 2026](#)).

2.2 Timing

BMW01 agreed that a data lag of two years and a management period of three years would be used, i.e. the first time the MP is run in 2027, data up to 2025 is used and the MP sets the catches of longline fisheries managed through the MP, and the purse seine FAD closure period, for the years 2028, 2029 and 2030.

Each MP evaluation runs through nine three-year management period cycles, with the MP being evaluated in 2027, 2030, 2033 etc. up to 2051. The final year in the evaluations is 2054.

2.3 Assumed future catch and effort of model fisheries

The OMs are conditioned up to 2021 so that the MSE projections start from 2022. Catches and effort of the model fisheries from 2022 to 2024 are set to the currently available data, noting that uncertainties around the catches of domestic fisheries in the Vietnam, Indonesia, and the Philippines region will be considered in future sensitivity testing.

It is necessary to make assumptions about the future catches and effort of the fisheries not managed through the MP from 2025, including longline fishery components. BMW01 requested the SSP to use recent catch and effort levels where possible and to avoid selecting periods that disadvantage a sector or fishery.

In these evaluations the output of the MP is applied from 2028. It is therefore necessary to make assumptions for the future catches of the TLL fisheries in the period 2025 to 2027, i.e. the period between the last known catch or effort, and the start of the application of the MP, known as the ‘transient period’. For the evaluations presented here the catches of the TLL fisheries in this period are set equal to 2015-2024 average levels (40,347 mt p.a.) (Scott et al., 2026a; SPC-OFP, 2026a). For the other fisheries the same assumptions were made as when generating the ‘nuclear grid’ to design the HCRs (Scott et al., 2026a; SPC-OFP, 2026a), noting that the assumptions change depending on the bigeye MP spatial scenario.

The future effort of the purse seine fisheries is fixed at 2012 levels, consistent with the skipjack interim MP, but distributed between FAD-associated and free-school sets as determined by the bigeye MP. Estimating future levels for the purse seine fishery requires the assumption that the number of future FAD sets performed in a year is proportional to changes in the closure period. For example, shortening the closure period will not change the rate of FAD setting (e.g. a refocussing of effort toward FAD sets) (see Appendix).

The calculation of the scalars and baseline period used for modelling FAD associated purse seine effort is described in the Appendix. We highlight that the baseline period selected for purse seine and longline has no implications in this process – the key issue is the absolute level of fishing being considered. A different baseline would imply a different scalar but would result in the same absolute level of fishing/stock impact.

As mentioned previously, sensitivity testing of assumptions for fisheries not managed through the bigeye MP will be conducted in the future for specific MPs, in particular the future levels of fishing effort or bigeye catch by the domestic fisheries in the Indonesia, Philippines and Vietnam region.

3 Management procedure design

For a detailed discussion on the proposed design of the bigeye candidate MPs see [SPC-OFP \(2026a\)](#) and [SPC-OFP \(2026c\)](#).

An MP typically comprises three components:

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

The data collection and estimation method for the candidate bigeye MPs are discussed in detail in WCPFC-SC22-2026/MI-WP-02 ([Wickens et al., 2026](#)). The HCR input is the estimated spawning biomass, relative to the average estimated spawning biomass in 2012-2015 ($SB/SB_{2012-2015}$), as calculated by the estimation method.

For the candidate MPs presented here, the data collection and estimation method are the same. The differences between them are the HCRs.

As presented at BMW01 and SC22, the proposed bigeye MP comprises a continuum of pairs of HCRs: one that sets the fishing opportunities of the longline fishery, and one for the FAD associated purse seine fishery, defined as the number of months the FAD fishery is open ([SPC-OFP, 2026a](#)). Each pair of HCRs aims to achieve the same outcomes in terms of long-term bigeye stock status, but under an alternative FAD open scenario. Pairs of HCRs would allow for more or less longline fishing depending on the associated FAD open period, i.e. the shorter the FAD open period, the higher the longline catch of bigeye to achieve the same long-term outcome.

Each of the four bigeye MP spatial/fishery scenarios described in Table 1, and each of the candidate TRPs, including those evaluated as threshold TRPs, require different candidate MPs, i.e. require different pairs of HCRs that will achieve the selected TRP in the long-term. Each MP is therefore unique for that particular bigeye MP spatial/fishery scenario and selected TRP objective (Table 2).

SC21 and BMW01 supported a ‘Hillary step’ type of HCR, consistent with the adopted skipjack and South Pacific albacore HCRs. The step heights of the Hillary steps are defined by the nuclear grids ([SPC-OFP, 2026a](#)). The remaining components of the HCRs can be specified through different HCR formulations. A single HCR formulation is used for the evaluations presented in this report. An additional formulation is considered in [SPC-OFP \(2026c\)](#).

The parameters of all HCRs evaluated in this report, along with plots of their shapes, can be seen in the supporting information ([SPC-OFP, 2026d](#)).

Table 2: The MPs that have been designed to achieve the different targets under the different bigeye MP spatial/fishery scenarios.

Scenario	Lower TRP	60% above lower	70% above lower	Upper TRP
		TRP	TRP	
TLL (excl. HW)	MP 17	MP 18	MP 19	MP 20
TLL (incl. HW)	MP 13	MP 14	MP 15	MP 16
WCPO (excl. SIDS)	MP 5	MP 6	MP 7	MP 8
WCPO wide	MP 9	MP 10	MP 11	MP 12

3.1 Management procedure outputs

BMW01 agreed that BET MP evaluations should proceed using longline catch limits as the longline output control. The longline HCR of a HCR pair therefore sets a catch limit for the longline fisheries that are managed through the MP. The FAD HCR sets an EEZ FAD open period i.e. the HCR allows for a longer open period at higher estimates of stock status.

A ratio of approximately 3 months EEZ and 5 months high seas closure, rounded to the nearest quarter month (week), is used in the evaluations, consistent with recent FAD closure periods. For example: 1.5 months EEZ & 2.5 months high seas closure, and 3 months EEZ & 5 months high seas closure. This is converted to months open in the evaluations and HCR design.

BMW01 also noted that implementation may differ from the MP output; for example, although the MP output may be catch-based, some fisheries, including in PNA waters, may be implemented through effort-based arrangements such as the Vessel Day Scheme.

The overall longline catch set by the MP depends on the spatial/fishery scenario (Table 1). Implementation issues, such as flag-based catch limits or SIDS exemptions, are not explicitly considered in the evaluations. Instead, in the evaluations all longline fisheries managed through the MP have their catches adjusted by the same proportion, thereby producing a total longline bigeye catch for that managed component. Allocation of that catch is outside the MP process.

The spatial/fishery bigeye MP scenario in which the bigeye MP applies to longline fisheries across the WCPO excluding SIDS flagged vessels is broadly consistent with the existing Tropical Tuna Measure. It is therefore possible to estimate an approximate longline scalar for application to TT-CCM table 3 under the bigeye MP (see Appendix).

3.2 Evaluating a continuum of HCRs

Each time the MP is evaluated the estimation method is run to calculate an estimate of stock status (measured as $SB/SB_{2012-2015}$). In practice, the pair of HCRs used to set the bigeye MP-managed longline catch/effort limit and the FAD closure period to achieve the adopted TRP may then be negotiated by the Commission. These pairs of HCRs exist along the continuum defined by the

nuclear grids, for example, along the border between the regions that would achieve the lower TRP and of falling below that lower TRP at different levels of longline bigeye catch and FAD closure period (SPC-OFP, 2026a).

Obviously, the outcomes of these future negotiations are currently unknown: it is not possible to know which pairs of HCRs will actually be used in the future. WCPFC22 specified that the work should “Evaluate a range of HCRs controlling the tropical longline and tropical purse seine fleets, at different levels of FAD closure length (from 0 to 3 months) and tropical longline catch and/or effort, that form the basis of a continuum of MPs all tuned to achieve the same TRP” (WCPFC22 summary report, para 461b).

In these evaluations three pairs of HCRs are designed within a single MP: ‘FAD favoured’, ‘intermediate’ and ‘longline favoured’, where each attempts to achieve similar stock outcomes while distributing management responsibility differently between longline and purse seine fisheries (SPC-OFP, 2026d).

Table 3: EEZ and high seas FAD open periods for the three sets of HCR pairs for each MP.

HCR pair	EEZ FAD open period (months)	High seas FAD open period (months)
FAD favoured	12.0	12.0
Intermediate	10.5	9.5
Longline favoured	9.0	7.0

The FAD open period for each HCR pair is shown in Table 3. These represent the recent limits of the FAD closure period, as guided by WCPFC22. A ratio of approximately 3 months EEZ and 5 months high seas closure, rounded to the nearest quarter month (week), converted to open period is used.

Each candidate MP is then evaluated using three HCR pair selection scenarios:

- Only using the ‘FAD favoured’ pair;
- Only using the ‘longline favoured’ pair;
- Randomly selecting between the ‘FAD favoured’, ‘intermediate’ or ‘longline favoured’ pair each time the MP is evaluated.

It would be expected that all three HCR pair selection scenarios achieve the same objective in terms of long-term stock status but would potentially have different fishery outcomes, e.g. the distribution of catches of bigeye between the longline and purse seine fisheries.

Only using the ‘FAD-favoured’ or ‘longline-favoured’ pair can be considered as ‘edge’ cases which simulate the possible limits of the MP. Randomly selecting between three pairs offers the greatest potential variability in catch limits and FAD closure periods.

3.3 Meta-rules and constraints

BMW01 did not agree on specific meta-rules or constraints on the maximum change in fishing pressure between management periods. It was suggested that there may not be a need for the constraints to be specified by the MP as bigeye MP allocation and implementation arrangements would ultimately involve negotiated outcomes. This is reflected in the ‘random’ HCR scenario described above, in which the HCR pair used in any one management period does not depend on the HCR pair used in the previous management period, i.e. is effectively unconstrained. The role of meta-rules and constraints may be clarified under Agenda Item 6 (operational and implementation arrangements).

4 Performance indicators

Relative performance of the candidate MPs is evaluated by comparing calculated performance indicators. BMW01 agreed that the following candidate performance indicators should be used for the bigeye MP evaluations:

1. Stock status ($SB/SB_{F=0}$) in the WCPFC-CA, (measured as $SB_{\text{latest}}/SB_{F=0}$, i.e. SB in year y relative to the average $SB_{F=0}$ in years $y-10$ to $y-1$);
2. Proximity to the TRP, with threshold TRPs reported as probability of being above the TRP;
3. Probability that $SB/SB_{F=0}$ is above the Limit Reference Point, noting that the WCPFC requires the probability to be greater than 0.8;
4. Expected bigeye catch for fisheries managed through the bigeye MP, reported separately for longline and purse seine where feasible;
5. Expected vulnerable biomass for longline fisheries managed through the bigeye MP, as a proxy for catch rates. Here it is calculated as vulnerable biomass in the tropical regions relative to the average vulnerable biomass in the period 2019-2021. The expected relative vulnerable biomass for the FAD-associated purse seine fisheries is also presented;
6. Catch variability for fisheries managed through the bigeye MP, separated for longline and purse seine where feasible;
7. Effort variability for fisheries managed through the bigeye MP, separated for longline and purse seine where feasible;
8. F relative to F_{MSY} ; and
9. MSY .

The MSY based performance indicators are not yet available but will be in the future.

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

- Short (2028-2036)
- Medium (2037-2045)
- Long (2046-2054)

5 Results

This section presents a summary of the results using the performance indicators.

The results are presented using box plots in two different time periods: short-term (2028-2036) and long-term (2046-2054). The box and whiskers of the box plots 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.

The results using HCRs based on a single HCR formulation are considered here. A comparison with the performance of HCRs based on an alternative HCR formulation is presented in [SPC-OFP \(2026c\)](#). 1152 stochastic simulations are performed for each of the three HCR pair scenarios ('FAD favoured only', 'longline favoured only', 'random'), for each MP.

The results focus on two areas:

- Comparing across different TRP objectives
- Comparing across spatial/fishery bigeye MP scenarios

To facilitate comparison of results between spatial/fishery scenarios and TRP options, only the results from the 'random' HCR pair scenario are included here. The results from the 'FAD favoured only' and 'longline favoured only' scenarios are included in the supporting information ([SPC-OFP, 2026e](#)). Additionally, only the short- and long-term results are presented here. Full results for each MP can be seen in the supporting information ([SPC-OFP, 2026e](#)).

As noted previously, three different HCR scenarios are run for each MP, where a different HCR pair out of the three pairs defined for the evaluations may be selected in each management period. The full results show that the fishery performance indicators are affected by the HCR scenario, i.e. which of the HCR pairs are used in the evaluations. In practice, the HCR pair that is used in each management period will be a negotiated outcome and may include HCR pairs not evaluated here, but exist on the continuum of possible HCRs. As such, the expected results are illustrative only and the real results will ultimately depend on the HCR pairs that are selected.

5.1 Brief summary of results

TRP objectives

The selection of the TRP objective impacts several performance indicators.

The lower the TRP objective, the lower the probability of being above the Limit Reference Point (LRP). However, for all MPs evaluated the probability of being above the LRP was above 80%, the WCPFC's requirement.

The TRP objective also affects the expected bigeye catch levels of the longline fisheries managed through the bigeye MP, with the lower the TRP objective the higher the catch level, within a

spatial/fishery scenario. There is also a small impact on purse seine catches where lower TRP objectives result in slightly lower levels of catch, within a spatial/fishery scenario.

The expected relative vulnerable biomass increases with TRP objective, most notably for the longline fisheries, i.e. the lowest vulnerable biomass occurs under the lower TRP (50%) objective.

Spatial/fishery scenario

The choice of spatial/fishery scenario has little impact on the biological indicators (the expected spawning biomass depletion, and probability of being above the LRP). However, the choice does affect the fishery based indicators (Figure 4).

Care must be taken when comparing fishery based indicators between the four bigeye MP spatial/fishery scenarios as they manage different groups of longline fisheries (Table 1). The results will be partly driven by the impact of assumptions made about fisheries not managed through MP.

5.2 Biological indicators

Probability of being above the Limit Reference Point

A key performance indicator is the probability of the spawning biomass depletion being above the Limit Reference Point (LRP), noting that the WCPFC requires the probability to be greater than 0.8.

Comparing this probability across TRP objectives and spatial/fishery scenarios shows that the lowest probability occurs with the lower TRP as the objective (Table 4). The long-term probabilities are similar across spatial/fishery scenarios and HCR pair scenarios ('FAD favoured', 'longline favoured' and 'random').

Table 4: Probability of being above the LRP in the long-term, for each TRP objective and spatial/fishery scenario for the 'random' HCR pair scenario.

Target	TLL (excl. HW)	TLL (incl. HW)	WCPO (excl. SIDS)	WCPO wide
Lower TRP	0.88	0.88	0.88	0.89
60% above lower TRP	0.93	0.92	0.93	0.94
70% above lower TRP	0.95	0.96	0.96	0.96
Upper TRP	0.95	0.94	0.95	0.95

Expected depletion levels

The short- and long-term $SB/SB_{F=0}$ under different MPs is shown in Figure 1. Each MP is designed to achieve a specific TRP objective under a different spatial/fishery scenario. The results are unaffected by the HCR pair scenario, i.e. 'longline favoured', 'FAD favoured' and 'random' scenarios show similar results for this indicator (SPC-OFP, 2026e).

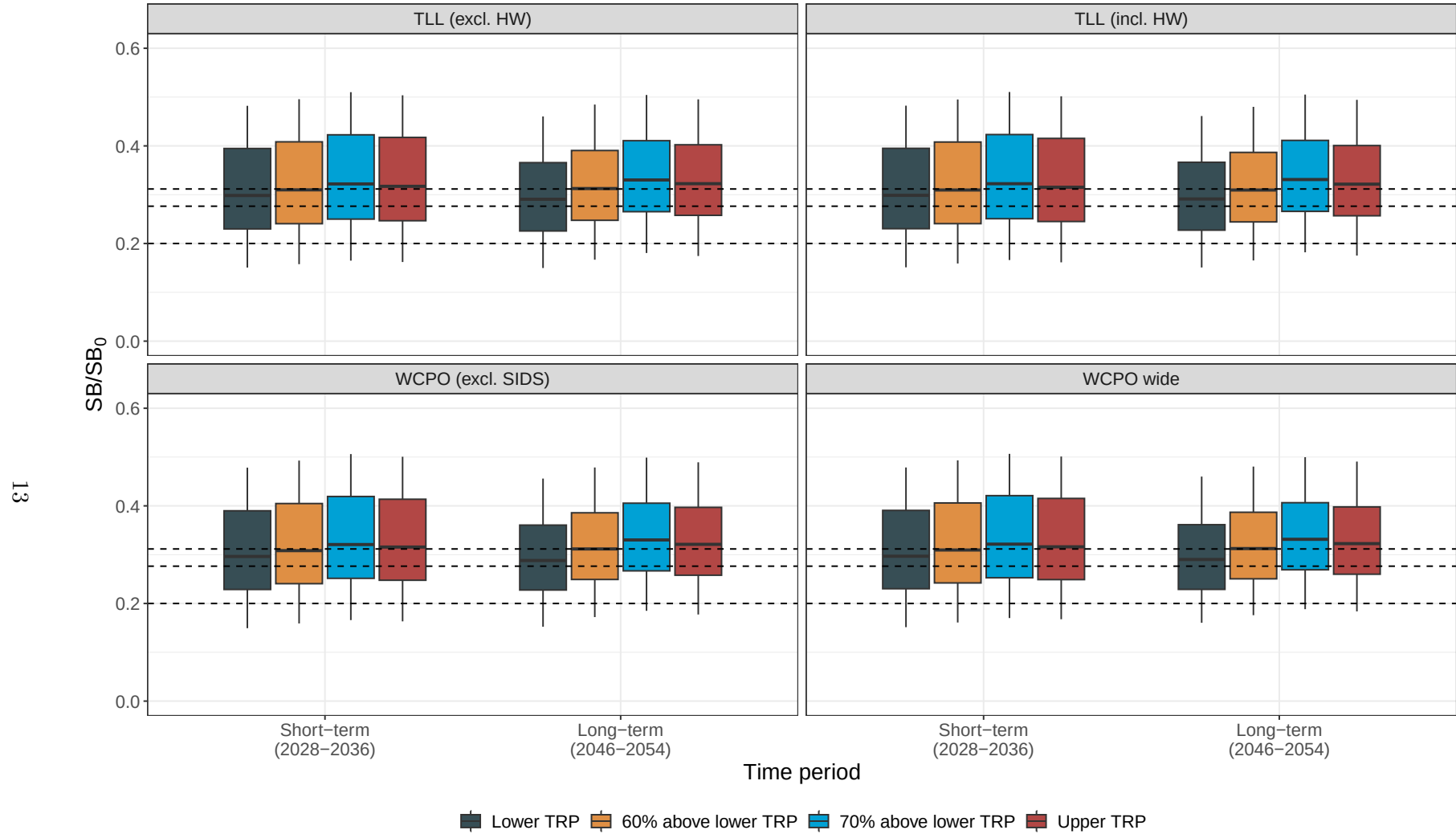


Figure 1: Box plots of spawning biomass depletion in the WCPFC-CA in the short- and long-term. In each spatial/fishery scenario each box is an MP designed to achieve a specific TRP objective. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value. The dashed horizontal lines show the upper and lower candidate TRPs, and the LRP.

The results from the other HCR pair scenarios and the probabilities of being above the different TRPs can be found in the supporting information (SPC-OFP, 2026e).

The median depletion levels at 60% and 70% probability of being above the lower TRP are approximately 1.03 and 1.11 x 2012-2015 average spawning biomass depletion, i.e. the median depletion level at the 70% probability of being above the lower TRP is higher than the upper TRP.

The resulting $SB/SB_{F=0}$ is slightly above the target TRP in all cases. This is because during the evaluations a small proportion of HCR inputs are estimated to be to the left of the Hillary step (SPC-OFP, 2026c). This results in lower levels of fishing that would occur had the HCR input remained on the step. The average level of fishing is therefore slightly lower than that set by the Hillary steps (from the nuclear grids) leading to slightly higher average levels of stock status. This is a result of the TRPs from the updated OM grid, requested by SC22, being close to the LRP, resulting in more frequent reductions in fishing pressure than with the OM grid based on the accepted 2023 assessment.

5.3 Fishery based indicators

As mentioned above, care must be taken when comparing the fishery based indicators between spatial/fishery scenarios as different groups of longline fisheries are managed through the bigeye MP and different assumptions are made in each scenario.

The indicator values are dependent on the HCR pair scenario, e.g. ‘FAD favoured’, ‘longline favoured’ or ‘random’. Only the ‘random’ HCR pair scenario are shown in the following figures to simplify comparison. The ‘random’ scenario incorporates the expected ranges of results under the ‘FAD favoured’ and ‘longline favoured’ scenarios. The actual values will depend on which HCR pairs are actually used in each management period. However, the figures allows comparison between the expected relative values across TRP objectives and spatial/fishery scenarios.

Expected catches

The expected bigeye catches of the longline fisheries managed through the bigeye MP and FAD associated purse seine fishery in the short- and long-term under each spatial/fishery scenario are shown in Figure 2 .

Each spatial/fishery bigeye MP scenario manages different groups of longline fisheries. As expected, the total catch managed through the MP changes with the scenario (see also Figure 4). The expected catch of the purse seine fisheries is unaffected by the spatial/fishery scenario.

The expected level of catch for the longline fishery is determined by the target TRP. The lower the target TRP, the higher the level of longline catch. For example, the highest catches occur with MPs designed to achieve the lower TRP.

Conversely, achieving the less depleted TRPs results in slightly higher purse seine catches than

achieving the more depleted TRPs. Each HCR pair scenario has the same level of purse seine fishing effort on average across the TRPs, e.g. for the ‘FAD favoured only’ scenario, the level of purse seine fishing effort is the same for each MP. The higher the effort, the higher the catch, for a fixed level of stock abundance. Under an MP that achieves a higher stock status, e.g. MPs that are designed to achieve the upper TRP, the ‘FAD favoured only’ scenario would therefore result in higher catches than under an MP designed to achieve a lower stock status, e.g. those designed to achieve the lower TRP. In general, there are limited impacts on purse seine catches across the different spatial scenarios and TRPs (see also Figure 4).

There is very little uncertainty in the longline catches as the MP sets a catch limit for these fisheries every management period (three years). The whiskers on the distributions of the catches are caused by the HCR input falling to the left of the Hillary step due to a combination of low estimated stock status and the TRP objective being close to the LRP with the updated OM grid, and therefore setting a lower catch limit.

There is greater uncertainty in the FAD associated purse seine catches. This fishery is effort managed (the MP sets the FAD closure period in each management period, and therefore how the total purse seine effort is distributed between FAD associated and free school). As the stock abundance varies in time, the catches taken will also vary in time leading to greater uncertainty.

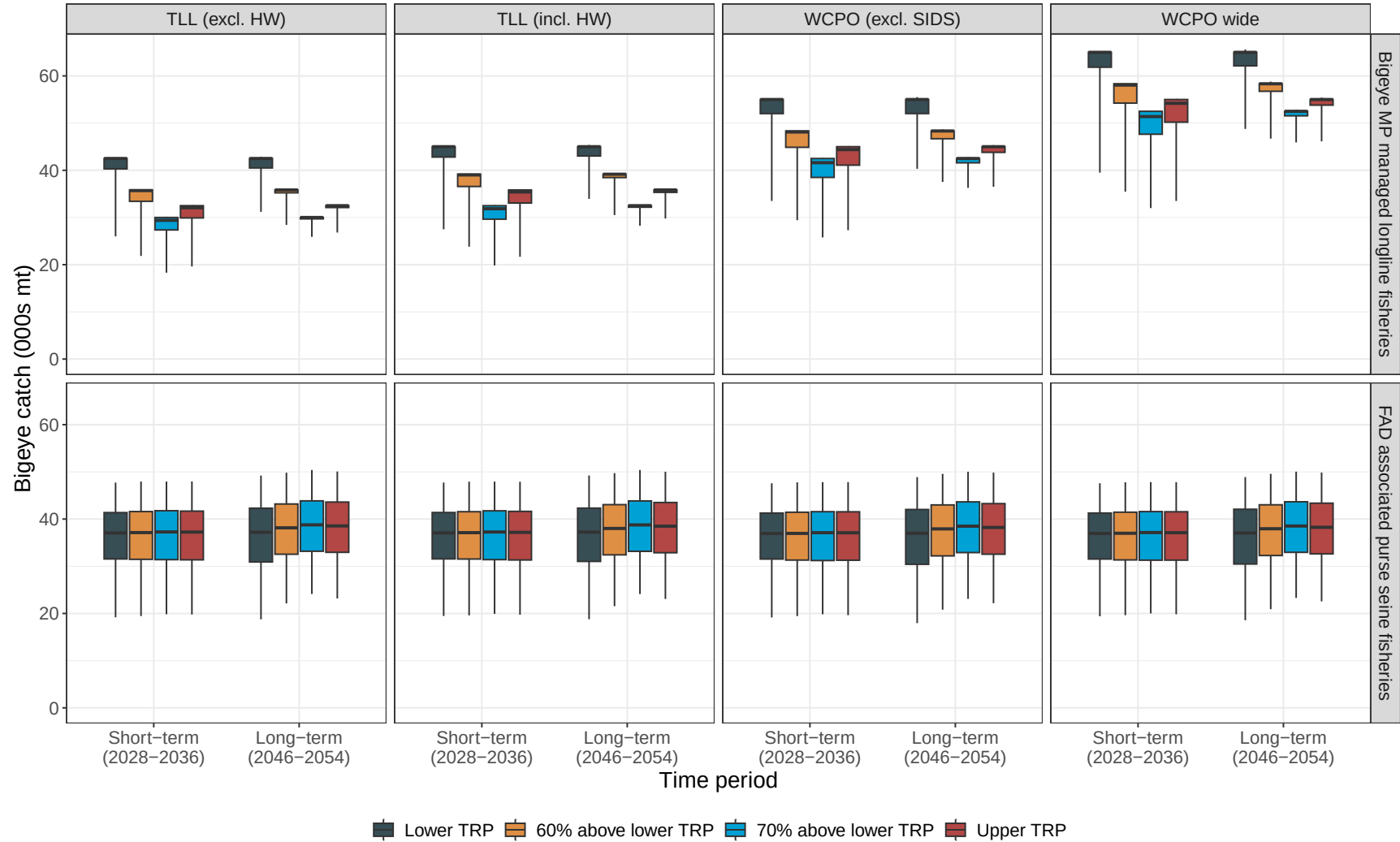


Figure 2: Expected annual bigeye catch (000s mt) of the longline fisheries managed through the bigeye MP (top row) and FAD associated purse seine fishery (bottom row) in the short- and long-term under each spatial/fishery scenario (columns), for the 'random' HCR pair scenario. Each box is an MP designed to achieve a specific TRP objective. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

Relative vulnerable biomass

Vulnerable biomass is the biomass that is available to a fishery through the selection pattern and is considered to be a proxy for catch rates (Figure 3). Here it is calculated for the tropical regions and presented as relative to the average vulnerable biomass in 2019-2021. The expected relative biomass is lower than the 2019-2021 average level for both the longline fisheries managed through the bigeye MP and the FAD associated purse seine fisheries, consistent with previous analyses, for all spatial/fishery scenarios and TRP objectives.

The FAD associated purse seine fishery selects smaller individuals, whereas the longline fishery selects larger individuals (Scott et al., 2026b), giving rise to the differences in expected vulnerable biomass between these fisheries.

Increases in long-term stock status, measured as $SB/SB_{F=0}$ (Figure 1), result in increases in expected vulnerable biomass for the longline fishery, e.g. comparing the expected vulnerable biomass designed to achieve the lower and upper TRPs. However, there are only moderate increases in vulnerable biomass for the purse seine fishery. This is potentially because the individuals that are selected by the FAD associated purse are too small to contribute to the spawning biomass used as the TRP stock status measure.

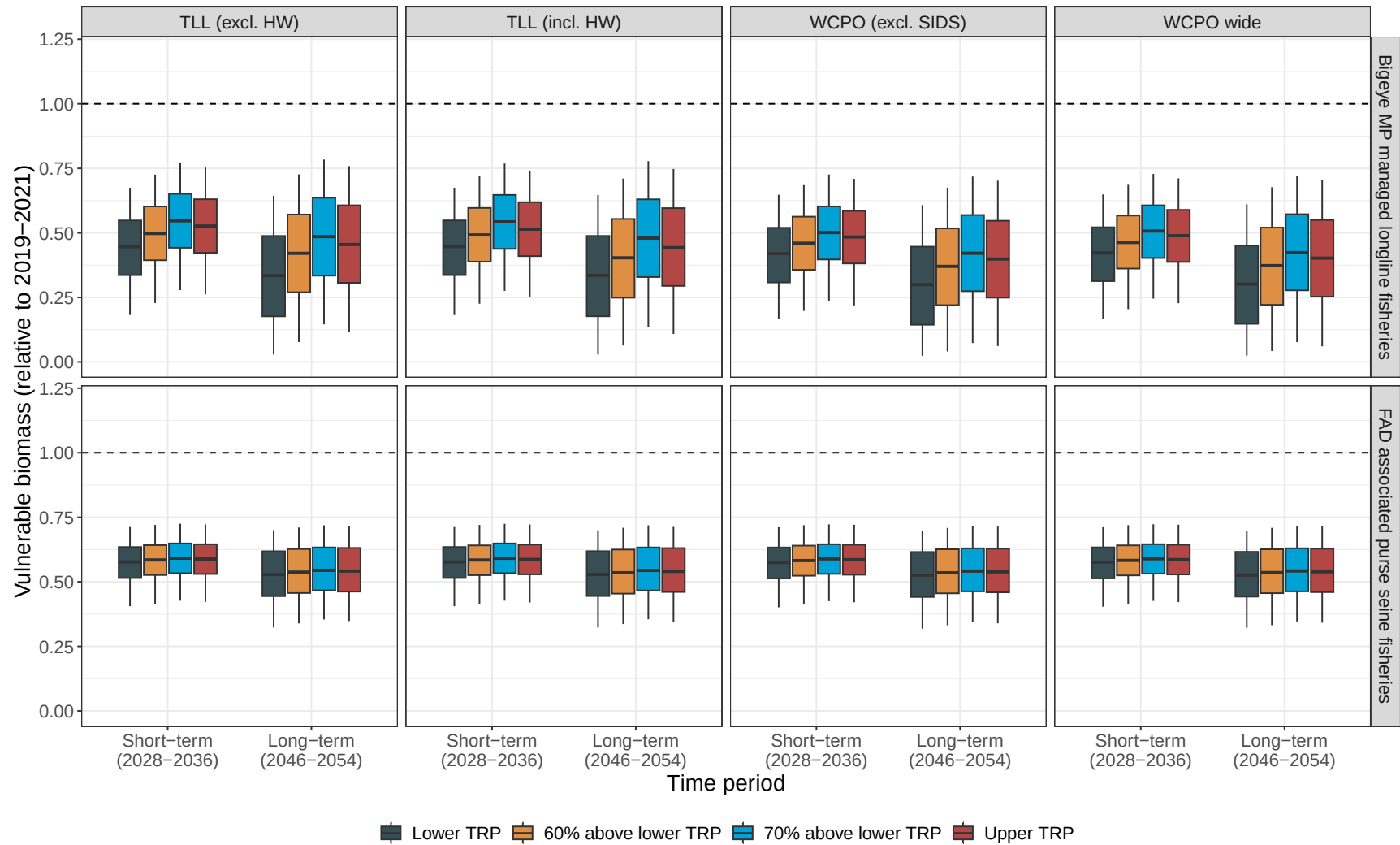


Figure 3: Expected vulnerable biomass in the tropical regions, relative to the average level in 2019-2021, of the longline fisheries managed through the bigeye MP (top row) and FAD associated purse seine fishery (bottom row) in the short- and long-term under each spatial/fishery scenario (columns), for the ‘random’ HCR pair scenario. Each box is an MP designed to achieve a specific TRP objective. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value. The dashed horizontal line shows the relative average level in 2019-2021.

Catch and effort variability

Catch and effort variability is measured as the absolute change in catch and effort between years. Figures of these indicators are not shown here, but the full results can be found in the supporting information ([SPC-OFP, 2026e](#)).

The MP sets a catch limit for the longline fisheries every three years. It should be noted that the levels of catch and effort variability are defined by the ability to switch between any of the three HCR pairs evaluated, e.g. swapping between ‘FAD favoured’, ‘longline favoured’ and ‘intermediate’ pairs. Under the ‘random’ HCR scenario there is no constraint or meta-rule applied to which HCR pair is selected, i.e. the selected HCR pair can go from ‘longline favoured only’ to ‘FAD favoured only’ between management periods. In practice, a negotiation of the FAD closure/longline catch combination desired to achieve the TRP for a management period will lead to different variability. The catch and effort variability results must therefore be interpreted with care, given the strong influence of the implemented methodology and range of option states defined by WCPFC22.

Under the ‘FAD favoured only’ and ‘longline favoured only’ HCR scenarios there is very little variability in the catches of the longline fisheries as the HCR input mostly remains on the Hillary step ([SPC-OFP, 2026c](#)). Under the ‘random’ HCR pair scenario, different HCR pairs are potentially selected every three years, each one setting different longline catches. The ‘random’ HCR pair scenario therefore produces some catch variability for the longline fisheries.

The FAD associated purse seine fisheries are managed by the setting of effort limits, through the FAD closure period. There is therefore always some catch variability as the stock abundance is variable in time. This variability is greater under the ‘random’ HCR scenario.

For effort variability the situation is reversed, with low variability for the purse seine fisheries and higher variability for the longline fisheries.

5.4 Comparing between bigeye management procedure spatial scenarios

As mentioned above, care must be taken when comparing results between the bigeye MP spatial/fishery scenarios, as different groups of fisheries are managed under each scenario and fixed catch or effort assumptions are made for fisheries not managed through the bigeye MP. The median long-term (2046-2054) catches of fisheries potentially managed through the MP (FAD associated purse seine, and the various longline fisheries) in each bigeye MP spatial scenario are compared in Figure 4.

Under each TRP objective, the total catch of bigeye is approximately the same across the bigeye MP spatial scenarios. However, the distribution of those catches between fisheries is different across TRP and spatial scenarios. The primary difference in total estimated catch results from the TRP considered, with a difference of approximately 10,000 mt between the lower TRP and lower TRP with a 70% threshold.

The FAD associated purse seine catches are constant across bigeye MP spatial scenarios. The catches of the southern longline fishery (projected on constant levels of effort in the evaluations), and non-US longline fisheries (projected on constant levels of catch in the evaluations) are largely unaffected by the TRP or bigeye MP spatial scenario.

Under the spatial scenario in which the portion of the Hawaiian longline fleet operating south of 20°N is excluded from being managed through the MP, the catches of that portion are fixed at 2600 mt p.a. This difference can be seen when comparing the catches of the Hawaiian longline fleet and the TLL, under the two scenarios when the TLL is managed through the MP, i.e. including and excluding the Hawaiian longline fleet.

The implementation and allocation arrangements for outputs of the bigeye MP remain matters for future discussion, noting that several CCMs have emphasised the need to ensure consistency with existing management systems and existing TTM arrangements ([WCPFC, 2026](#)).

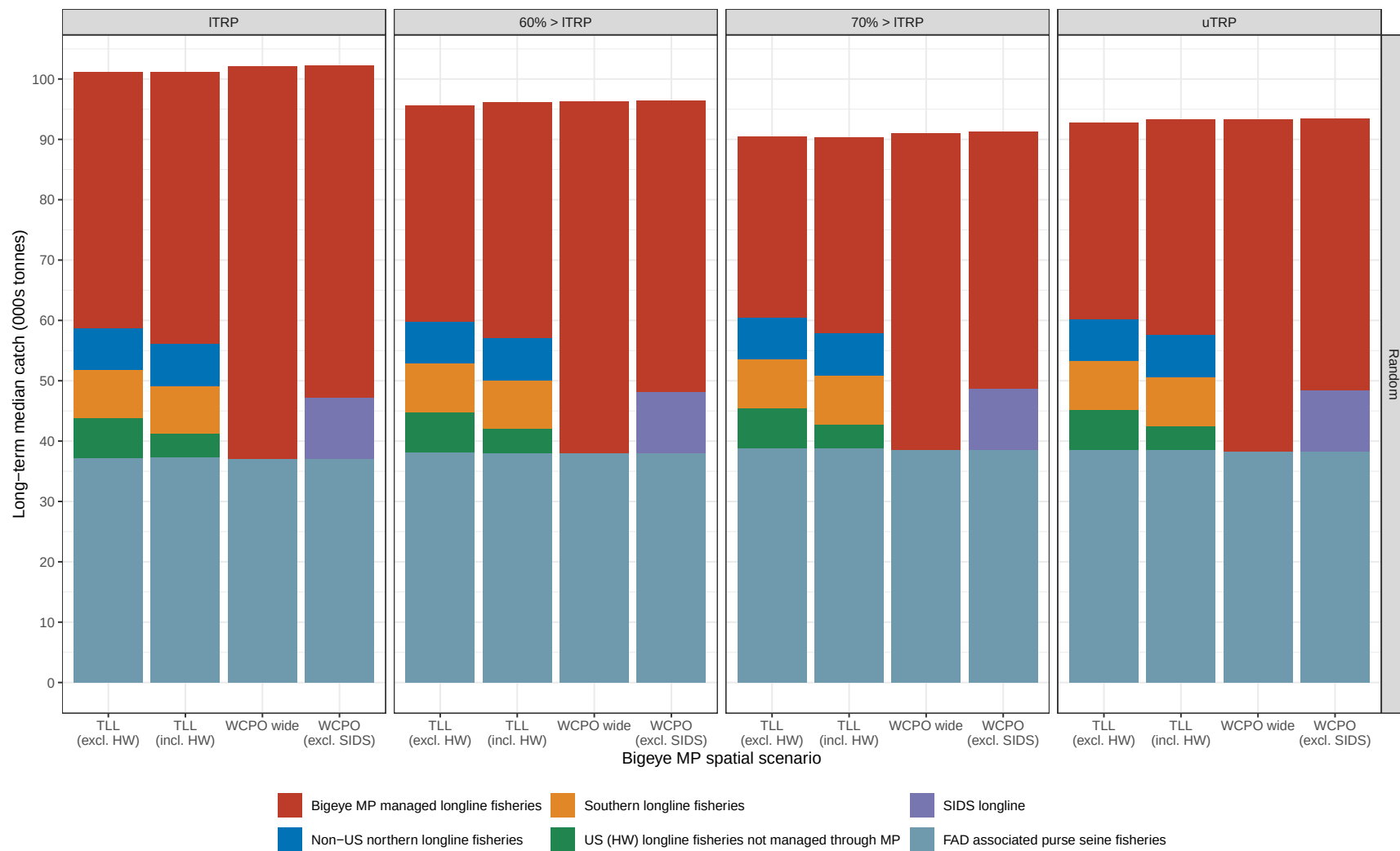


Figure 4: Bar chart of expected median long-term (2046-2054) bigeye catches by fisheries potentially managed through the bigeye MP in each bigeye MP spatial scenario, under alternative TRP objectives (columns), for the 'random' HCR pair scenario.

6 Further work

Additional work will include the calculation of the two requested MSY based performance indicators not presented in this report. Sensitivity testing of assumptions for fisheries not managed through the bigeye MP will also be conducted in the future for specific MPs, in particular the future levels of fishing effort or bigeye catch by the domestic fisheries in Indonesia, Philippines and Vietnam. Noting the limited time between BMW02 and WCPFC23, any further work will need to be prioritised and BMW02 may wish to provide guidance.

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Declaration of generative AI and AI-assisted technologies in the SC paper preparation process

No AI technologies were used in the preparation of this paper.

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Appendix: Calculation of scalars for FAD closure periods and longline catches

The nuclear grid represents the long-term bigeye stock outcomes in terms of depletion relative to the levels in 2012-2015 under alternative scenarios for future longline catch levels and purse seine FAD closure period durations. Development of the grid involves running long-term stock projections across the range of Operating Models (OMs) that capture plausible states of nature.

Implementing this requires the identification of the likely level of fishing (purse seine FAD sets, longline catch) for the relevant fishery units under each scenario. This used the same approach as used for the evaluations of the tropical tuna CMM (e.g. SC22-MI-IP-04).

For purse seine:

- A baseline period of 2019-2021 was used. Over this period a 3 month EEZ FAD closure and 5 month high seas FAD closure was in place.
- Given the assumption that the skipjack MP implied a total effort equal to 2012 levels, a scalar of 1.17 was applied to the number of FAD sets during this period (EEZ/high seas), to raise effort up from 2019-2021 levels to those seen in 2012. This represents a ‘scaled’ baseline period.
- The level of FAD effort under alternative FAD closure periods (EEZ and high seas) was calculated from that scaled baseline period. As an example, for a reduction of one month of EEZ FAD closure, an additional 1/9th FAD sets from the baseline level would be assumed (there being 9 months available for EEZ FAD fishing during a 3 month closure). A similar approach is taken for the high seas component (a month being an additional 1/7th FAD sets).
- The resulting total number of sets is related to the 2019-2021 baseline level to develop the scalar required for projections.

The approach used for FAD modelling assumes a direct relationship between the change in FAD closure duration and the number of FAD sets resulting. It therefore does not assume that a greater rate of FAD setting might occur as the FAD closure period is reduced. In turn, unusual situations such as those seen in 2024, where very low total FAD set numbers were seen compared to expected levels, would not be captured. This would form a part of the monitoring strategy for the bigeye MP.

For longline:

- A baseline period of 2019-2021 was used.

We highlight that the baseline period selected for purse seine and longline has no implications in this process – the key issue is the absolute level of fishing being considered. A different baseline would imply a different scalar but would result in the same absolute level of fishing/stock impact.

Appendix: Approximate Tropical Tuna Measure longline catch scalar

The spatial/fishery bigeye MP scenario in which the bigeye MP applies to longline fisheries across the WCPO excluding SIDS flagged vessels is broadly consistent with the existing Tropical Tuna Measure. It is therefore possible to estimate an approximate longline scalar for application to TT-CCM table 3 under the bigeye MP.

The resulting expected longline catch managed through the bigeye MP for the WCPO excluding the SIDS flagged vessels does not include the expected catches in the WCPFC-CA overlap area. The average catches of bigeye in the overlap area in the period 2015-2024, excluding SIDS catches, are approximately 4800 mt.

The sum of the country specific limits in table 3 is 63,355 mt. Taking the expected bigeye MP managed longline catch from the scenario in which the bigeye MP manages the longline fisheries in the WCPO excluding SIDS flagged vessels, adding on an assumed level of catches in the overlap area based on 2015-2024 levels (4800 mt), and dividing by the table 3 sum of the country specific limits (63,355) mt will therefore yield an approximate longline scalar.

An example plot of expected approximate longline scalar is shown below (Figure 5). In this figure the expected catches have been rescaled to be the longline scalar. This plot is based on Figure 2 in the main results section, but only shows the longline bigeye MP catches under the WCPO excluding SIDS flagged vessels scenario.

Note that this approximate scalar is based on current values in the measure and may be affected by any increases to the table, for example through additional observer coverage. The scalar should be treated with caution and is offered as an approximate guide.

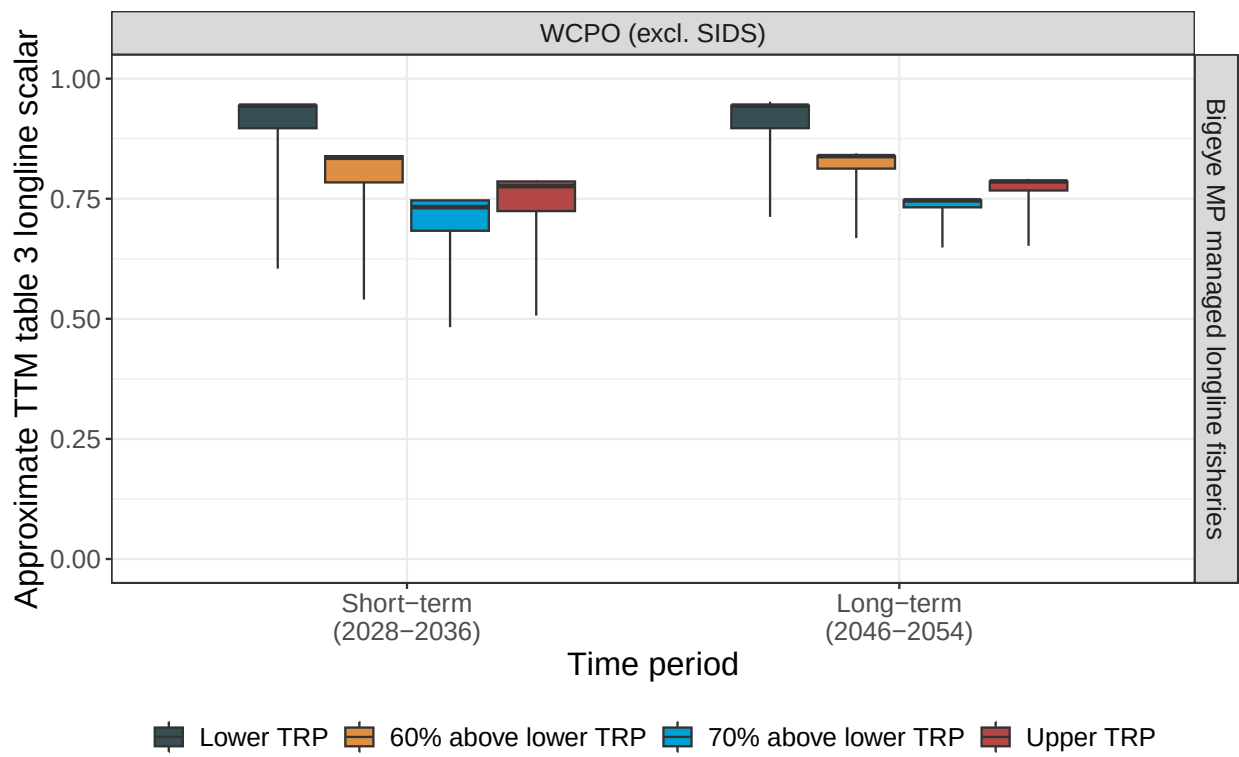


Figure 5: Expected approximate longline scalar for application to TT-CCM table 3 under the bigeye MP in the short- and long-term based on the scenario in which the bigeye MP manages longlines in the WCPO excluding SIDS, for the 'random' HCR pair scenario. Each box is an MP designed to achieve a specific TRP objective. The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.