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BIGEYE TUNA MANAGEMENT PROCEDURE EVALUATIONS

WCPFC-SC22-2026-MI-WP04
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Submitted by

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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 preliminary evaluations of proposed candidate bigeye MPs. Performance indicators are calculated and used to compare the relative performance of the candidate MPs.

WCPFC22 requested that a range of harvest control rules (HCRs, a key component of an MP) be evaluated that control the tropical longline (TLL) and tropical purse seine fleets, at different levels of TLL catch and/or effort and FAD closure length. The proposed bigeye MP, presented at the first WCPFC Bigeye Management Workshop (BMW01), 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 closure period, i.e. the longer the FAD closure 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 closure period and the longline catch/effort limit, in each management period would be negotiated by the Commission.

As requested by BMW01, three bigeye MP spatial scenarios are evaluated, each of which specifies different longline fisheries that would be managed through the bigeye MP. Given time constraints, BMW01 specified four different candidate Target Reference Points (TRPs) to be evaluated in the short-term. However, an additional candidate TRP has been evaluated here. The MPs are therefore designed around five TRPs, based around long-term spawning biomass depletion being above the 'lower' TRP (0.94 x 2012-2015 average spawning biomass depletion) and 'upper' TRP (1.06 x 2012-2015 average spawning biomass depletion) with probabilities of 50% and 70%, with an additional probability of 60% 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. Instead, 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. 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 presented below 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.

SC22 is invited to:

- Review the technical implementation of the WCPFC22 and BMW01 requests in the development of the bigeye MPs;
- Consider the preliminary results of the evaluations and provide advice to the BMW02 on key outcomes.
- Note that the performance indicators for catch and effort variability are significantly influenced by the technical implementation;
- Note the volume of results arising and provide guidance on how these can be effectively presented to managers;
- Request SC guidance on proposed further work priorities between SC22 and BMW02.

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.

The WCPFC mixed fishery framework is described in WCPFC-SC22-2026/MI-WP-03, including summaries of recent guidance and decisions made at WCPFC22 and the first WCPFC Bigeye Management Workshop (BMW01) (Scott et al., 2026a). The initial WCPFC mixed fishery approach proposed that longline fisheries operating between 20°N and 10°S, referred to as the tropical longline (TLL) fishery, would be managed through the bigeye MP. Other fisheries that catch bigeye are managed through the MPs for skipjack (purse seine, pole and line, domestic fisheries of Indonesia, Vietnam and the Philippines - excluding those operating in archipelagic waters), and South Pacific albacore (southern longline fishery that operates south of 10°S). The stock status of bigeye would therefore be influenced not just by the bigeye MP, but also by the skipjack MP and, to a lesser extent, the South Pacific albacore MP.

Discussions on the bigeye MP at WCPFC22 focussed on the relatively small proportion of bigeye catch that would be controlled through the bigeye MP if the MP only managed the TLL (approximately 27% of 2020-2022 average levels) and 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 TLL and tropical purse seine fleets, at different levels of TLL catch and/or effort and FAD closure length, 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 closure period. 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 preliminary evaluations of proposed candidate bigeye MPs. 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 range of longline fisheries managed through the bigeye MP were proposed at BMW01 for evaluation (Table 1).

Table 1: Spatial ranges of the bigeye management procedure scenarios agreed at BMW01.

Scenario	Fisheries managed through the bigeye MP
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.
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.
WCPO wide	All longline fisheries in the WCPO (i.e. from 50°N to 50°S), including Hawaiian longline fleet.

For the scenario in which all longline fisheries in the WCPO are managed through the bigeye MP, 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).

Noting the workload defined by BMW01, the candidate TRPs were specific to the spatial range of the bigeye MP:

- Evaluate the three candidate spatial ranges for one TRP level (e.g. 0.94 x 2012-2015 average spawning biomass depletion, 50% probability).

- Evaluate the four candidate TRP levels for one spatial range (e.g. the 20°N-10°S tropical longline, excluding the Hawaii longline fishery).

Ultimately it proved feasible to additionally evaluate the upper TRP at the 70% threshold. This report therefore presents the results from evaluating 15 MPs, across the three spatial bigeye MP scenarios, for five different TRPs, including those with probability thresholds. The results presented in this report should be considered as preliminary.

Feedback from SC22 will be incorporated into future evaluations to be presented at BMW02, where feasible.

2 Management Strategy Evaluation framework

2.1 Operating models

The evaluations use the candidate operating model (OM) grid of 480 models described in WCPFC-SC22-2026/MI-WP-01, 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 (Scott et al., 2026b). The candidate OM grid includes uncertainty in steepness, growth, natural mortality, tag mixing, future levels of effort creep on purse seine and longline fisheries and future recruitment variability.

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 effort 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 the domestic fisheries in Vietnam, Indonesia, and the Philippines 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. For the evaluations presented here the same assumptions were made as when generating the 'nuclear grid' to design the HCRs (Scott et al., 2026a), noting that the assumptions change depending on the bigeye MP spatial scenario (see Table 4 and Table 5 in the Appendices).

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'. Here we assume that 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).

The future effort of the purse seine fisheries is fixed at 2012 levels, 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).

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 Indonesia, Philippines and Vietnam.

3 Management procedure design

For a detailed discussion on the proposed design of the bigeye candidate MPs see WCPFC-SC22-2026/MI-WP-03 (Scott et al., 2026a).

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 ($SB/SB_{2012\text{-}2015}$), 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 (BMW01-A5_Pres_01_Rev2), 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. 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 closure period, i.e. the longer the FAD closure period, the higher the longline catch of bigeye to achieve the same long-term outcome.

Each of the three bigeye MP spatial scenarios described in Table 1, and each of the candidate TRPs considered here (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 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. With this design, the estimated stock status ideally remains on the 'step' of the HCR as it fluctuates in time. The heights of the Hillary steps should therefore set the catch or effort limit of the longline fisheries managed through the bigeye MP and the FAD closure period that are consistent with achieving the TRP objectives in the long-term. The heights of the steps are derived from running long-term projections at different levels of future longline catch and different FAD closure periods. This combination of different longline and FAD associated purse seine fishing pressure is referred to as a 'nuclear grid' and is explained in more detail in WCPFC-SC22-2026/MI-WP-03 (Scott et al., 2026a). There is a separate nuclear grid for each bigeye MP spatial scenario, and they are used to assist the design of the HCR pairs that are evaluated here.

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

Scenario	Lower TRP	60% above lower TRP	70% above lower TRP	Upper TRP	70% above upper TRP
TLL (excl. HW)	MP 4	MP 5	MP 6	MP 7	MP 9
TLL (incl. HW)	MP 13	MP 14	MP 15	MP 16	MP 18
WCPO wide	MP 22	MP 23	MP 24	MP 25	MP 27

3.1 Management procedure outputs

BMW01 agreed that BET MP evaluations should proceed using longline catch limits as the longline output control and purse seine FAD closure period as the purse seine output control. The longline HCR of a HCR pair therefore sets a catch limit for the longline fisheries that are managed through the MP. Note that the FAD HCR sets an EEZ FAD open period, not closed period, i.e. the HCR allows for a longer open period at higher estimates of stock status. This is consistent with general HCR shapes where fishing pressure can be greater at higher estimates of stock status, and facilitates

plotting of the HCR. Of course, it is straightforward to convert from an open period to a closed period.

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.

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 range scenario (Table 1). Implementation issues, such as flag-based catch limits or SIDS exemptions, are not 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.

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 $SB/SB_{2012\text{-}2015}$). 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 would then be negotiated by the Commission. These pairs of HCRs exist along the continuum defined by the borders between the regions in the nuclear grid plots, 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. In this way the FAD closure period is a negotiated outcome each time the MP is run, rather than prescribed by the MP. Each pair of HCRs would achieve the same long-term bigeye stock status but under different fishery specific outcomes, depending on the FAD closure scenario.

For example, to achieve a long-term $SB/SB_{F=0}$ that represents achieving the lower TRP on average (50%), using the bigeye MP spatial scenario where the MP manages the TLL excluding the Hawaiian longlines, with a 0 month FAD closure, the required longline catch would be 45,000 mt (see Figure 11 in WCPFC-SC22-2026/MI-WP-03). Under a 1.5 month EEZ FAD closure and 2.5 month high seas FAD closure, the required longline catch would be 50,000 mt. Under a 3 month EEZ FAD closure and 5 month high seas FAD closure, the required longline catch would be 55,000 mt.

Obviously, the outcomes of these future negotiations are currently unknown and it is not possible to know which pairs of HCRs will actually be used in the future. To test candidate MPs it is necessary to simulate a continuum of pairs of HCRs. 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 (see figures in the Appendices, such as Figure 10 as an example).

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

HCR pair	EEZ FAD closure (months)	High seas FAD closure (months)
FAD favoured	0.0	0.0
Intermediate	1.5	2.5
Longline favoured	3.0	5.0

The FAD closure 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) 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 HCR design

As mentioned above the step heights of the Hillary steps are defined by the nuclear grids in WCPFC-SC22-2026/MI-WP-03. The rest of the HCR shapes are designed around:

HCR at lower levels of estimated stock status:

- Minimum output at $SB/SB_{F=0}$ of 0.2, converted to the approximate estimation method equivalent.
- Minimum longline catch set to a quarter of 2019-2021 average catch;

- Minimum EEZ FAD open period set to 6 months;

Hillary step:

- Step position given by the long-term objective $SB/SB_{F=0}$, converted to the approximate estimation method equivalent ($SB/SB_{2012\text{-}2015}$);
- Width of step set to $SB/SB_{F=0}$ of 0.25, converted to the approximate estimation method equivalent.

HCR at higher levels of estimated stock status:

- Maximum longline catch set to 10% higher than the height of the step;
- Maximum FAD open period set to one month longer than the step height (up to a maximum of 12 months);

The parameters of all HCRs evaluated in this report, along with plots of their shapes, can be seen in the Appendices (Table 6).

3.4 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 hard coded into 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.

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 $SB_{latest}/SB_{F=0}$, 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 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 FMSY; 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

A brief summary of the results are presented here using box and bar plots in the three different time periods. 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.

Five candidate MPs are evaluated for each of the three bigeye MP spatial scenarios, where each aims to achieve a different TRP in the long-term (Table 2), giving 15 candidate MPs in total. 960 stochastic simulations are performed for each of the three HCR pair scenarios, for each MP. This means that, along with the large number of requested performance indicators, there are a lot of results to present.

Care must be taken when comparing results between the three bigeye MP spatial scenarios as they manage different groups of longline fisheries (Table 1). Although it is possible to directly compare the biological performance indicators (stock status, and the probabilities of being above the LRP and the various TRPs) across the spatial scenarios, the results of the fishery based performance indicators (those based on catch, effort and vulnerable biomass) are presented separately for each scenario.

The biological performance indicators for all three MP spatial scenarios are presented here. However, due to the volume of results, only the fishery performance indicators for the MP scenario in which the TLL, excluding the Hawaiian longline fleet, is managed through the MP are presented here. Figures of the fishery performance indicators for the other two MP scenarios are found in the Appendices noting that the pattern of results is broadly the same (Figure 25 to Figure 32).

Tables of results are also found in the Appendices.

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 results below 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 presented below are illustrative only and the real results will ultimately depend on the HCR pairs that are selected.

5.1 Biological performance indicators

Expected stock status

The expected $SB/SB_{F=0}$ of each MP, under each HCR pair scenario and bigeye MP spatial scenario, in each time period is shown in Figure 1 as box plots. The median long-term value of each HCR pair scenario of each MP is at, or slightly above, the level that the MP was designed to achieve (Table 2). For example, MPs 4, 13 and 22 aim to achieve a median value equal to the lower TRP, whilst MPs 7, 16 and 25 aim to achieve a median value equal to the upper TRP (shown as dashed lines).

The MPs designed so that long-term $SB/SB_{F=0}$ has a 70% chance of being above the lower TRP (MPs 6, 15, 24) result in similar levels of long-term $SB/SB_{F=0}$ as those designed to achieve the upper TRP (MPs 7, 16, 25) on average (50%).

Generally, there is little difference between the results in different time periods. This is because the target stocks statuses (i.e. the difference between the lower and upper TRPs) and the starting stock status are similar. However, achieving the lower TRP with 50% and 60% probabilities in the long-term corresponds to reductions in the stock status over time.

There is little difference in $SB/SB_{F=0}$ between the HCR pair scenarios. This is because each HCR pair is designed to achieve the same long-term stock status so selecting between them will not affect the long-term outcome. However, there are differences between the fishery performance indicators between the HCR pair scenarios (see below).

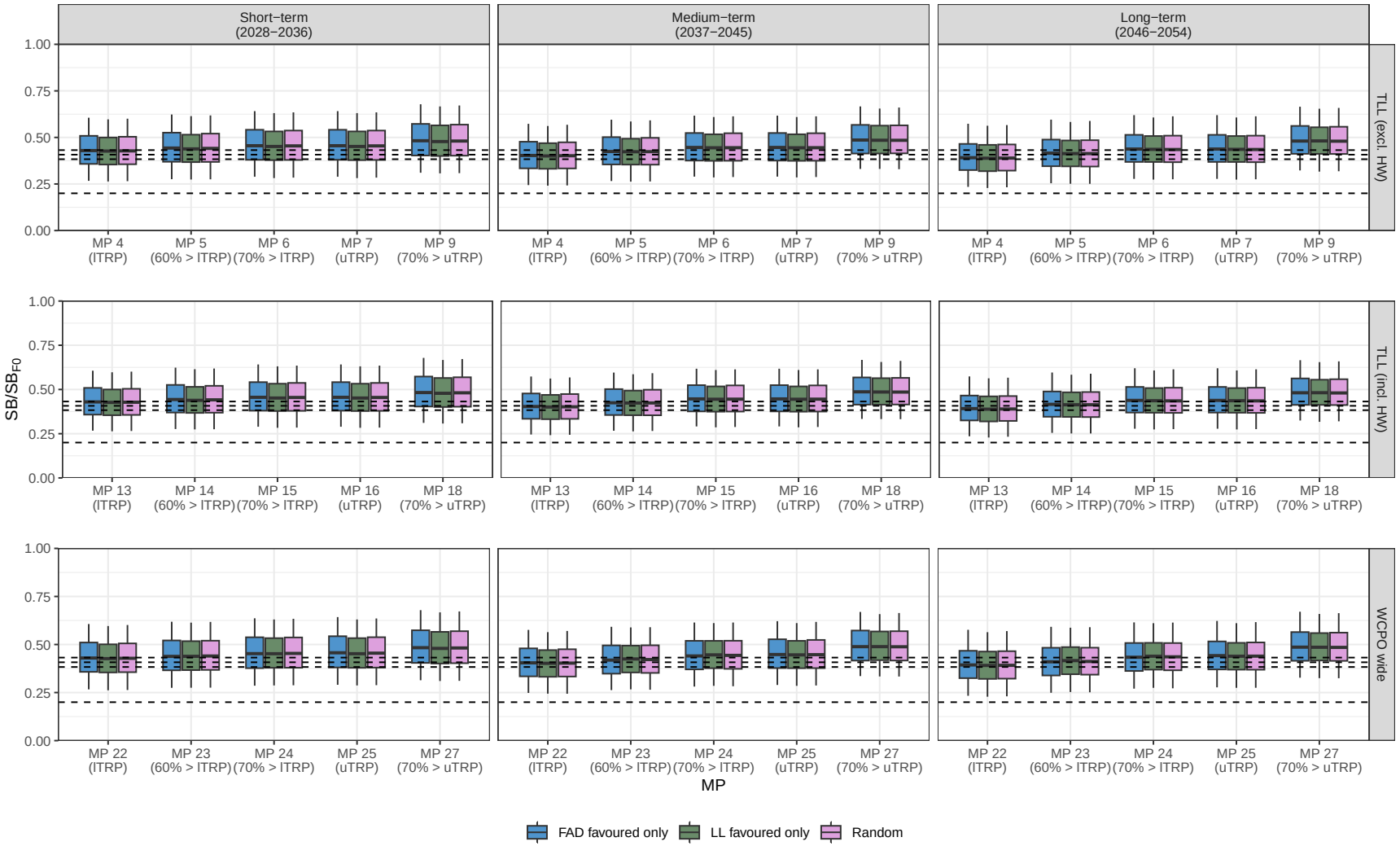

Figure 1: Box plots of $SB/SB_{F=0}$ in the WCPFC-CA in each time period (columns), for each bigeye MP spatial scenario (rows) and for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). 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, middle and lower candidate TRPs, and the LRP.

Expected probability above Limit and Target Reference Points

The expected probabilities of being above the lower and upper TRPs of each MP, under each HCR pair scenario and bigeye MP spatial scenario, in each time period are shown in Figure 2 and Figure 3 respectively.

All probabilities of being above the associated TRPs are slightly higher than their target probability, e.g. the probability of MP 5 being above the lower TRP is slightly above the 60% target (Table 2). This is because the HCRs have been designed using the associated cell of the nuclear grid results. The nuclear grids have a finite granularity leading to slightly more conservative HCRs being designed. Additionally, a small proportion of the MP evaluations result in HCR inputs to the left of the Hillary step, leading to lower levels of fishing being set and resulting in slightly higher stock status.

As described above, there is little difference between the HCR pair scenarios with regards the probabilities, given the designing of the pairs to achieve those outcomes.

The probabilities of being above the LRP are almost 1 for all MPs and bigeye MP scenarios (Figure 4). The WCPFC specifies that an adopted harvest strategy should have a probability of being above the LRP of at least 0.8.

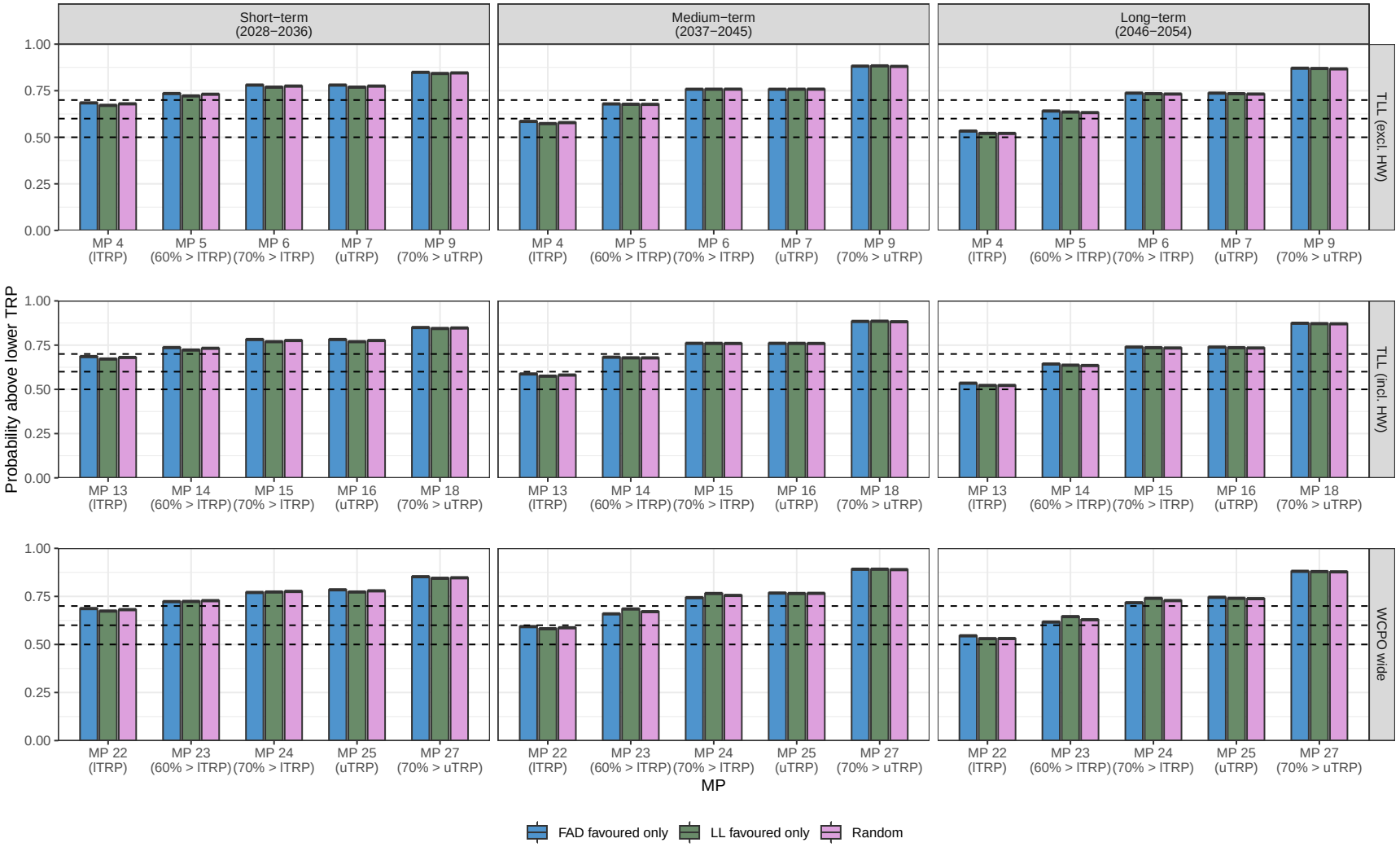

Figure 2: Probability of $SB/SB_{F=0}$ in the WCPFC-CA being above the lower TRP in each time period (columns), for each bigeye MP spatial scenario (rows) and for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The three dashed horizontal lines show the probabilities at 0.5, 0.6 and 0.7 as specified at BMW01

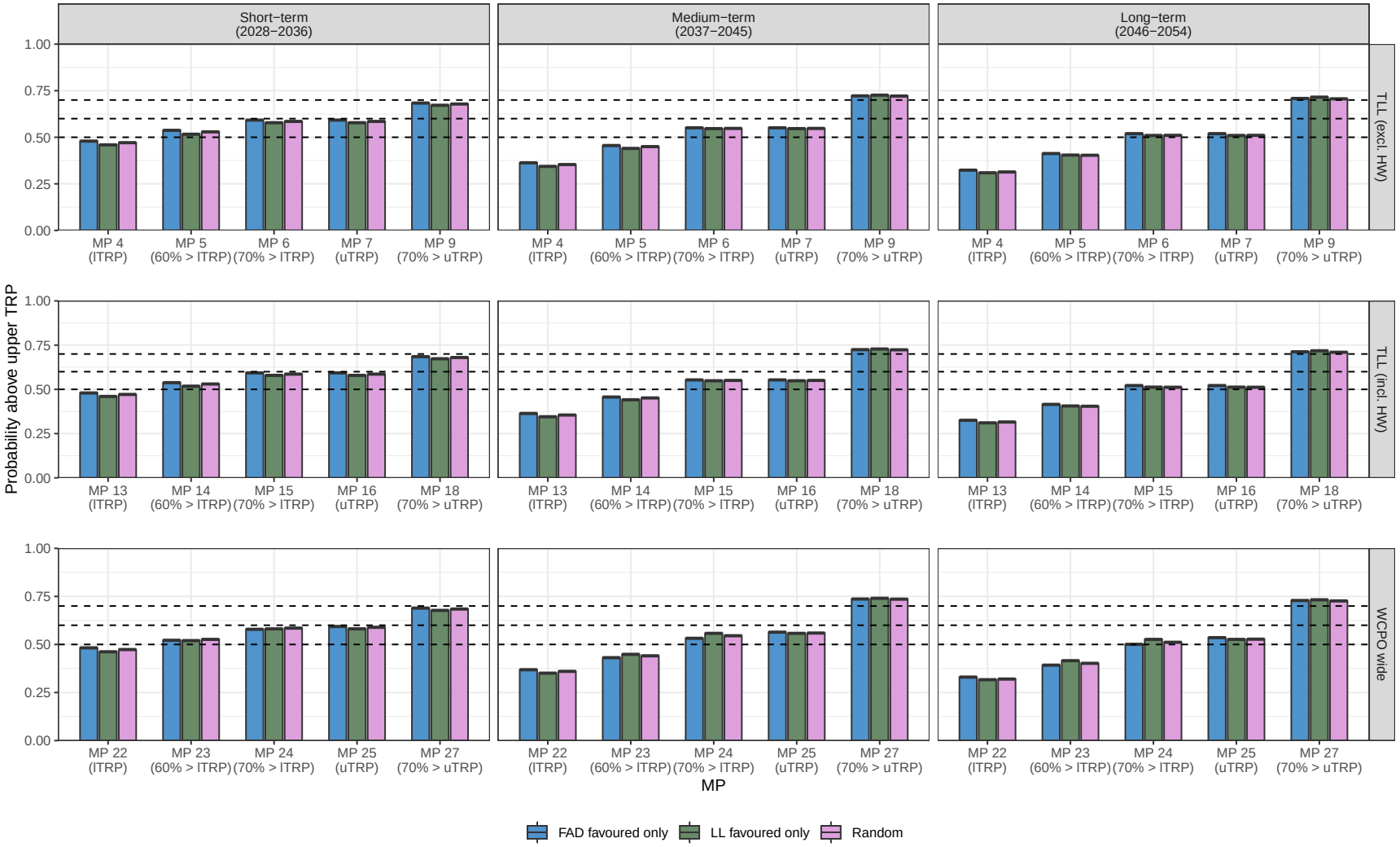

Figure 3: Probability of $SB/SB_{F=0}$ in the WCPFC-CA being above the upper TRP in each time period (columns), for each bigeye MP spatial scenario (rows) and for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The three dashed horizontal lines show the probabilities at 0.5, 0.6 and 0.7 as specified at BMW01.

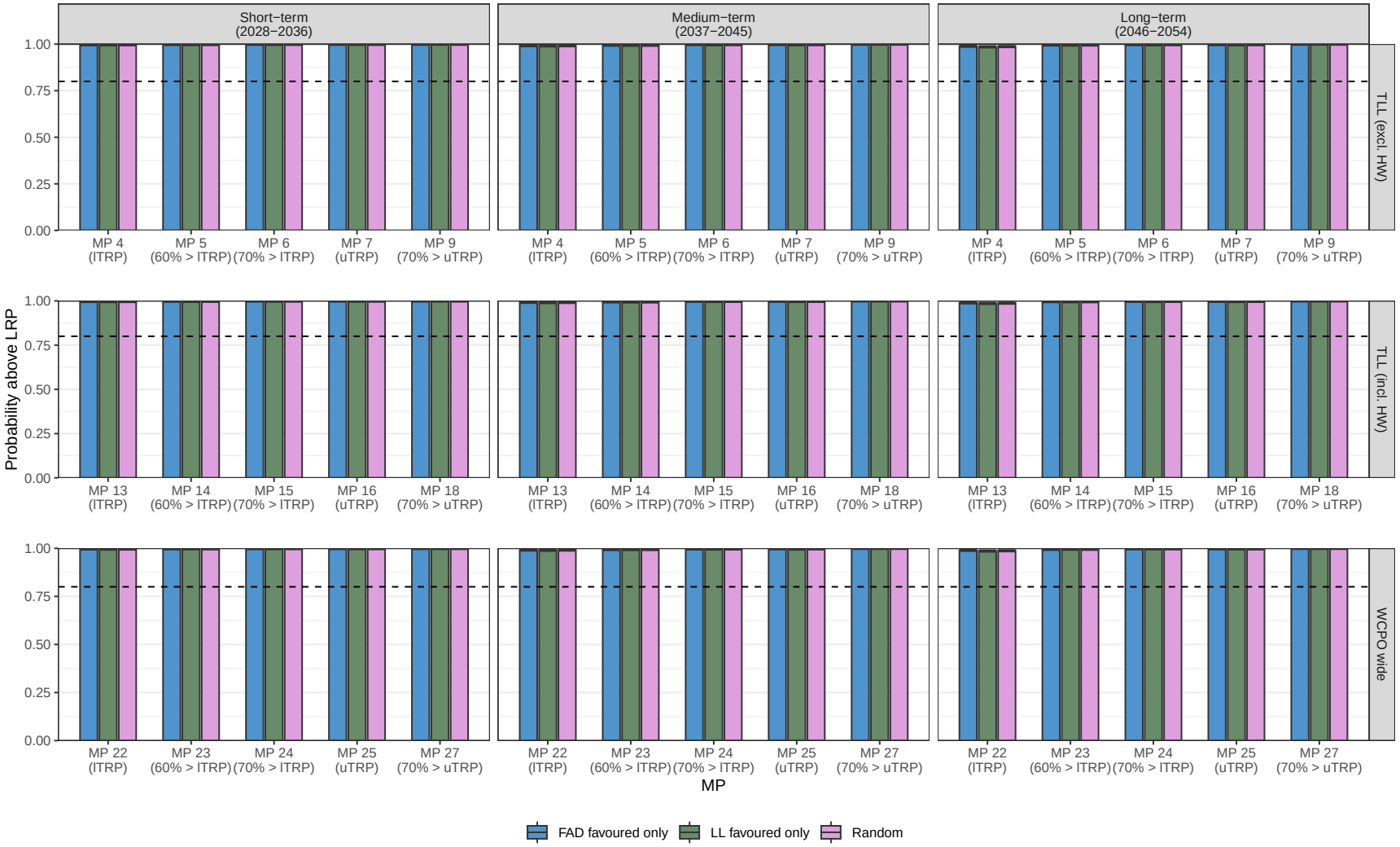

Figure 4: Probability of $SB/SB_{F=0}$ in the WCPFC-CA being above the Limit Reference Point in each time period (columns), for each bigeye MP spatial scenario (rows) and for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The dashed horizontal line is at 0.8, the minimum probability required by WCPFC.

5.2 Fishery performance indicators

This section presents the expected catches, vulnerable biomass, and catch and effort variability for the longline fisheries managed through the bigeye MP and the FAD associated purse seine fisheries.

Due to the volume of results, only the bigeye MP scenario when the MP manages the tropical longline fishery, excluding the Hawaiian longline fleet is considered here. The results from the other two MP scenarios can be found in the Appendices, with similar patterns of relative results.

Expected catches

The expected catches of the longline fisheries managed through the bigeye MP and the FAD associated purse seine fisheries are shown in Figure 5.

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 under MP 4, particularly in the medium- and long-term, are caused by the HCR input falling to the left of the Hillary step because of low estimated stock status, and therefore setting a lower catch limit. The lower whiskers show the 97.5 percentile range, i.e. the probability of this happening is very low. Under the 'random' HCR scenario there is an increase in uncertainty as the catch limit set in each management period may be different to the one preceeding it.

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.

There is a clear difference between the expected catches under each HCR pair scenario. As expected, under the 'FAD favoured only' scenario longline catches are lower than the other HCR pair scenarios, whilst purse seine catches are higher than the other HCR pair scenarios. Under the 'longline favoured only' scenario, the opposite happens. Under the 'random' HCR scenario, the median catches lie in between the other two scenarios.

Achieving the upper TRP results in lower catches for the longline fisheries in all time periods compared to those from achieving the lower TRP (e.g. comparing the results from MP 4 and MP 7). Conversely, achieving the upper TRP results in slightly higher purse seine catches than achieving the lower TRP. 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. MP 7 that achieves the upper TRP, the 'FAD favoured only' scenario would therefore result in higher catches than under an MP that achieves a lower stock status, e.g. MP 4 that achieves the lower TRP. However, there are limited impacts on purse seine catches across the different spatial scenarios and TRPs (Figure 9).

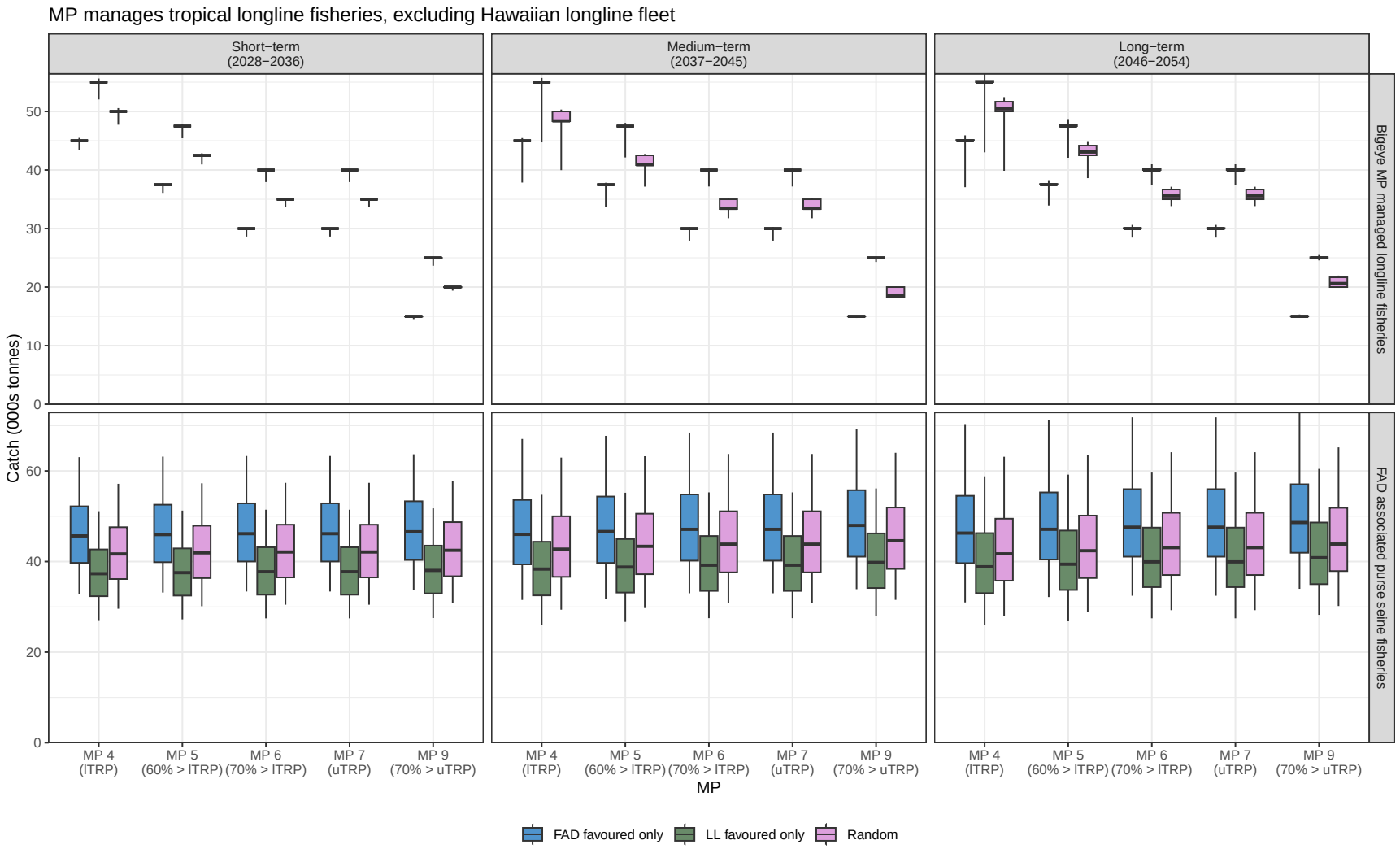

Figure 5: Box plots of expected catch taken by the longline fisheries managed through the bigeye MP (top row) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

Expected 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 6). Here it is 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.

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.

Under the 'longline favoured only' scenario expected vulnerable biomass is higher than the 'FAD favoured only' scenario, for the same MP, for both the longline and the purse seine fishery (although the difference is relatively small for the longline fisheries). This suggests that higher levels of FAD associated purse seine fishing leads to a reduction in catch rates of bigeye for both longline and FAD associated purse seine fisheries, though most notably in the purse seine fishery.

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, for the same HCR scenario, e.g. comparing the expected vulnerable biomass under MPs 4 and 7 under the 'longline favoured only' HCR scenario. 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.

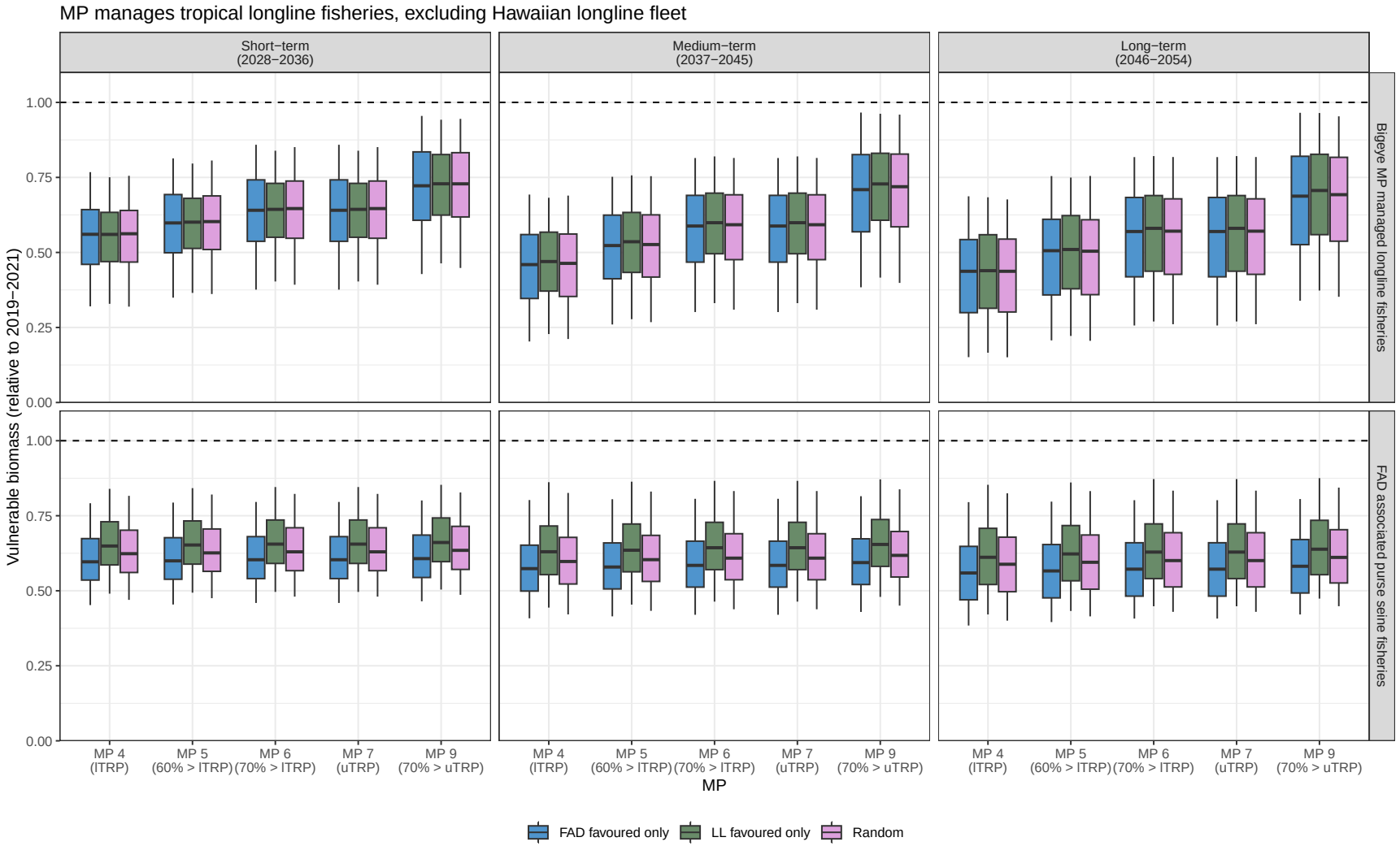

Figure 6: Box plots of expected vulnerable biomass, relative to the average level in 2019-2021, of the longline fisheries managed through the bigeye MP (top row) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). 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 variability

Catch variability is measured as the absolute change in catch between years (Figure 7). Interpreting uncertainty around the variability can be challenging so for clarity this indicator is presented as a bar chart of median values instead of a box plot.

The MP sets a catch limit for the longline fisheries every three years. Under the 'FAD favoured only' and 'longline favoured only' HCR scenarios there is very little variability in the catches of the longline fisheries (the variability is close to 0). Under the 'random' HCR scenario, different HCR pairs are potentially selected every three years, each one setting different longline catches. This scenario therefore produces higher catch variability for the longline fisheries, although this variability is still low.

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.

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 'LL favoured only' to 'FAD favoured only' between management periods. The level of variability is therefore defined by the ability to switch between any of the three HCR pairs evaluated. 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. These, and the effort variability results below, must therefore be interpreted with care, given the strong influence of the implemented methodology and range of option states defined by WCPFC22.

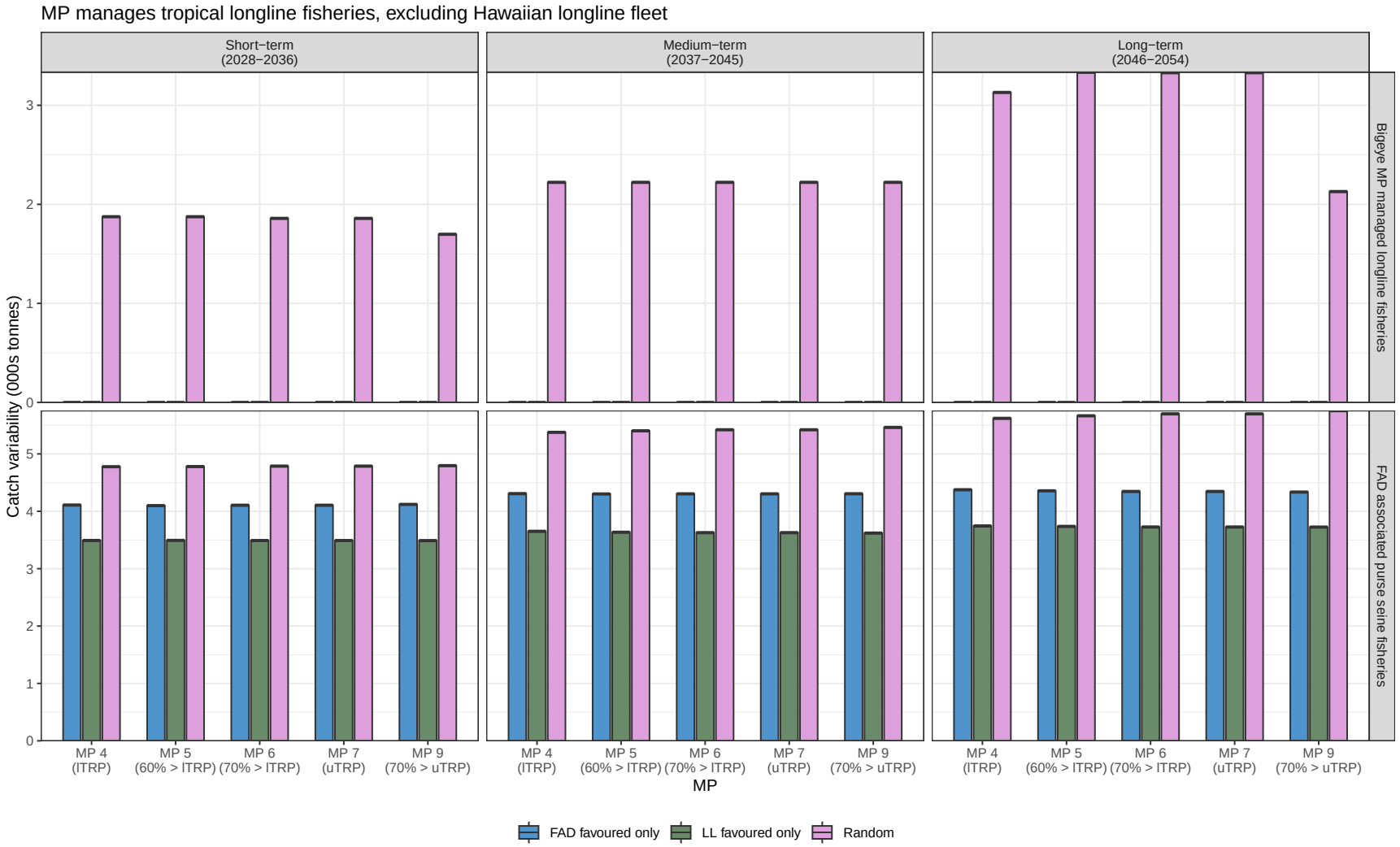

Figure 7: Bar charts of expected median catch variability of the longline fisheries managed through the bigeye MP (top row) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs).

Effort variability

Effort variability is measured as the absolute change in catch between years (Figure 8). As with the catch variability indicator, for clarity this indicator is presented as a bar chart of median values.

For the 'FAD favoured only' and 'longline favoured only' HCR scenarios, the purse seine effort variability is essentially zero. This is because these HCR scenarios prescribe a fixed level of effort (so long as the HCR input remains on the Hillary step). Under the 'random' HCR scenario the different HCRs may be selected in each management period, thereby leading to different levels of FAD associated purse seine fishing effort being set (noting that the annual total of FAD associated and free-school purse seine fishing effort remains at 2012 levels). This results in relatively high levels of purse seine variability.

For the longline fisheries there is always some effort variability, as the fishery is managed through the setting of catch limits. This variability is generally greater under the 'random' HCR scenario (see comment above about the negotiation of the FAD closure period will result in different variability).

Longline variability decreases as stock size increases. This may reflect greater 'stability' in spawning biomass as stock size increases, where adult abundance is less influenced by incoming recruits.

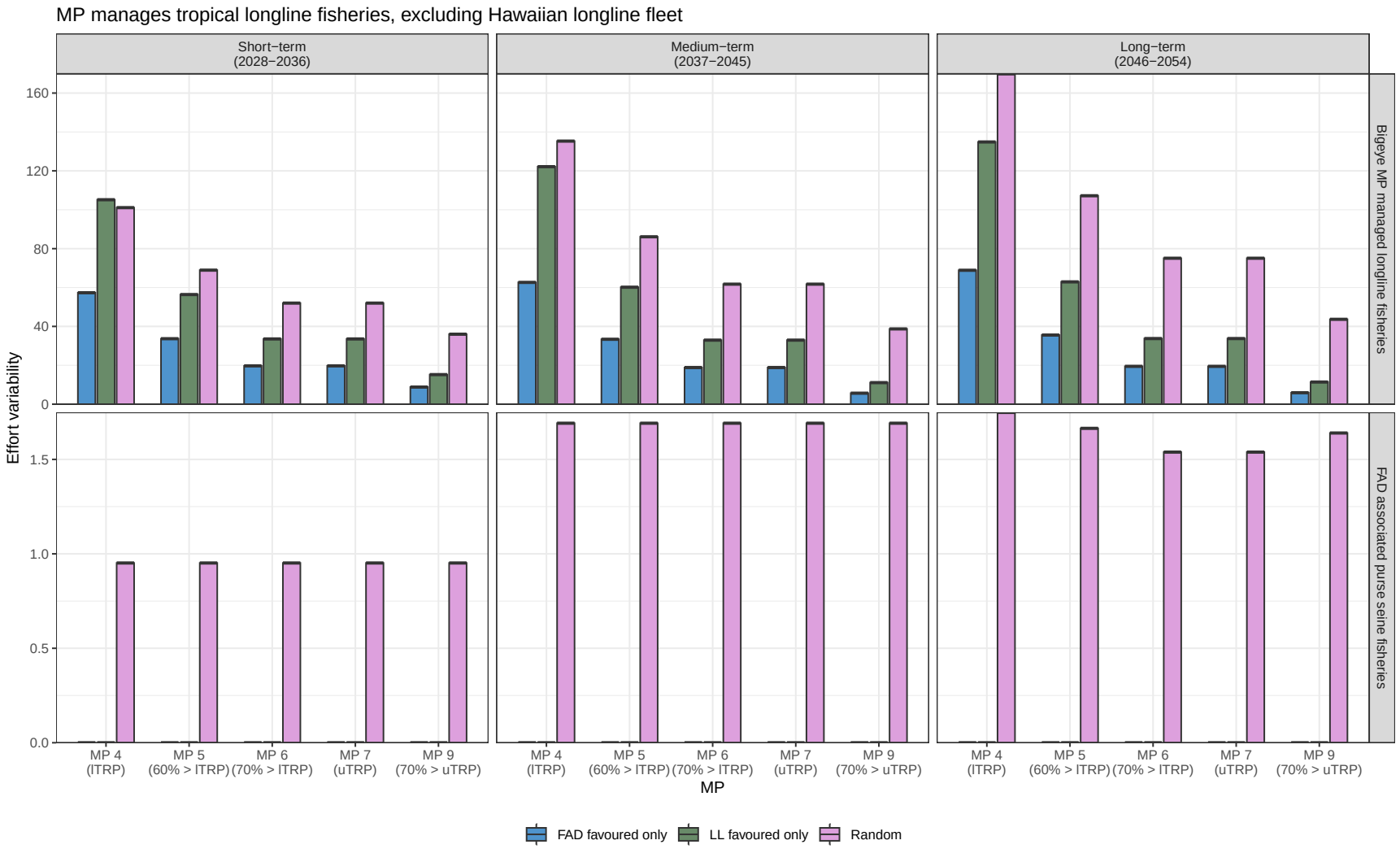

Figure 8: Bar chart of expected median effort variability of the longline fisheries managed through the bigeye MP (top row, measured as millions of hooks) and the FAD associated purse seine fishery (bottom row, measured as thousands of sets) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs).

5.3 Comparing between bigeye management procedure spatial scenarios

As mentioned above, care must be taken when comparing results between the bigeye MP spatial scenarios, as different groups of fisheries are managed under each scenario. 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 9.

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, spatial scenarios and HCR pair scenarios. The total catch of bigeye is slightly higher under the 'longline favoured only' HCR scenario.

The FAD associated purse seine catches are constant across bigeye MP spatial scenarios, but are higher under the 'FAD favoured only' HCR scenario. 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, bigeye MP spatial scenario or HCR pair 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).

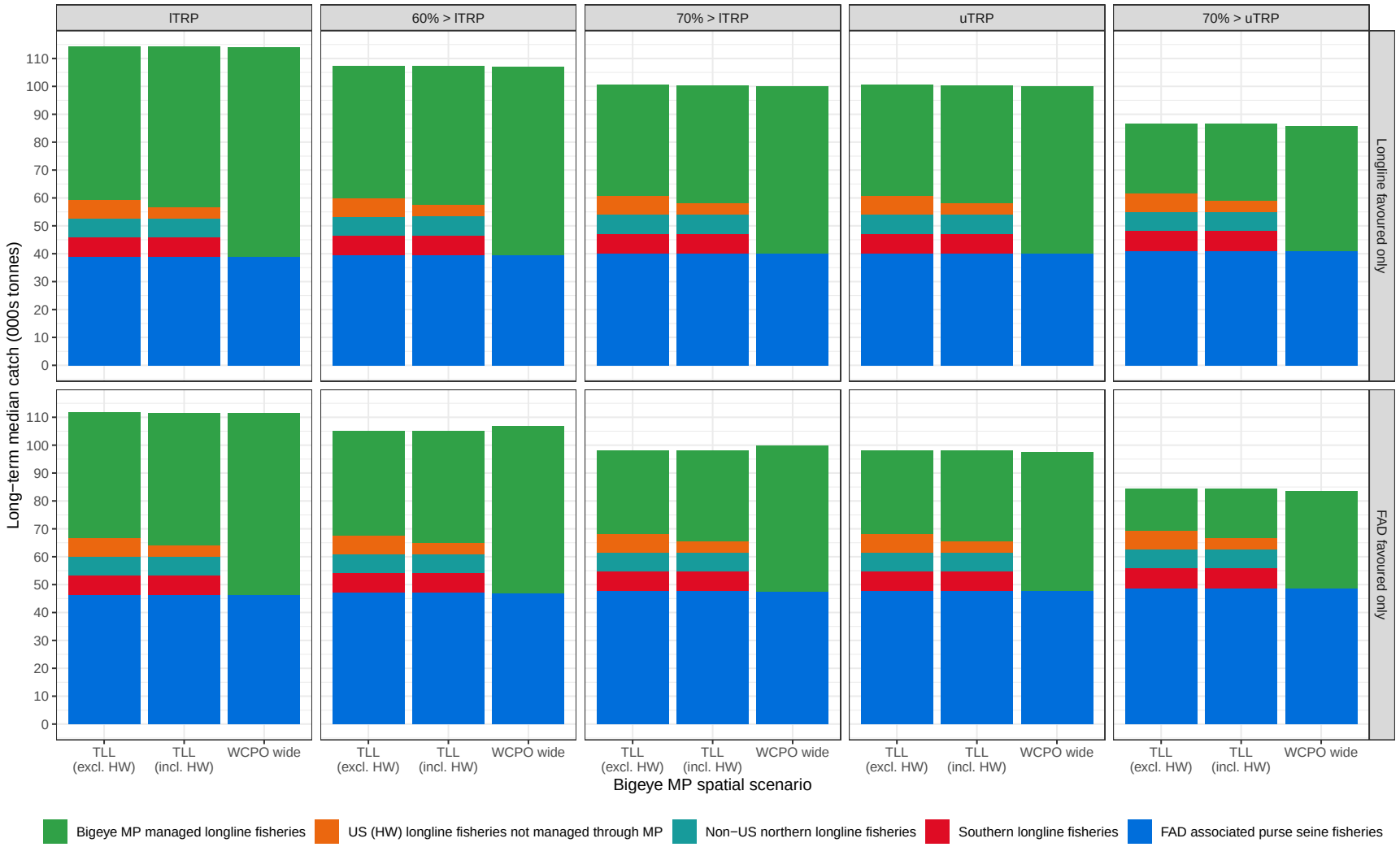

Figure 9: Bar chart of expected median long-term (2046-2054) bigeye catches by fisheries potentially managed through the bigeye MP in each bigeye MP spatial scenario, under alternative TRP objectives (columns), and either 'longline favoured only' (top row) or 'FAD favoured only' (bottom row) HCR pairs.

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 SC22 and BMW02, work will be prioritised towards these issues although SC22 may wish to provide guidance.

Acknowledgments

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

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7 Appendix: Future assumptions for fisheries not managed through the bigeye MP

The future catch and effort assumptions for fisheries not managed through the bigeye MP are give in Table 4 and Table 5. See WCPFC-SC22-2026/MI-WP-03 for further details (Scott et al., 2026a).

Table 4: Future effort assumptions for the fisheries in the operating models that are managed through the skipjack management procedure.

Fishery segment	Future fishing assumptions
Pole and line	Future effort fixed at average 2001-2004 average levels.
Purse seine	Total future effort fixed at 2012 levels. FAD associated and free-school distribution of total effort is set by nuclear grid.
Domestic (Indonesia, Vietnam, the Phillipines)	Future effort fixed at average 2016-2018 levels, including those operating in archipelagic waters.

Table 5: Future bigeye catch and effort assumptions for the longline fisheries under the different bigeye management procedure spatial scenarios.

Bigeye MP scenario	Southern longline	Hawaiian longline	Non-US northern longline
TLL including Hawaiian longline fleet	Effort consistent with South Pacific albacore MP.	Catches of fleet operating north of 20°N fixed at 3932 mt p.a. Catches of fleet operating south of 20°N set by bigeye MP.	Catches fixed at 2015-2024 average (approximately 6700 mt p.a.).
TLL excluding Hawaiian longline fleet	Effort consistent with South Pacific albacore MP.	Catches fixed at 6554 mt p.a.	Catches fixed at 2015-2024 average (approximately 6700 mt p.a.).
WCPO wide	Catches set by bigeye MP.	Catches set by bigeye MP.	Catches set by bigeye MP.

8 Appendix: Harvest control rule parameters

The parameters for each HCR used in evaluations are given in Table 6. Note that the HCR output for the FAD-associated purse seine fisheries is EEZ FAD open period, not closed period. Of course, it is straightforward to convert from an open period to a closed period. A ratio of 3 months EEZ and 5 months high seas FAD closure, rounded to the nearest quarter month (week), is used in the evaluations.

Table 6: Harvest control rule parameters for each of the three HCR pairs, for each MP. The HCRs in each HCR pair have the same input parameters (estimated $SB/SB_{2012\text{-}2015}$). The output parameters are 000s tonnes of bigeye catch for the longline fisheries and EEZ FAD open period in months.

MP	Scenario	HCR pair		Limit	Step start	Step end	Maximum
MP 4 (ITRP)	TLL excl. HW	FAD favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.74	1.14	56.17
			Longline catch (000s t)	9.62	45.00	45.00	49.50
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.73	1.14	56.06
			Longline catch (000s t)	9.62	50.00	50.00	55.00
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.73	1.13	56.01
			Longline catch (000s t)	9.62	55.00	55.00	60.50
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 5 (60% > ITRP)	TLL excl. HW	FAD favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.78	1.18	57.65
			Longline catch (000s t)	9.62	37.50	37.50	41.25
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.77	1.17	57.50
			Longline catch (000s t)	9.62	42.50	42.50	46.75
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.77	1.17	57.57
			Longline catch (000s t)	9.62	47.50	47.50	52.25
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 6 (70% > ITRP)	TLL excl. HW	FAD favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.81	1.21	59.05
			Longline catch (000s t)	9.62	30.00	30.00	33.00
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.81	1.21	58.96
			Longline catch (000s t)	9.62	35.00	35.00	38.50
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.81	1.21	59.03
			Longline catch (000s t)	9.62	40.00	40.00	44.00
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
		FAD favoured	Estimated $SB/SB_{2012\text{-}2015}$	0.60	0.81	1.21	59.05
			Longline catch (000s t)	9.62	30.00	30.00	33.00

MP	Scenario	HCR pair		Limit	Step start	Step end	Maxi-mum
MP 7 (uTRP)	TLL excl. HW		EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012-2015}$	0.60	0.81	1.21	58.96
			Longline catch (000s t)	9.62	35.00	35.00	38.50
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.81	1.21	59.03
			Longline catch (000s t)	9.62	40.00	40.00	44.00
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 9 (70% > uTRP)	TLL excl. HW	FAD favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.88	1.28	61.73
			Longline catch (000s t)	9.62	15.00	15.00	16.50
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012-2015}$	0.60	0.88	1.28	61.66
			Longline catch (000s t)	9.62	20.00	20.00	22.00
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.88	1.28	61.73
			Longline catch (000s t)	9.62	25.00	25.00	27.50
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 13 (ITRP)	TLL incl. HW	FAD favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.74	1.14	59.52
			Longline catch (000s t)	10.19	47.50	47.50	52.25
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012-2015}$	0.60	0.73	1.14	59.40
			Longline catch (000s t)	10.19	52.50	52.50	57.75
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.73	1.13	59.35
			Longline catch (000s t)	10.19	57.50	57.50	63.25
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 14 (60% > ITRP)	TLL incl. HW	FAD favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.78	1.18	61.10
			Longline catch (000s t)	10.19	40.00	40.00	44.00
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012-2015}$	0.60	0.77	1.17	60.94
			Longline catch (000s t)	10.19	45.00	45.00	49.50
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.77	1.18	61.00
			Longline catch (000s t)	10.19	50.00	50.00	55.00
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 15 (70% > ITRP)	TLL incl. HW	FAD favoured	Estimated $SB/SB_{2012-2015}$	0.60	0.81	1.21	62.59
			Longline catch (000s t)	10.19	32.50	32.50	35.75
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated $SB/SB_{2012-2015}$	0.60	0.81	1.21	62.48
			Longline catch (000s t)	10.19	37.50	37.50	41.25

MP	Scenario	HCR pair		Limit	Step start	Step end	Maxi-mum
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.81	1.21	62.55
			Longline catch (000s t)	10.19	42.50	42.50	46.75
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 16 (uTRP)	TLL incl. HW	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.81	1.21	62.59
			Longline catch (000s t)	10.19	32.50	32.50	35.75
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.81	1.21	62.48
			Longline catch (000s t)	10.19	37.50	37.50	41.25
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.81	1.21	62.55
			Longline catch (000s t)	10.19	42.50	42.50	46.75
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 18 (70% > uTRP)	TLL incl. HW	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.88	1.28	65.44
			Longline catch (000s t)	10.19	17.50	17.50	19.25
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.88	1.28	65.36
			Longline catch (000s t)	10.19	22.50	22.50	24.75
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.88	1.28	65.43
			Longline catch (000s t)	10.19	27.50	27.50	30.25
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 22 (ITRP)	WCPO	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.74	1.14	79.03
			Longline catch (000s t)	13.51	65.00	65.00	71.50
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.74	1.14	78.82
			Longline catch (000s t)	13.51	70.00	70.00	77.00
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.74	1.14	78.83
			Longline catch (000s t)	13.51	75.00	75.00	82.50
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 23 (60% > ITRP)	WCPO	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.77	1.17	80.43
			Longline catch (000s t)	13.51	60.00	60.00	66.00
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.78	1.18	80.94
			Longline catch (000s t)	13.51	62.50	62.50	68.75
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.78	1.18	81.02
			Longline catch (000s t)	13.51	67.50	67.50	74.25

MP	Scenario	HCR pair		Limit	Step start	Step end	Maxi-mum
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 24 (70% > ITRP)	WCPO	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.81	1.21	82.61
			Longline catch (000s t)	13.51	52.50	52.50	57.75
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.82	1.22	83.10
			Longline catch (000s t)	13.51	55.00	55.00	60.50
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.82	1.22	83.13
			Longline catch (000s t)	13.51	60.00	60.00	66.00
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 25 (uTRP)	WCPO	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.82	1.22	83.27
			Longline catch (000s t)	13.51	50.00	50.00	55.00
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.82	1.22	83.10
			Longline catch (000s t)	13.51	55.00	55.00	60.50
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		LL favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.82	1.22	83.13
			Longline catch (000s t)	13.51	60.00	60.00	66.00
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00
MP 27 (70% > uTRP)	WCPO	FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.89	1.29	87.05
			Longline catch (000s t)	13.51	35.00	35.00	38.50
			EEZ FAD open period (months)	6.00	12.00	12.00	12.00
		Intermediate	Estimated SB/$SB_{2012-2015}$	0.60	0.89	1.29	86.94
			Longline catch (000s t)	13.51	40.00	40.00	44.00
			EEZ FAD open period (months)	6.00	10.50	10.50	11.50
		FAD favoured	Estimated SB/$SB_{2012-2015}$	0.60	0.89	1.29	87.03
			Longline catch (000s t)	13.51	45.00	45.00	49.50
			EEZ FAD open period (months)	6.00	9.00	9.00	10.00

9 Appendix: HCR plots

Plots of the HCRs used in the evaluations are presented below. The HCRs are grouped under the associated MP, with three pairs of HCR for each MP. Note that the HCR output for the FAD-associated purse seine fisheries is EEZ FAD open period, not closed period. Of course, it is straightforward to convert from an open period to a closed period. A ratio of 3 months EEZ and 5 months high seas FAD closure, rounded to the nearest quarter month (week), is used in the evaluations.

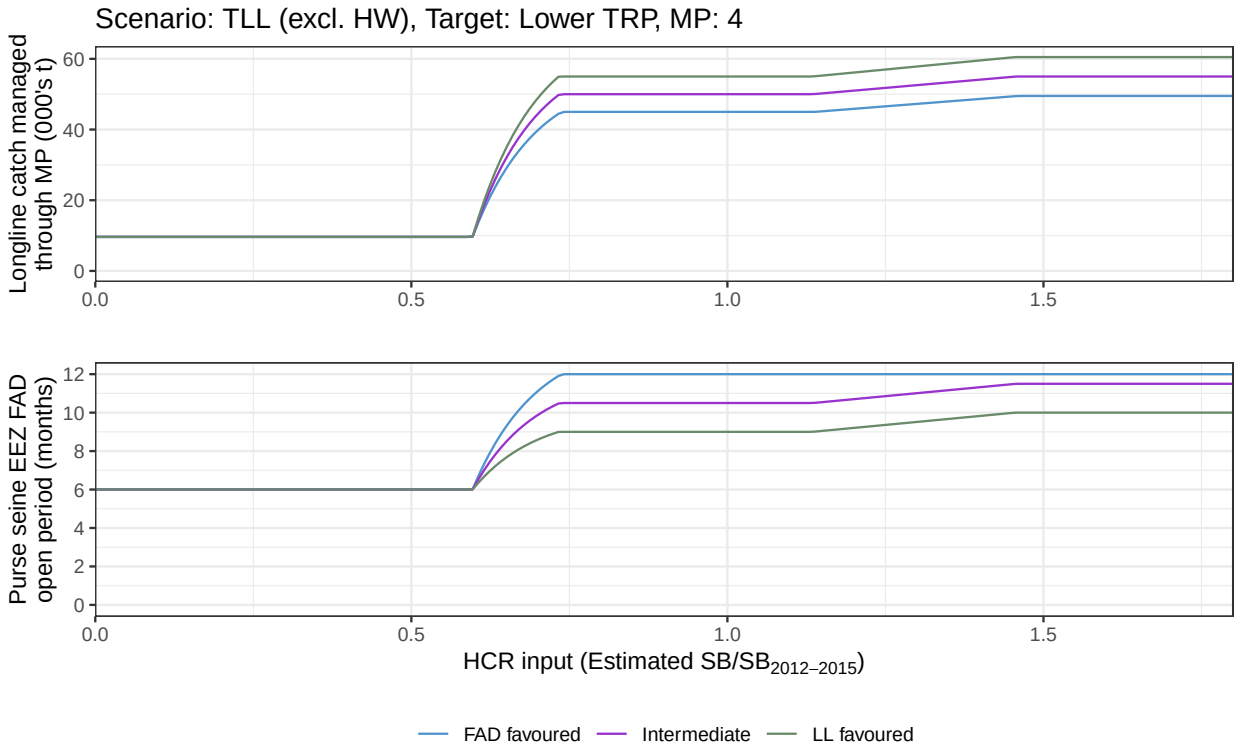

Figure 10

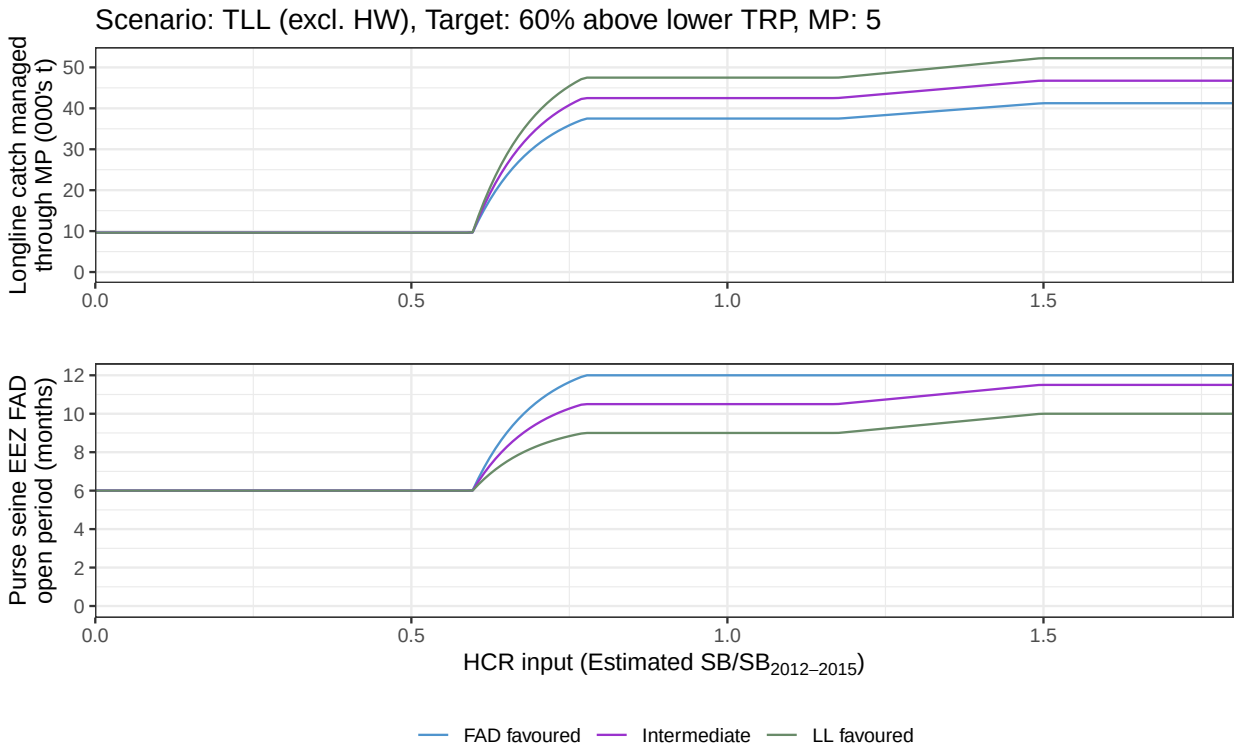

Figure 11

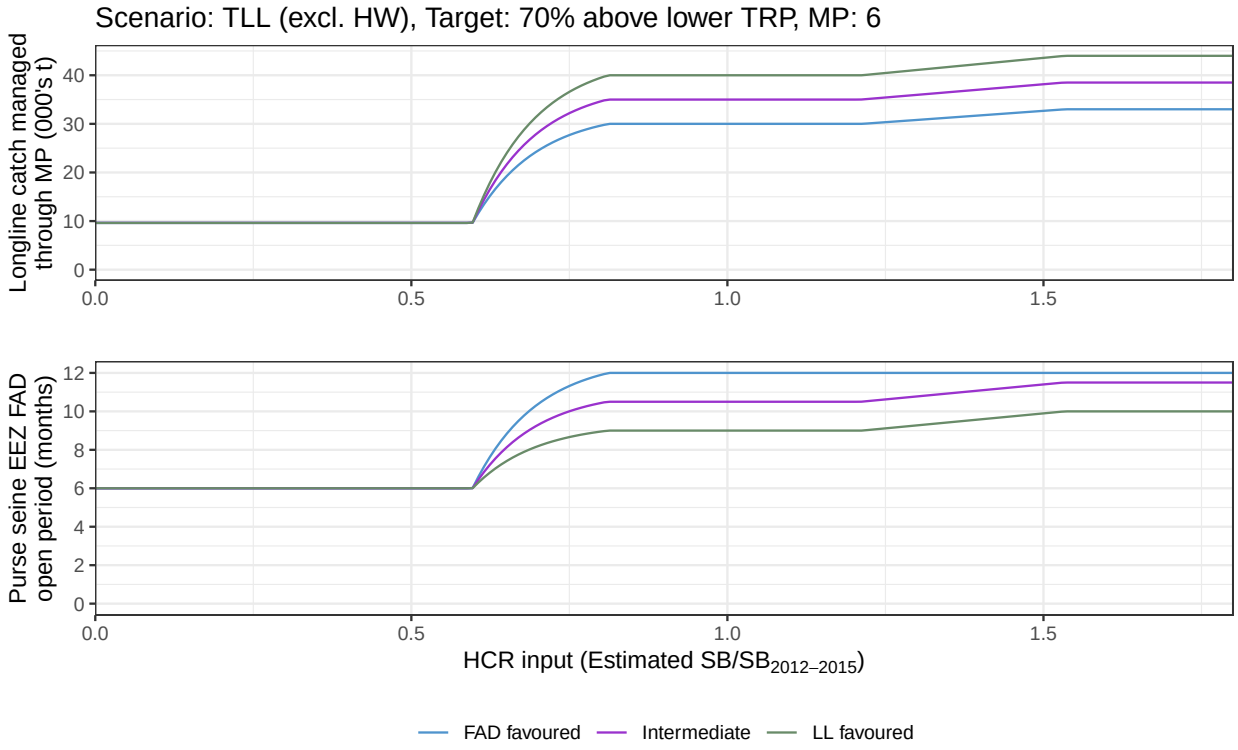

Figure 12

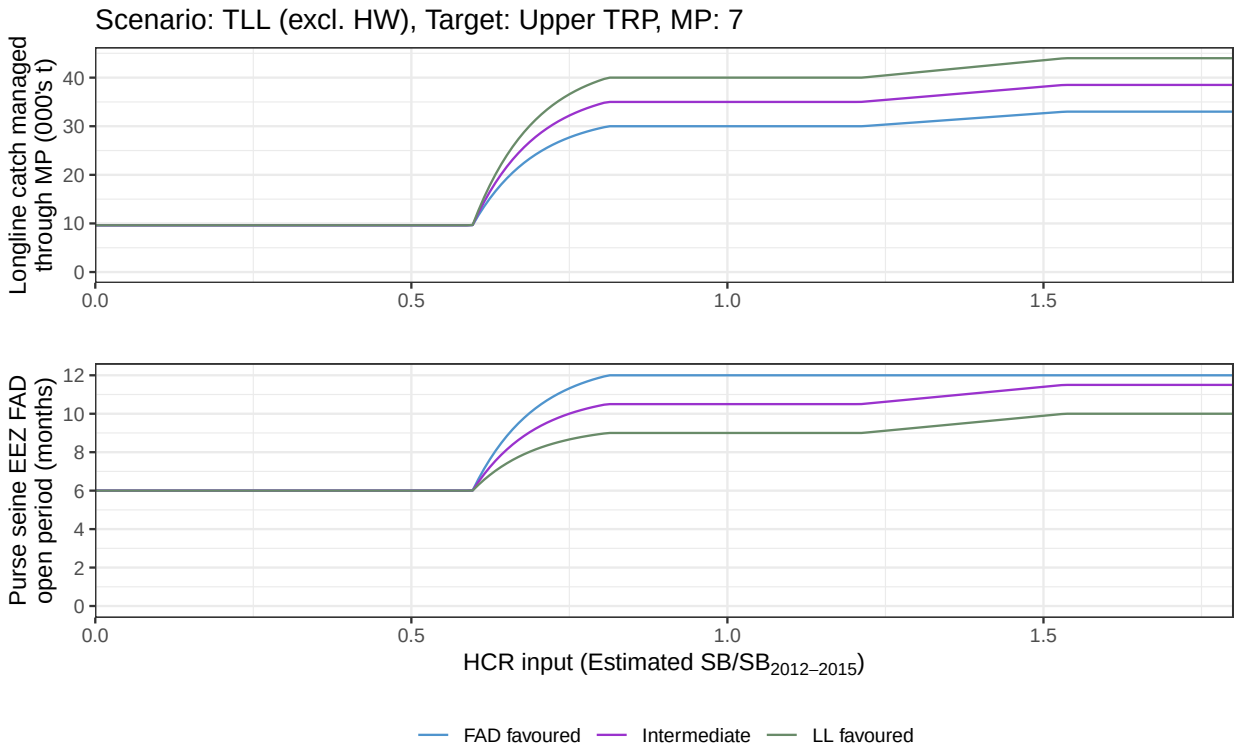

Figure 13

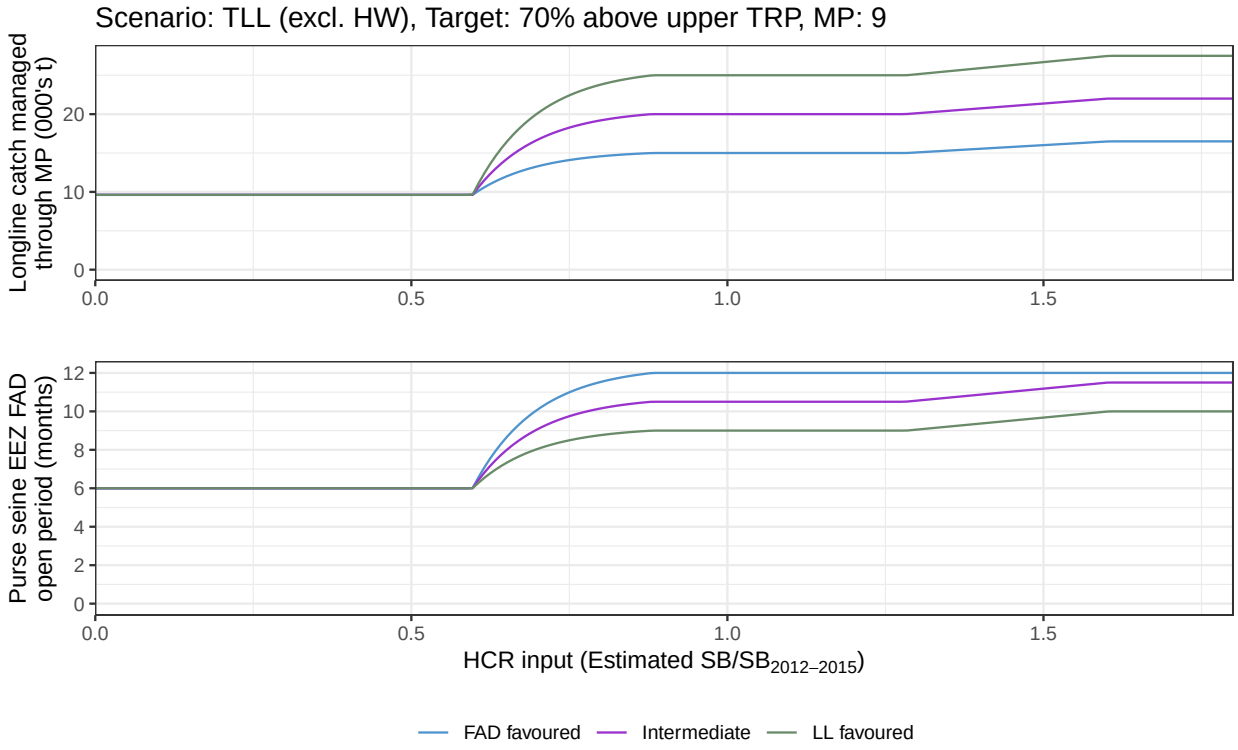

Figure 14

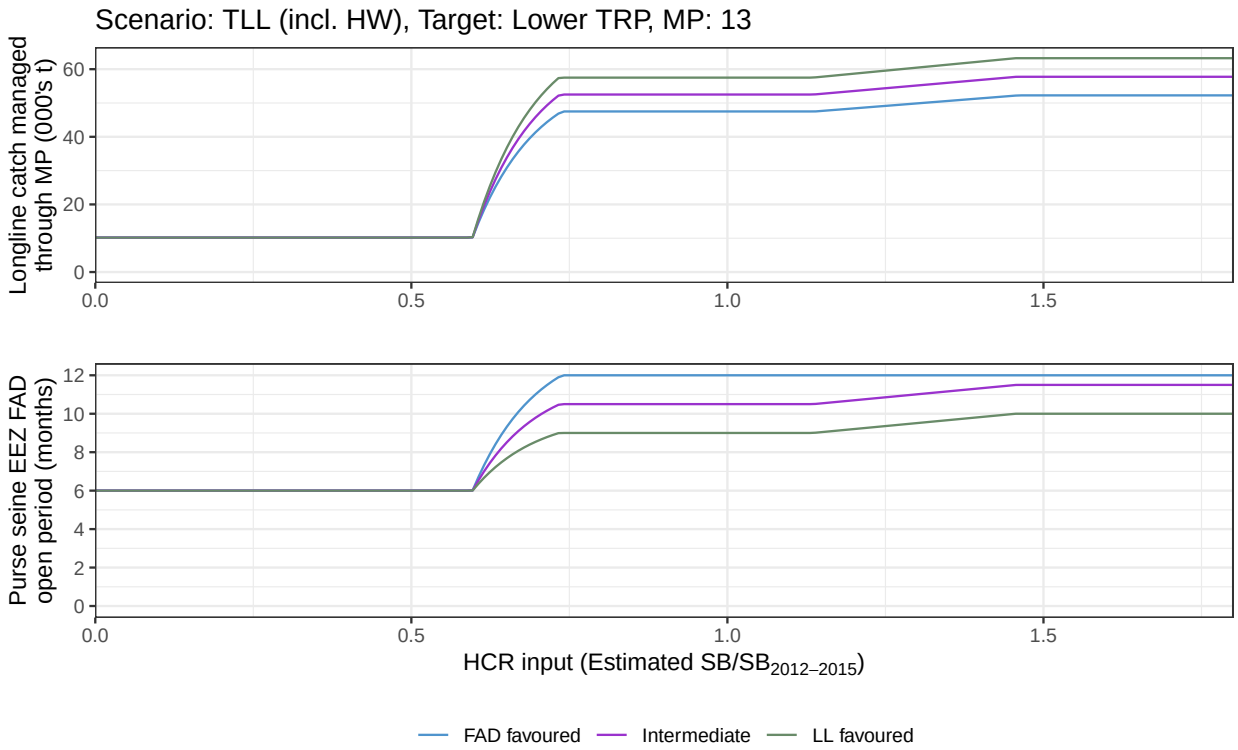

Figure 15

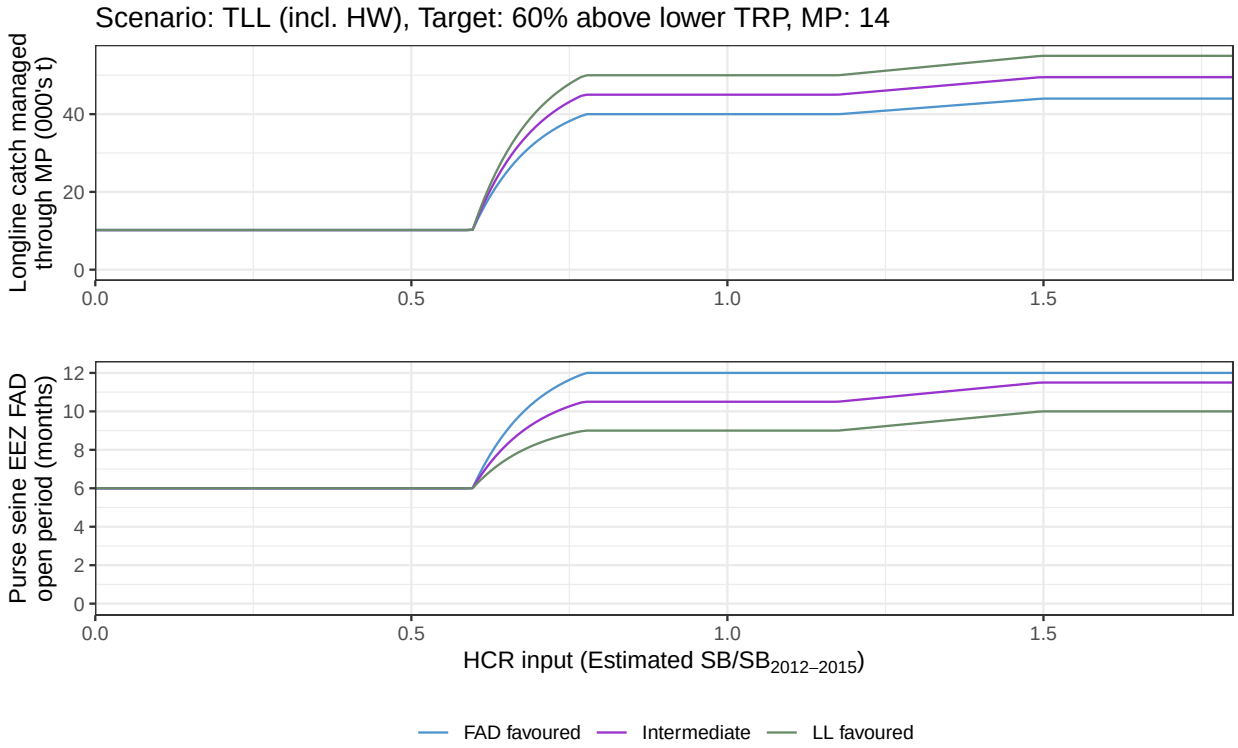

Figure 16

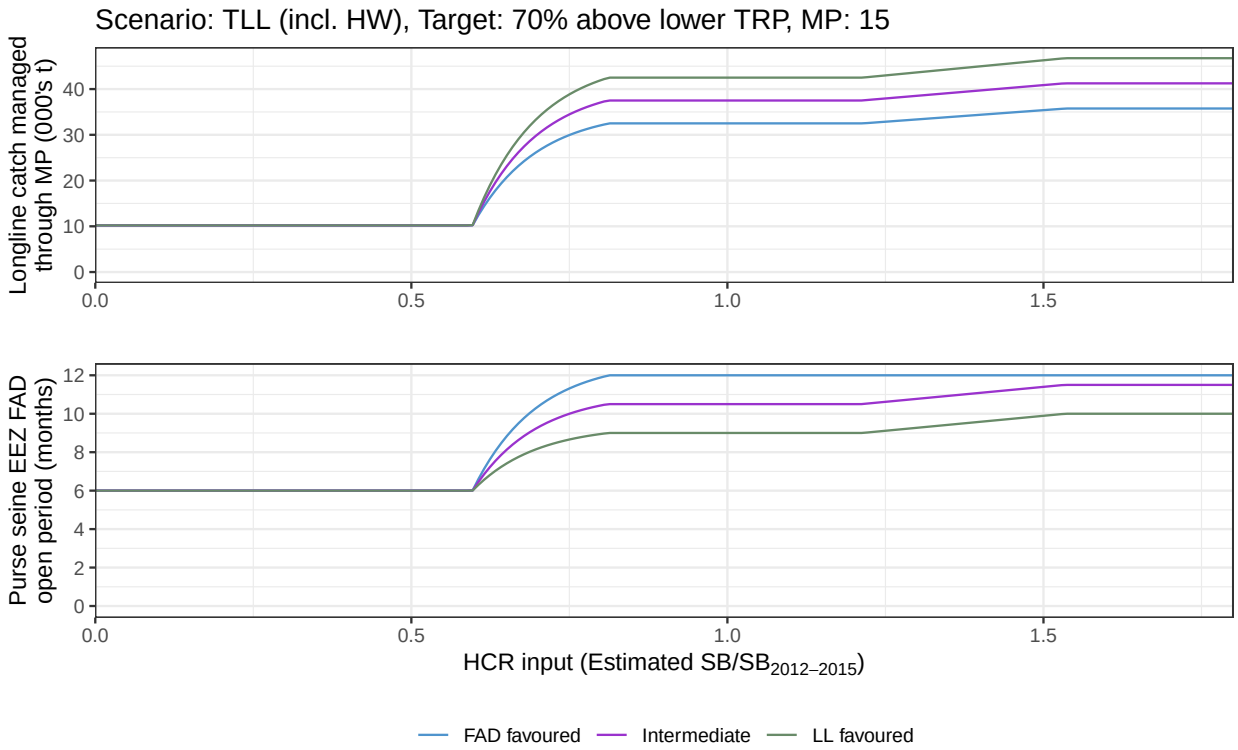

Figure 17

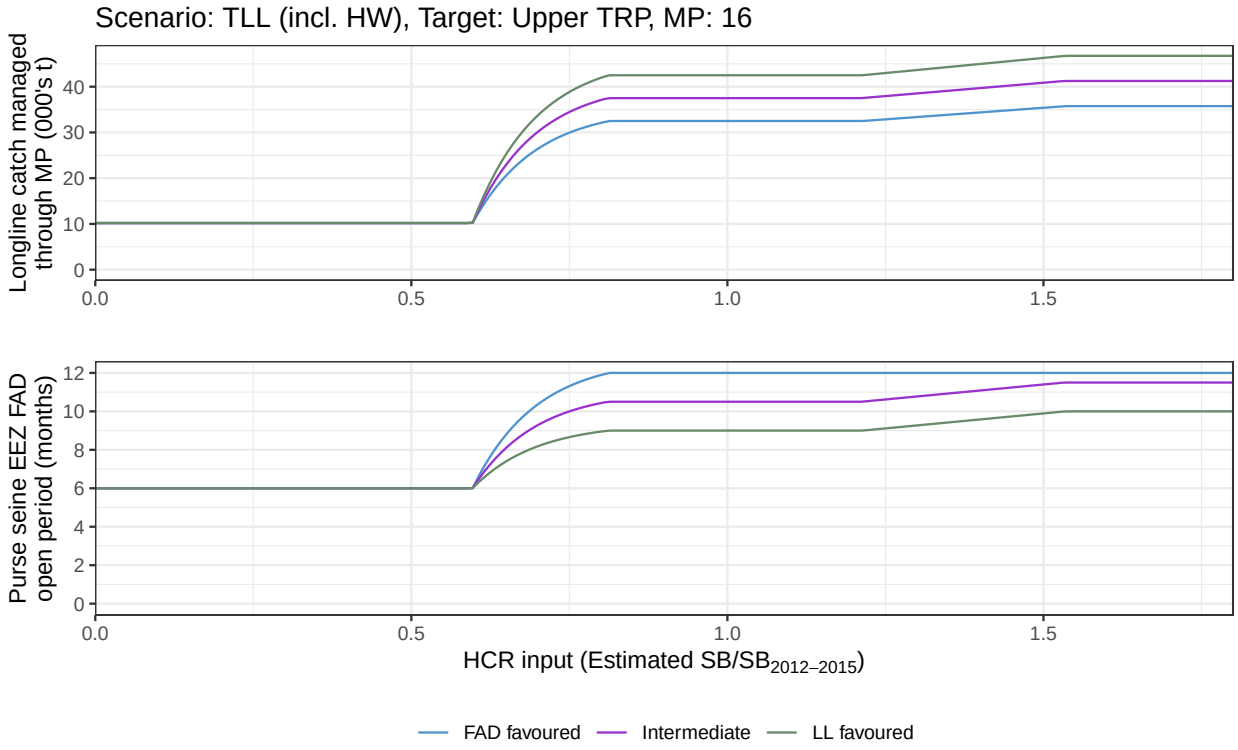

Figure 18

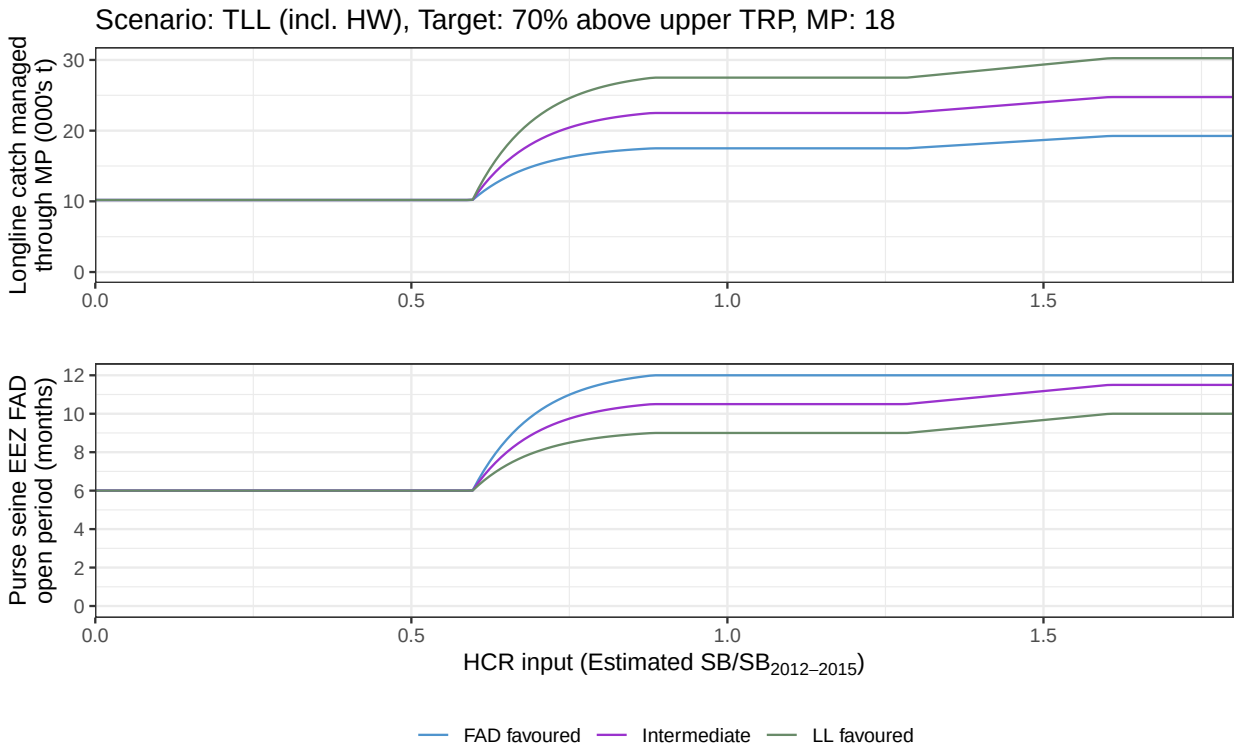

Figure 19

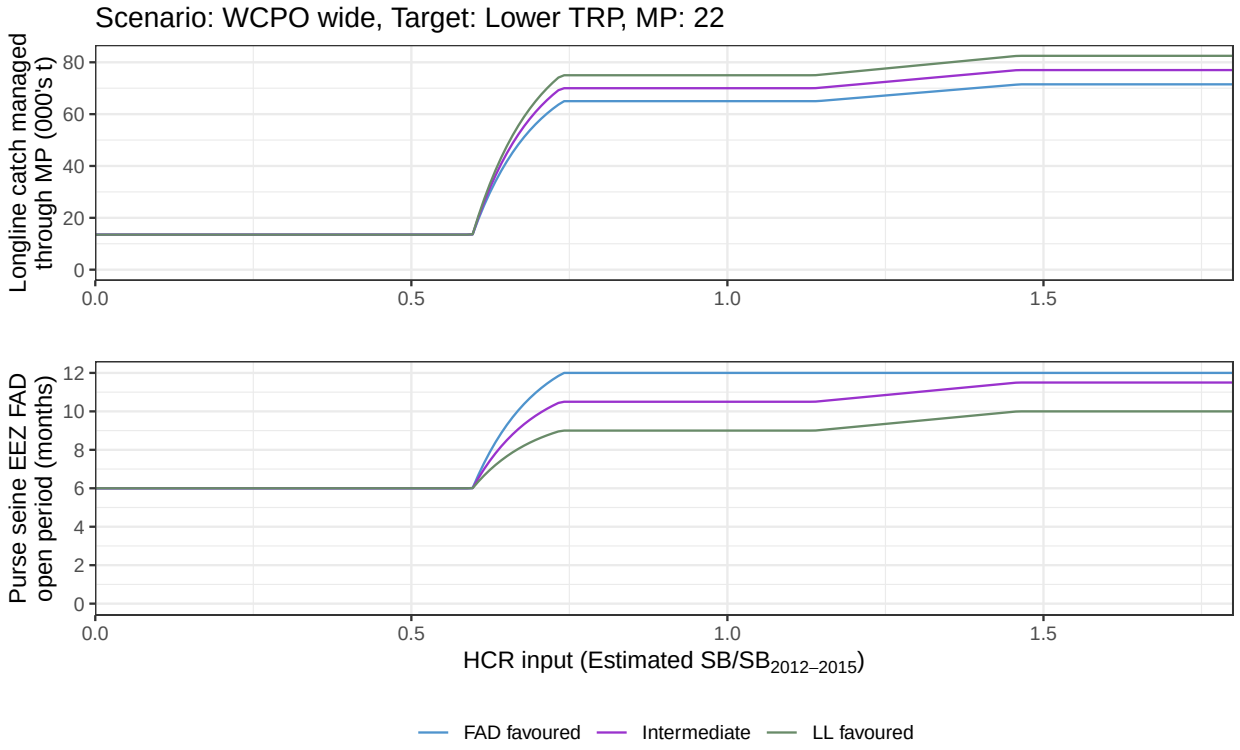

Figure 20

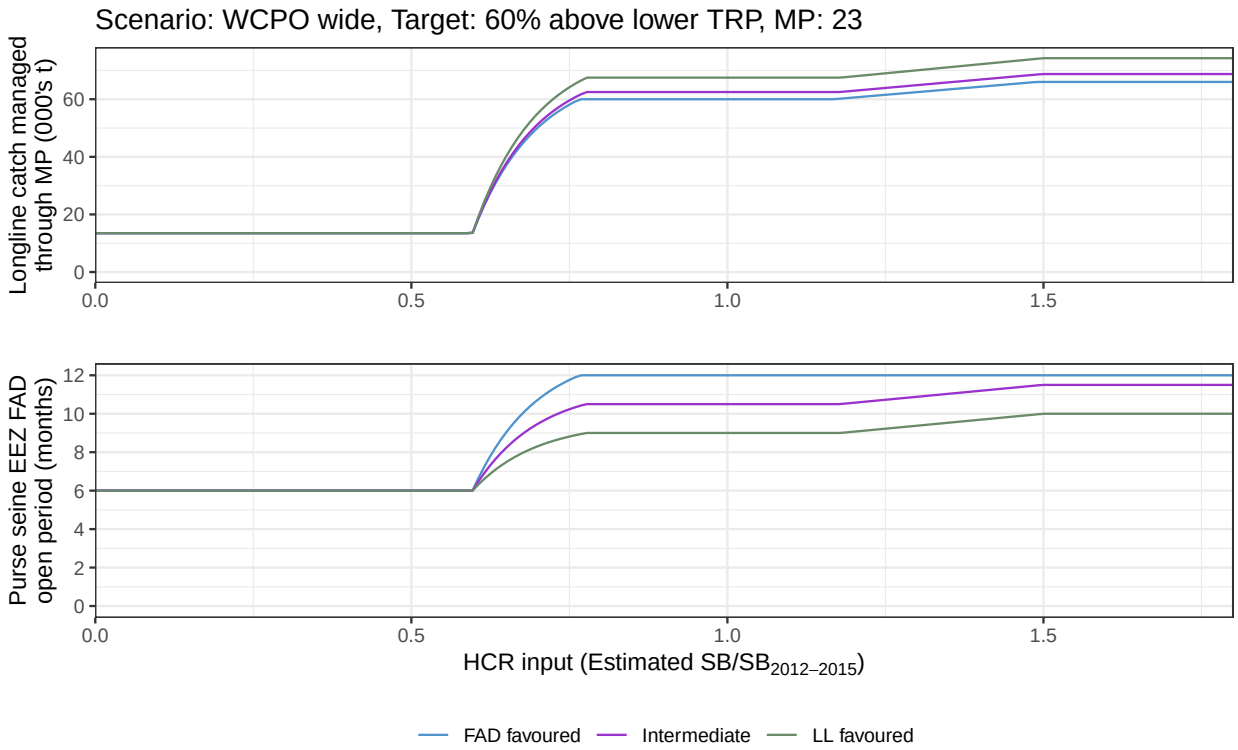

Figure 21

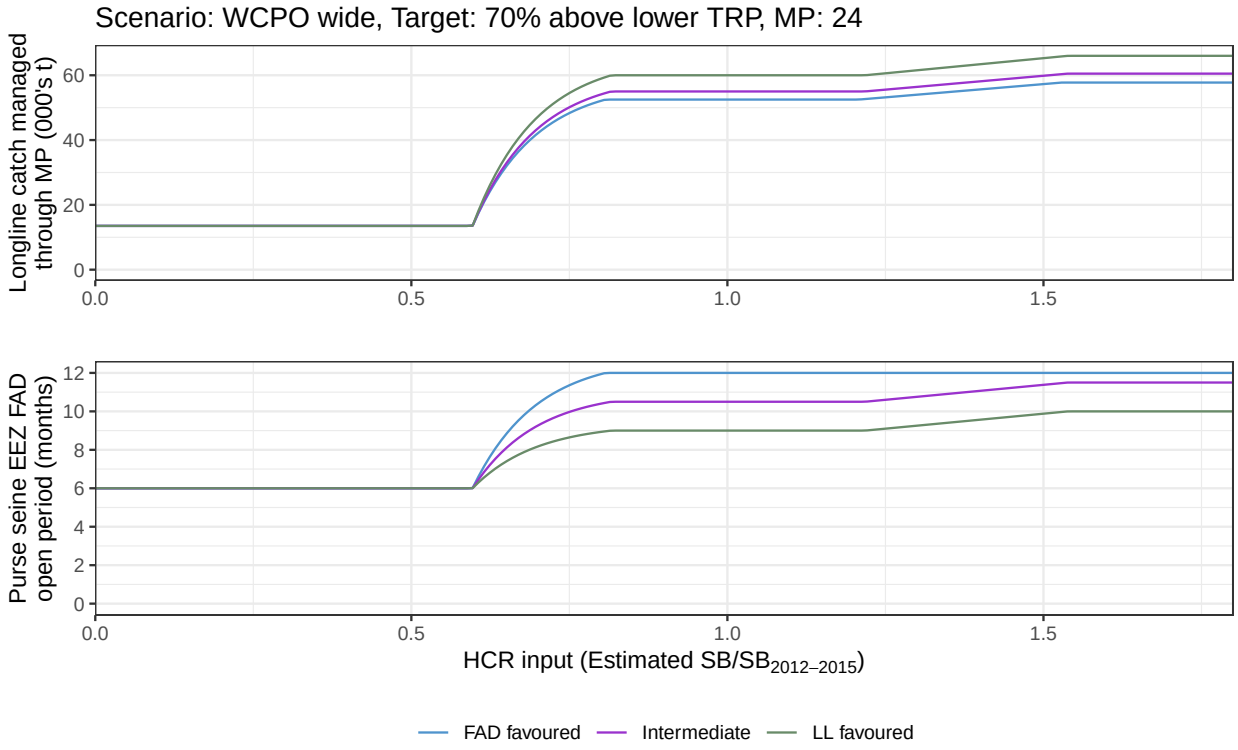

Figure 22

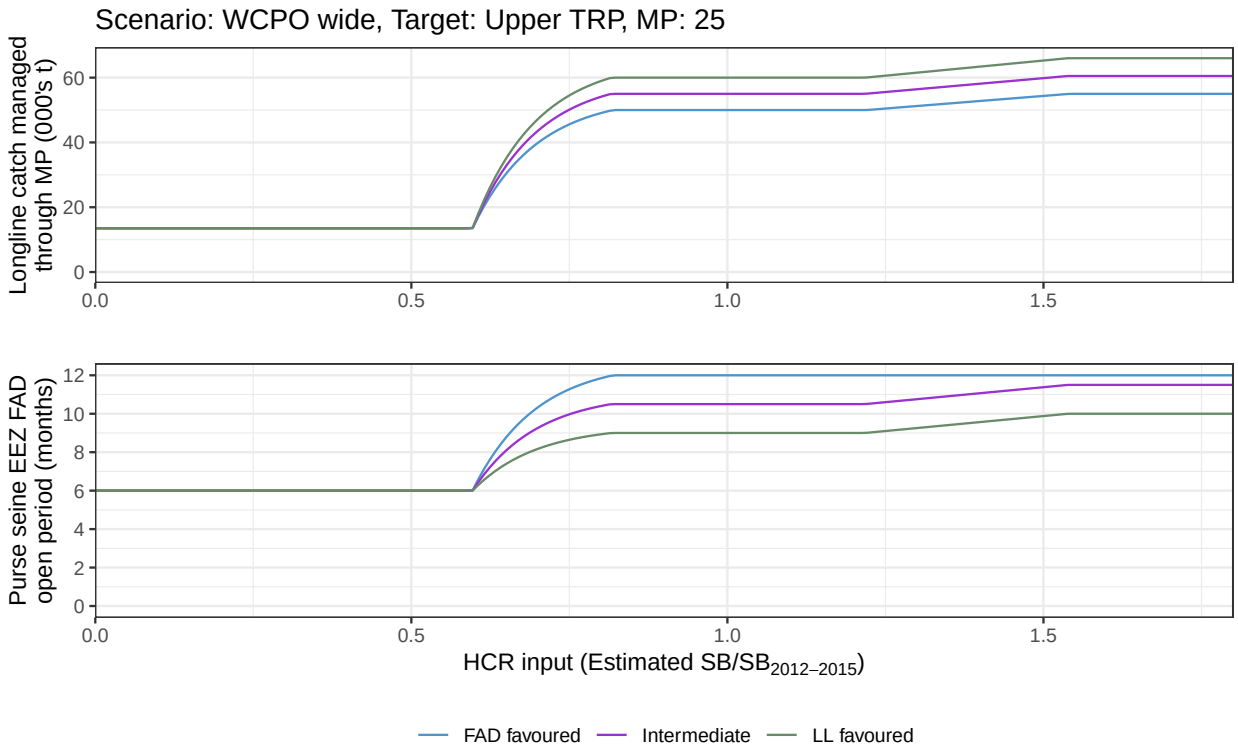

Figure 23

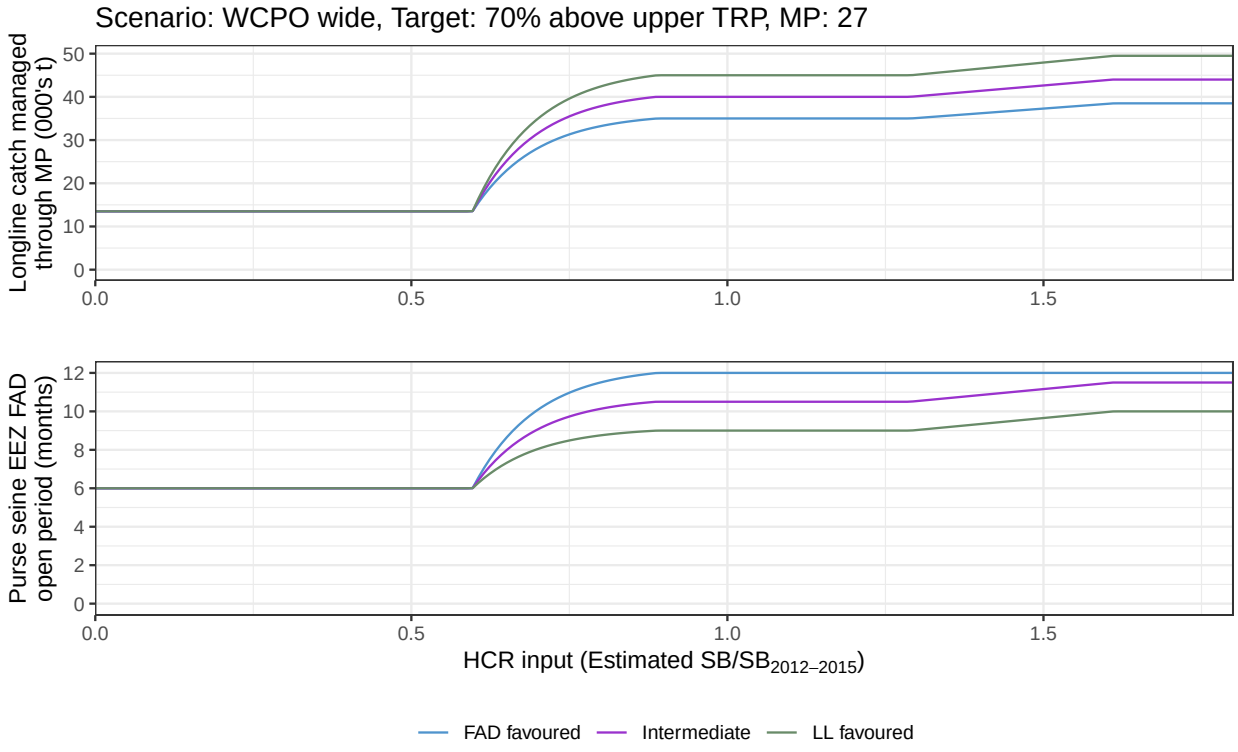

Figure 24

10 Appendix: Results tables

This appendix presents tables of the performance indicators. The tables are separated by time period (short-term: 2028-2036; medium-term: 2037-2045; long-term: 2046-2054), and also by bigeye MP spatial scenario. For each MP there are three sets of results for each of the HCR pair scenarios that were run.

Table 7: Performance indicators in the short-term (2028-2036) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, excluding the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 4 (ITRP)	FAD favoured	1	0.68	0.48	1.05 (0.66,1.49)	46 (33,63)	4.1	1.3e-10	0.6 (0.45,0.79)	45 (43,45)	4.7e-10	57	0.56 (0.32,0.77)
	LL favoured	1	0.67	0.46	1.05 (0.65,1.46)	37 (27,51)	3.5	1e-10	0.65 (0.49,0.84)	55 (52,56)	6.5e-10	110	0.56 (0.33,0.75)
	Random	1	0.68	0.47	1.05 (0.65,1.47)	42 (30,57)	4.8	0.95	0.62 (0.47,0.82)	50 (48,51)	1.9	100	0.56 (0.32,0.76)
MP 5 (60% > ITRP)	FAD favoured	1	0.73	0.54	1.09 (0.68,1.53)	46 (33,63)	4.1	1.3e-10	0.6 (0.45,0.79)	38 (36,38)	3.4e-10	34	0.6 (0.35,0.81)
	LL favoured	1	0.72	0.52	1.08 (0.67,1.51)	38 (27,51)	3.5	9.7e-11	0.65 (0.49,0.84)	48 (45,48)	4.9e-10	56	0.6 (0.37,0.8)
	Random	1	0.73	0.53	1.08 (0.67,1.52)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	43 (41,43)	1.9	69	0.6 (0.36,0.81)
MP 6 (70% > ITRP)	FAD favoured	1	0.78	0.59	1.12 (0.71,1.57)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	30 (29,30)	2.5e-10	20	0.64 (0.38,0.86)
	LL favoured	1	0.77	0.58	1.11 (0.69,1.55)	38 (27,51)	3.5	9.6e-11	0.66 (0.5,0.85)	40 (38,40)	3.8e-10	34	0.64 (0.4,0.84)
	Random	1	0.77	0.59	1.12 (0.7,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	35 (34,35)	1.9	52	0.65 (0.39,0.85)
MP 7 (uTRP)	FAD favoured	1	0.78	0.59	1.12 (0.71,1.57)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	30 (29,30)	2.5e-10	20	0.64 (0.38,0.86)
	LL favoured	1	0.77	0.58	1.11 (0.69,1.55)	38 (27,51)	3.5	9.6e-11	0.66 (0.5,0.85)	40 (38,40)	3.8e-10	34	0.64 (0.4,0.84)
	Random	1	0.77	0.59	1.12 (0.7,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	35 (34,35)	1.9	52	0.65 (0.39,0.85)
MP 9 (70% > uTRP)	FAD favoured	1	0.85	0.68	1.18 (0.76,1.66)	47 (34,64)	4.1	1.4e-10	0.61 (0.46,0.8)	15 (15,15)	1.4e-10	8.8	0.72 (0.43,0.95)
	LL favoured	1	0.84	0.67	1.17 (0.75,1.64)	38 (28,52)	3.5	1e-10	0.66 (0.5,0.85)	25 (24,25)	2.5e-10	15	0.73 (0.46,0.94)
	Random	1	0.85	0.68	1.18 (0.76,1.65)	42 (31,58)	4.8	0.95	0.63 (0.49,0.83)	20 (19,20)	1.7	36	0.73 (0.45,0.95)

Table 8: Performance indicators in the medium-term (2037-2045) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, excluding the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 4 (ITRP)	FAD favoured	0.99	0.59	0.36	0.99 (0.6,1.41)	46 (32,67)	4.3	1.4e-10	0.57 (0.41,0.8)	45 (38,45)	4.9e-10	63	0.46 (0.2,0.69)
	LL favoured	0.99	0.57	0.34	0.98 (0.59,1.38)	38 (26,55)	3.7	1.1e-10	0.63 (0.44,0.86)	55 (45,56)	7e-10	120	0.47 (0.23,0.68)
	Random	0.99	0.58	0.35	0.99 (0.59,1.39)	43 (29,63)	5.4	1.7	0.6 (0.42,0.83)	48 (40,50)	2.2	140	0.46 (0.21,0.69)
MP 5 (60% > ITRP)	FAD favoured	0.99	0.68	0.46	1.04 (0.65,1.46)	47 (32,68)	4.3	1.4e-10	0.58 (0.41,0.81)	38 (34,38)	3.8e-10	33	0.52 (0.26,0.75)
	LL favoured	0.99	0.68	0.44	1.04 (0.65,1.44)	39 (27,55)	3.6	1.1e-10	0.64 (0.45,0.86)	48 (42,48)	5.4e-10	60	0.54 (0.28,0.76)
	Random	0.99	0.68	0.45	1.04 (0.65,1.45)	43 (30,63)	5.4	1.7	0.6 (0.43,0.83)	41 (37,43)	2.2	86	0.53 (0.27,0.75)
MP 6 (70% > ITRP)	FAD favoured	1	0.76	0.55	1.09 (0.71,1.51)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	30 (28,30)	2.8e-10	19	0.59 (0.3,0.81)
	LL favoured	1	0.76	0.55	1.09 (0.7,1.5)	39 (28,55)	3.6	1e-10	0.64 (0.46,0.87)	40 (37,40)	4.1e-10	33	0.6 (0.33,0.82)
	Random	1	0.76	0.55	1.09 (0.71,1.5)	44 (31,64)	5.4	1.7	0.61 (0.44,0.83)	33 (32,35)	2.2	62	0.59 (0.31,0.81)
MP 7 (uTRP)	FAD favoured	1	0.76	0.55	1.09 (0.71,1.51)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	30 (28,30)	2.8e-10	19	0.59 (0.3,0.81)
	LL favoured	1	0.76	0.55	1.09 (0.7,1.5)	39 (28,55)	3.6	1e-10	0.64 (0.46,0.87)	40 (37,40)	4.1e-10	33	0.6 (0.33,0.82)
	Random	1	0.76	0.55	1.09 (0.71,1.5)	44 (31,64)	5.4	1.7	0.61 (0.44,0.83)	33 (32,35)	2.2	62	0.59 (0.31,0.81)
MP 9 (70% > uTRP)	FAD favoured	1	0.88	0.72	1.19 (0.81,1.64)	48 (34,69)	4.3	1.4e-10	0.59 (0.43,0.82)	15 (15,15)	1.4e-10	5.7	0.71 (0.38,0.97)
	LL favoured	1	0.88	0.73	1.19 (0.81,1.61)	40 (28,56)	3.6	1e-10	0.65 (0.48,0.87)	25 (24,25)	2.4e-10	11	0.73 (0.42,0.96)
	Random	1	0.88	0.72	1.19 (0.81,1.62)	45 (32,64)	5.5	1.7	0.62 (0.45,0.84)	19 (18,20)	2.2	39	0.72 (0.4,0.96)

Table 9: Performance indicators in the long-term (2046-2054) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, excluding the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 4 (ITRP)	FAD favoured	0.99	0.53	0.32	0.96 (0.58,1.41)	46 (31,70)	4.4	1.4e-10	0.56 (0.38,0.8)	45 (37,46)	5.9e-10	69	0.44 (0.15,0.69)
	LL favoured	0.99	0.52	0.31	0.95 (0.56,1.38)	39 (26,59)	3.7	1.5e-10	0.61 (0.42,0.85)	55 (43,56)	1e-09	130	0.44 (0.17,0.68)
	Random	0.99	0.52	0.31	0.95 (0.57,1.39)	42 (28,63)	5.6	1.7	0.59 (0.4,0.82)	50 (40,52)	3.1	170	0.44 (0.15,0.68)
MP 5 (60% > ITRP)	FAD favoured	1	0.64	0.41	1.02 (0.62,1.46)	47 (32,71)	4.4	1.4e-10	0.57 (0.4,0.8)	38 (34,38)	4.4e-10	36	0.51 (0.21,0.75)
	LL favoured	1	0.64	0.4	1.01 (0.62,1.43)	39 (27,59)	3.7	1.3e-10	0.62 (0.43,0.86)	48 (42,49)	6.4e-10	63	0.51 (0.22,0.75)
	Random	1	0.63	0.4	1.01 (0.62,1.44)	42 (29,64)	5.7	1.7	0.59 (0.41,0.83)	43 (39,45)	3.3	110	0.5 (0.21,0.75)
MP 6 (70% > ITRP)	FAD favoured	1	0.74	0.52	1.07 (0.68,1.52)	48 (32,72)	4.3	1.3e-10	0.57 (0.41,0.8)	30 (28,31)	3.1e-10	19	0.57 (0.26,0.82)
	LL favoured	1	0.73	0.51	1.07 (0.67,1.49)	40 (27,60)	3.7	1.2e-10	0.63 (0.45,0.87)	40 (37,41)	5.2e-10	34	0.58 (0.27,0.82)
	Random	1	0.73	0.51	1.07 (0.68,1.51)	43 (29,64)	5.7	1.5	0.6 (0.43,0.83)	36 (34,37)	3.3	75	0.57 (0.26,0.82)
MP 7 (uTRP)	FAD favoured	1	0.74	0.52	1.07 (0.68,1.52)	48 (32,72)	4.3	1.3e-10	0.57 (0.41,0.8)	30 (28,31)	3.1e-10	19	0.57 (0.26,0.82)
	LL favoured	1	0.73	0.51	1.07 (0.67,1.49)	40 (27,60)	3.7	1.2e-10	0.63 (0.45,0.87)	40 (37,41)	5.2e-10	34	0.58 (0.27,0.82)
	Random	1	0.73	0.51	1.07 (0.68,1.51)	43 (29,64)	5.7	1.5	0.6 (0.43,0.83)	36 (34,37)	3.3	75	0.57 (0.26,0.82)
MP 9 (70% > uTRP)	FAD favoured	1	0.87	0.71	1.18 (0.79,1.63)	49 (34,73)	4.3	1.2e-10	0.58 (0.42,0.81)	15 (15,15)	1.4e-10	5.9	0.69 (0.34,0.97)
	LL favoured	1	0.87	0.72	1.18 (0.78,1.61)	41 (28,60)	3.7	1.2e-10	0.64 (0.47,0.88)	25 (25,26)	2.7e-10	11	0.71 (0.37,0.96)
	Random	1	0.87	0.71	1.18 (0.78,1.62)	44 (30,65)	5.8	1.6	0.61 (0.45,0.84)	21 (20,22)	2.1	44	0.69 (0.35,0.95)

Table 10: Performance indicators in the short-term (2028-2036) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, including the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 13 (ITRP)	FAD favoured	1	0.69	0.48	1.05 (0.66,1.49)	46 (33,63)	4.1	1.3e-10	0.6 (0.45,0.79)	48 (46,48)	4.8e-10	57	0.56 (0.32,0.77)
	LL favoured	1	0.67	0.46	1.05 (0.65,1.47)	37 (27,51)	3.5	1e-10	0.65 (0.49,0.84)	58 (55,58)	6.4e-10	100	0.56 (0.33,0.75)
	Random	1	0.68	0.47	1.05 (0.65,1.47)	42 (30,57)	4.8	0.95	0.62 (0.47,0.82)	53 (50,53)	1.9	97	0.56 (0.32,0.76)
MP 14 (60% > ITRP)	FAD favoured	1	0.74	0.54	1.09 (0.68,1.53)	46 (33,63)	4.1	1.3e-10	0.6 (0.45,0.79)	40 (38,40)	3.6e-10	34	0.6 (0.35,0.81)
	LL favoured	1	0.72	0.52	1.08 (0.67,1.51)	38 (27,51)	3.5	9.9e-11	0.65 (0.49,0.84)	50 (48,50)	4.9e-10	56	0.6 (0.37,0.8)
	Random	1	0.73	0.53	1.08 (0.68,1.52)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	45 (43,45)	1.9	67	0.6 (0.36,0.81)
MP 15 (70% > ITRP)	FAD favoured	1	0.78	0.59	1.12 (0.71,1.57)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	33 (31,33)	2.7e-10	21	0.64 (0.37,0.86)
	LL favoured	1	0.77	0.58	1.11 (0.7,1.55)	38 (27,51)	3.5	9.6e-11	0.66 (0.5,0.85)	43 (40,43)	3.9e-10	34	0.64 (0.4,0.84)
	Random	1	0.78	0.59	1.12 (0.7,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	38 (36,38)	1.9	52	0.64 (0.39,0.85)
MP 16 (uTRP)	FAD favoured	1	0.78	0.59	1.12 (0.71,1.57)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	33 (31,33)	2.7e-10	21	0.64 (0.37,0.86)
	LL favoured	1	0.77	0.58	1.11 (0.7,1.55)	38 (27,51)	3.5	9.6e-11	0.66 (0.5,0.85)	43 (40,43)	3.9e-10	34	0.64 (0.4,0.84)
	Random	1	0.78	0.59	1.12 (0.7,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	38 (36,38)	1.9	52	0.64 (0.39,0.85)
MP 18 (70% > uTRP)	FAD favoured	1	0.85	0.69	1.18 (0.76,1.66)	47 (34,64)	4.1	1.4e-10	0.61 (0.46,0.8)	18 (17,18)	1.7e-10	9.8	0.72 (0.42,0.94)
	LL favoured	1	0.84	0.67	1.17 (0.75,1.64)	38 (28,52)	3.5	9.8e-11	0.66 (0.5,0.85)	28 (26,28)	2.7e-10	16	0.72 (0.46,0.94)
	Random	1	0.85	0.68	1.18 (0.76,1.65)	42 (31,58)	4.8	0.95	0.63 (0.49,0.83)	23 (22,23)	1.8	37	0.72 (0.44,0.94)

Table 11: Performance indicators in the medium-term (2037-2045) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, including the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 13 (ITRP)	FAD favoured	0.99	0.59	0.36	0.99 (0.6,1.41)	46 (32,67)	4.3	1.4e-10	0.57 (0.41,0.8)	48 (40,48)	5.2e-10	62	0.46 (0.2,0.69)
	LL favoured	0.99	0.57	0.35	0.98 (0.59,1.38)	38 (26,55)	3.7	1.1e-10	0.63 (0.44,0.86)	58 (47,58)	7.1e-10	120	0.47 (0.23,0.69)
	Random	0.99	0.58	0.36	0.99 (0.6,1.39)	43 (29,63)	5.4	1.7	0.6 (0.42,0.83)	51 (42,53)	2.2	130	0.47 (0.21,0.69)
MP 14 (60% > ITRP)	FAD favoured	0.99	0.68	0.46	1.04 (0.65,1.46)	47 (32,68)	4.3	1.4e-10	0.58 (0.41,0.81)	40 (36,40)	4e-10	34	0.52 (0.26,0.75)
	LL favoured	0.99	0.68	0.44	1.04 (0.65,1.44)	39 (27,55)	3.6	1.1e-10	0.64 (0.45,0.86)	50 (45,51)	5.5e-10	59	0.54 (0.28,0.76)
	Random	0.99	0.68	0.45	1.04 (0.65,1.45)	43 (30,63)	5.4	1.7	0.6 (0.43,0.83)	43 (39,45)	2.2	84	0.53 (0.27,0.75)
MP 15 (70% > ITRP)	FAD favoured	1	0.76	0.55	1.1 (0.71,1.51)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	33 (30,33)	3.1e-10	20	0.58 (0.3,0.81)
	LL favoured	1	0.76	0.55	1.09 (0.7,1.5)	39 (28,55)	3.6	1e-10	0.64 (0.46,0.87)	43 (40,43)	4.1e-10	33	0.6 (0.33,0.82)
	Random	1	0.76	0.55	1.09 (0.71,1.51)	44 (31,64)	5.4	1.7	0.61 (0.44,0.83)	36 (34,38)	2.2	61	0.59 (0.31,0.81)
MP 16 (uTRP)	FAD favoured	1	0.76	0.55	1.1 (0.71,1.51)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	33 (30,33)	3.1e-10	20	0.58 (0.3,0.81)
	LL favoured	1	0.76	0.55	1.09 (0.7,1.5)	39 (28,55)	3.6	1e-10	0.64 (0.46,0.87)	43 (40,43)	4.1e-10	33	0.6 (0.33,0.82)
	Random	1	0.76	0.55	1.09 (0.71,1.51)	44 (31,64)	5.4	1.7	0.61 (0.44,0.83)	36 (34,38)	2.2	61	0.59 (0.31,0.81)
MP 18 (70% > uTRP)	FAD favoured	1	0.88	0.72	1.19 (0.82,1.64)	48 (34,69)	4.3	1.3e-10	0.59 (0.43,0.81)	18 (17,18)	1.6e-10	6.5	0.7 (0.38,0.95)
	LL favoured	1	0.89	0.73	1.19 (0.82,1.61)	40 (28,56)	3.6	1e-10	0.65 (0.48,0.87)	28 (27,28)	2.5e-10	12	0.72 (0.41,0.95)
	Random	1	0.88	0.72	1.19 (0.82,1.62)	45 (32,64)	5.5	1.7	0.62 (0.45,0.84)	21 (21,23)	2.2	39	0.71 (0.39,0.95)

Table 12: Performance indicators in the long-term (2046-2054) for the bigeye MP spatial scenario where the MP manages the tropical longline fisheries, including the Hawaiian longline fleet. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 13 (ITRP)	FAD favoured	0.99	0.53	0.33	0.96 (0.58,1.41)	46 (31,70)	4.4	1.4e-10	0.56 (0.38,0.8)	48 (39,48)	6.3e-10	68	0.44 (0.15,0.69)
	LL favoured	0.99	0.52	0.31	0.95 (0.56,1.38)	39 (26,59)	3.8	1.4e-10	0.61 (0.42,0.85)	58 (45,59)	9.6e-10	130	0.45 (0.17,0.69)
	Random	0.99	0.52	0.32	0.96 (0.57,1.39)	42 (28,63)	5.6	1.8	0.59 (0.4,0.83)	53 (42,55)	3.2	160	0.44 (0.15,0.68)
MP 14 (60% > ITRP)	FAD favoured	1	0.64	0.42	1.02 (0.62,1.46)	47 (32,71)	4.4	1.4e-10	0.57 (0.4,0.8)	40 (36,41)	4.6e-10	36	0.5 (0.21,0.75)
	LL favoured	1	0.64	0.41	1.01 (0.62,1.43)	39 (27,59)	3.7	1.3e-10	0.62 (0.43,0.86)	50 (45,51)	6.5e-10	62	0.51 (0.22,0.75)
	Random	1	0.63	0.4	1.02 (0.62,1.45)	42 (29,64)	5.7	1.7	0.59 (0.42,0.83)	46 (41,47)	3.3	100	0.5 (0.21,0.76)
MP 15 (70% > ITRP)	FAD favoured	1	0.74	0.52	1.08 (0.68,1.52)	48 (32,72)	4.3	1.3e-10	0.57 (0.41,0.8)	33 (31,33)	3.5e-10	21	0.56 (0.25,0.81)
	LL favoured	1	0.74	0.51	1.07 (0.67,1.49)	40 (28,60)	3.7	1.2e-10	0.63 (0.45,0.87)	43 (40,44)	5.3e-10	34	0.58 (0.27,0.82)
	Random	1	0.73	0.51	1.07 (0.68,1.51)	43 (29,64)	5.7	1.5	0.6 (0.43,0.83)	38 (36,40)	3.3	74	0.57 (0.26,0.82)
MP 16 (uTRP)	FAD favoured	1	0.74	0.52	1.08 (0.68,1.52)	48 (32,72)	4.3	1.3e-10	0.57 (0.41,0.8)	33 (31,33)	3.5e-10	21	0.56 (0.25,0.81)
	LL favoured	1	0.74	0.51	1.07 (0.67,1.49)	40 (28,60)	3.7	1.2e-10	0.63 (0.45,0.87)	43 (40,44)	5.3e-10	34	0.58 (0.27,0.82)
	Random	1	0.73	0.51	1.07 (0.68,1.51)	43 (29,64)	5.7	1.5	0.6 (0.43,0.83)	38 (36,40)	3.3	74	0.57 (0.26,0.82)
MP 18 (70% > uTRP)	FAD favoured	1	0.87	0.71	1.18 (0.8,1.63)	49 (34,73)	4.3	1.1e-10	0.58 (0.42,0.81)	18 (17,18)	1.7e-10	6.8	0.68 (0.33,0.95)
	LL favoured	1	0.87	0.72	1.18 (0.78,1.61)	41 (28,60)	3.7	1.1e-10	0.64 (0.47,0.88)	28 (27,28)	3e-10	12	0.7 (0.37,0.96)
	Random	1	0.87	0.71	1.18 (0.79,1.62)	44 (30,65)	5.8	1.6	0.61 (0.45,0.84)	23 (22,24)	2.2	44	0.68 (0.35,0.94)

Table 13: Performance indicators in the short-term (2028-2036) for the bigeye MP spatial scenario where the MP manages the longline fisheries in the WCPO. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 22 (ITRP)	FAD favoured	1	0.69	0.48	1.05 (0.65,1.49)	46 (33,63)	4.1	1.2e-10	0.6 (0.45,0.79)	65 (63,66)	4.9e-10	74	0.73 (0.48,0.93)
	LL favoured	1	0.67	0.46	1.05 (0.64,1.46)	37 (27,51)	3.5	9.2e-11	0.65 (0.49,0.84)	75 (72,76)	6.1e-10	110	0.73 (0.5,0.94)
	Random	1	0.68	0.47	1.05 (0.65,1.48)	42 (30,57)	4.8	0.95	0.62 (0.47,0.82)	70 (67,71)	1.9	110	0.73 (0.5,0.93)
MP 23 (60% > ITRP)	FAD favoured	1	0.72	0.52	1.08 (0.67,1.52)	46 (33,63)	4.1	1.2e-10	0.6 (0.45,0.79)	60 (58,60)	4.4e-10	56	0.75 (0.5,0.95)
	LL favoured	1	0.72	0.52	1.08 (0.68,1.51)	38 (27,51)	3.5	8.9e-11	0.65 (0.49,0.84)	68 (65,68)	5e-10	71	0.76 (0.53,0.97)
	Random	1	0.73	0.53	1.08 (0.68,1.52)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	63 (61,64)	1.3	72	0.76 (0.53,0.96)
MP 24 (70% > ITRP)	FAD favoured	1	0.77	0.58	1.11 (0.7,1.56)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	53 (50,53)	3.8e-10	39	0.78 (0.53,0.99)
	LL favoured	1	0.77	0.58	1.11 (0.7,1.55)	38 (27,51)	3.5	8.9e-11	0.66 (0.5,0.85)	60 (57,60)	4.4e-10	49	0.8 (0.57,1)
	Random	1	0.78	0.59	1.11 (0.71,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	56 (53,56)	1.3	57	0.79 (0.55,1)
MP 25 (uTRP)	FAD favoured	1	0.78	0.59	1.12 (0.71,1.58)	46 (33,63)	4.1	1.2e-10	0.6 (0.46,0.8)	50 (47,50)	3.8e-10	35	0.79 (0.54,1)
	LL favoured	1	0.77	0.58	1.11 (0.7,1.55)	38 (27,51)	3.5	8.9e-11	0.66 (0.5,0.85)	60 (57,60)	4.4e-10	49	0.8 (0.57,1)
	Random	1	0.78	0.59	1.12 (0.71,1.56)	42 (30,57)	4.8	0.95	0.63 (0.48,0.82)	55 (52,55)	1.9	67	0.79 (0.56,1)
MP 27 (70% > uTRP)	FAD favoured	1	0.85	0.69	1.19 (0.77,1.67)	46 (34,64)	4.1	1.6e-10	0.61 (0.46,0.8)	35 (33,35)	2.8e-10	21	0.85 (0.59,1.06)
	LL favoured	1	0.84	0.68	1.18 (0.76,1.64)	38 (28,52)	3.5	1.2e-10	0.66 (0.5,0.85)	45 (42,45)	3.8e-10	28	0.86 (0.62,1.07)
	Random	1	0.85	0.68	1.18 (0.76,1.65)	42 (31,58)	4.8	0.95	0.63 (0.49,0.83)	40 (38,40)	1.8	51	0.86 (0.61,1.06)

Table 14: Performance indicators in the medium-term (2037-2045) for the bigeye MP spatial scenario where the MP manages the longline fisheries in the WCPO. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 22 (ITRP)	FAD favoured	0.99	0.59	0.37	0.99 (0.61,1.41)	46 (31,67)	4.3	1.3e-10	0.57 (0.41,0.8)	65 (53,66)	5.5e-10	82	0.64 (0.38,0.86)
	LL favoured	0.99	0.58	0.35	0.99 (0.6,1.38)	38 (26,55)	3.6	1.1e-10	0.63 (0.45,0.86)	75 (60,76)	7.2e-10	130	0.66 (0.4,0.88)
	Random	0.99	0.59	0.36	0.99 (0.6,1.4)	43 (29,63)	5.4	1.7	0.6 (0.42,0.83)	68 (56,70)	2.2	140	0.65 (0.38,0.87)
MP 23 (60% > ITRP)	FAD favoured	0.99	0.66	0.43	1.03 (0.64,1.45)	46 (32,68)	4.3	1.3e-10	0.58 (0.41,0.8)	60 (53,61)	5e-10	61	0.67 (0.41,0.89)
	LL favoured	0.99	0.68	0.45	1.04 (0.65,1.45)	39 (27,55)	3.6	1e-10	0.63 (0.45,0.86)	68 (60,68)	6e-10	76	0.71 (0.43,0.93)
	Random	0.99	0.67	0.44	1.03 (0.65,1.45)	43 (30,63)	5.4	1.7	0.6 (0.43,0.83)	63 (55,64)	1.7	92	0.69 (0.41,0.91)
MP 24 (70% > ITRP)	FAD favoured	1	0.74	0.53	1.08 (0.69,1.51)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	53 (48,53)	4.2e-10	39	0.72 (0.45,0.93)
	LL favoured	1	0.77	0.56	1.09 (0.7,1.5)	39 (27,55)	3.6	1e-10	0.64 (0.46,0.87)	60 (55,61)	5e-10	49	0.76 (0.5,0.97)
	Random	1	0.76	0.55	1.09 (0.69,1.51)	44 (31,63)	5.4	1.7	0.61 (0.44,0.83)	55 (51,56)	1.7	69	0.74 (0.47,0.95)
MP 25 (uTRP)	FAD favoured	1	0.77	0.56	1.1 (0.71,1.52)	47 (33,68)	4.3	1.3e-10	0.58 (0.42,0.81)	50 (46,50)	4.1e-10	34	0.73 (0.46,0.95)
	LL favoured	1	0.77	0.56	1.09 (0.7,1.5)	39 (27,55)	3.6	1e-10	0.64 (0.46,0.87)	60 (55,61)	5e-10	49	0.76 (0.5,0.97)
	Random	1	0.77	0.56	1.1 (0.7,1.52)	44 (31,64)	5.4	1.7	0.61 (0.44,0.83)	53 (50,55)	2.2	78	0.74 (0.47,0.96)
MP 27 (70% > uTRP)	FAD favoured	1	0.89	0.74	1.2 (0.82,1.64)	48 (34,69)	4.3	1.4e-10	0.59 (0.43,0.81)	35 (34,35)	2.7e-10	16	0.82 (0.55,1.04)
	LL favoured	1	0.89	0.74	1.2 (0.82,1.62)	40 (28,56)	3.6	1e-10	0.65 (0.48,0.87)	45 (44,45)	3.6e-10	24	0.85 (0.58,1.07)
	Random	1	0.89	0.74	1.2 (0.82,1.63)	45 (32,64)	5.5	1.7	0.62 (0.45,0.84)	38 (38,40)	2.2	54	0.84 (0.56,1.05)

Table 15: Performance indicators in the long-term (2046-2054) for the bigeye MP spatial scenario where the MP manages the longline fisheries in the WCPO. $SB/SB_{F=0}$ is presented as relative to the TRP, i.e. relative to the average depletion in 2012-2015. The value shown is the median, or the probability. Values in parenthesis are the 95th percentile range.

		Biological				Purse seine				Longline			
MP (target)	HCR scenario	Prob. > LRP	Prob. > ITRP	Prob. > uTRP	Relative $SB/SB_{F=0}$	Catch (000s t)	Catch var. (000s t)	Effort var. (000s sets)	Rel. vuln. biomass	Catch (000s t)	Catch var. (000s t)	Effort var. (mil. hooks)	Rel. vuln. biomass
MP 22 (ITRP)	FAD favoured	0.99	0.55	0.33	0.97 (0.57,1.41)	46 (32,70)	4.4	1.3e-10	0.56 (0.39,0.8)	65 (52,66)	6.7e-10	90	0.61 (0.31,0.85)
	LL favoured	0.99	0.53	0.32	0.96 (0.56,1.38)	39 (26,59)	3.7	1.5e-10	0.61 (0.43,0.85)	75 (60,77)	1.1e-09	140	0.63 (0.34,0.87)
	Random	0.99	0.53	0.32	0.96 (0.57,1.4)	42 (28,63)	5.6	1.8	0.59 (0.41,0.83)	71 (56,73)	3.3	170	0.62 (0.32,0.85)
MP 23 (60% > ITRP)	FAD favoured	0.99	0.62	0.39	1.01 (0.61,1.45)	47 (32,71)	4.4	1.3e-10	0.56 (0.39,0.8)	60 (53,61)	5.9e-10	63	0.64 (0.35,0.87)
	LL favoured	1	0.64	0.42	1.02 (0.62,1.44)	39 (27,59)	3.7	1.2e-10	0.62 (0.44,0.86)	68 (60,69)	6.9e-10	80	0.68 (0.39,0.92)
	Random	1	0.63	0.4	1.01 (0.62,1.45)	42 (29,63)	5.6	1.7	0.59 (0.41,0.83)	64 (57,66)	2.5	110	0.66 (0.37,0.89)
MP 24 (70% > ITRP)	FAD favoured	1	0.72	0.5	1.06 (0.66,1.51)	47 (32,72)	4.4	1.3e-10	0.57 (0.41,0.8)	53 (49,54)	5e-10	41	0.7 (0.4,0.93)
	LL favoured	1	0.74	0.53	1.08 (0.67,1.5)	40 (27,60)	3.7	1.2e-10	0.63 (0.45,0.87)	60 (56,62)	6e-10	50	0.73 (0.44,0.97)
	Random	1	0.73	0.51	1.07 (0.67,1.51)	43 (29,64)	5.7	1.6	0.6 (0.43,0.83)	57 (53,58)	2.5	79	0.71 (0.42,0.94)
MP 25 (uTRP)	FAD favoured	1	0.75	0.54	1.08 (0.68,1.53)	48 (33,72)	4.3	1.3e-10	0.57 (0.41,0.8)	50 (47,51)	4.8e-10	36	0.71 (0.42,0.95)
	LL favoured	1	0.74	0.53	1.08 (0.67,1.5)	40 (27,60)	3.7	1.2e-10	0.63 (0.45,0.87)	60 (56,62)	6e-10	50	0.73 (0.44,0.97)
	Random	1	0.74	0.53	1.08 (0.67,1.51)	43 (29,64)	5.7	1.6	0.6 (0.43,0.83)	56 (52,58)	3.3	91	0.71 (0.43,0.95)
MP 27 (70% > uTRP)	FAD favoured	1	0.88	0.73	1.19 (0.8,1.65)	49 (34,73)	4.3	1.3e-10	0.58 (0.42,0.8)	35 (34,36)	3e-10	17	0.81 (0.51,1.05)
	LL favoured	1	0.88	0.73	1.19 (0.8,1.62)	41 (28,60)	3.7	1.3e-10	0.64 (0.47,0.87)	45 (44,46)	4.4e-10	24	0.83 (0.54,1.08)
	Random	1	0.88	0.73	1.19 (0.8,1.63)	44 (30,65)	5.7	1.6	0.61 (0.45,0.84)	41 (40,42)	2.8	62	0.82 (0.52,1.06)

11 Appendix: Fishery performance indicator plots

This appendix presents fishery performance indicator plots for the bigeye MP scenarios in which the bigeye MP manages the tropical longline fisheries, including the Hawaiian longline fleet, and in which the bigeye MP manages all longline fisheries in the WCPO.

Detailed analysis is not presented as the patterns of results are similar to the results when the MP manages the tropical longline fisheries, excluding the Hawaiian longline fleet, in the main results section.

11.1 Bigeye management procedure manages the tropical longline fisheries, including the Hawaiian longline fleet

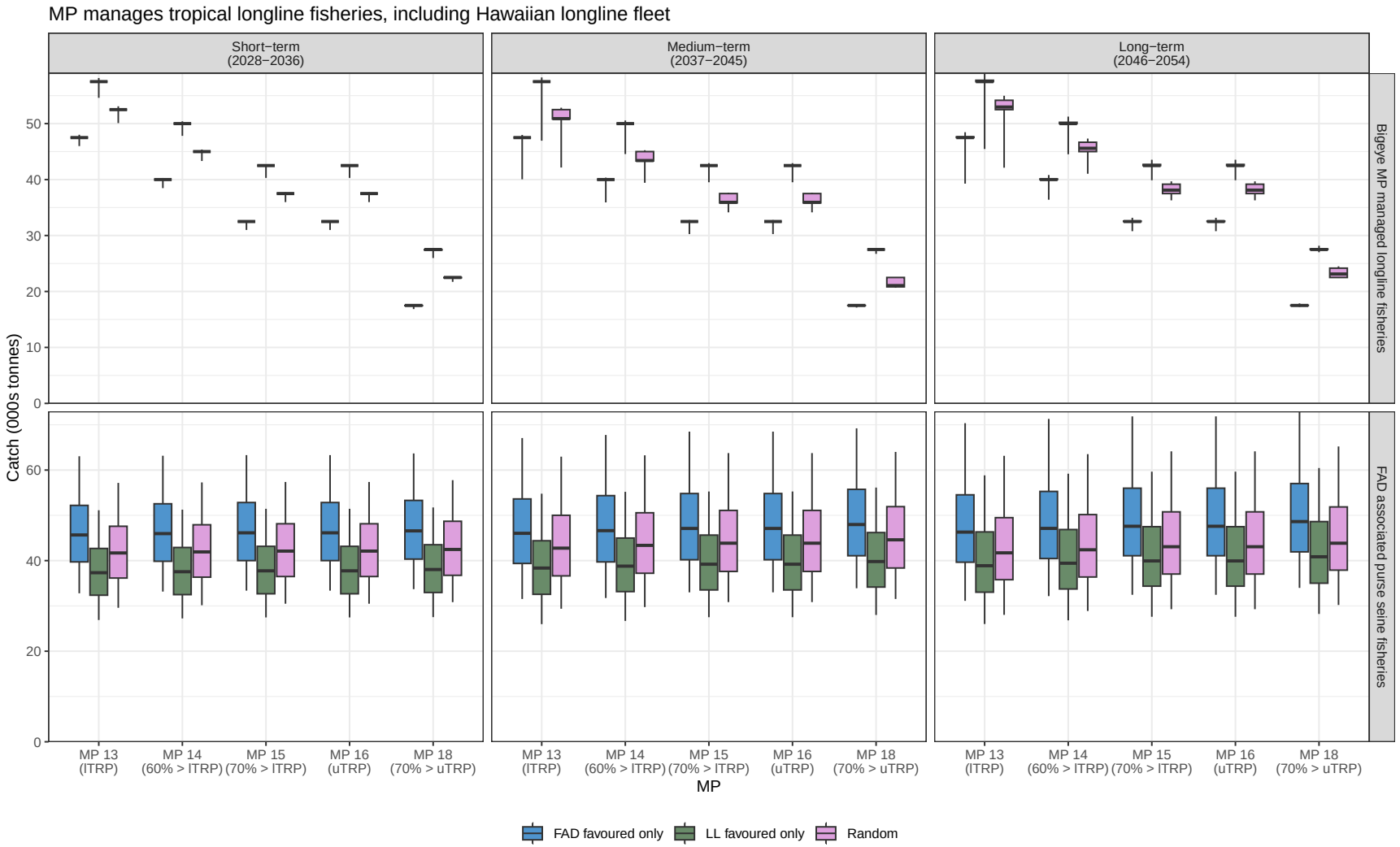

Figure 25: Box plots of expected catch taken by the longline fisheries managed through the bigeye MP (top row, the tropical longline fisheries including the Hawaiian fleet) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

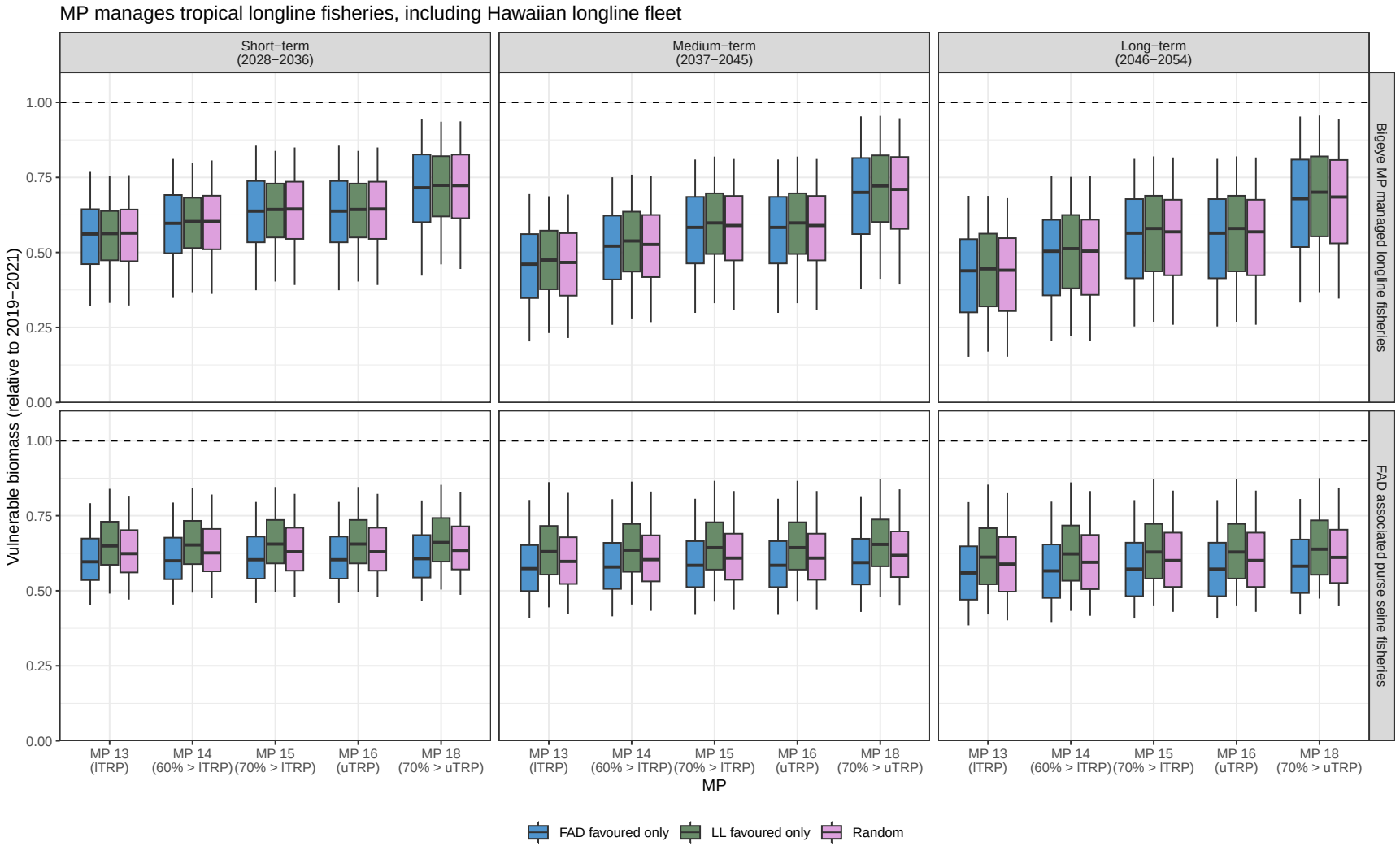

Figure 26: Box plots of expected vulnerable biomass, relative to the average level in 2019-2021, of the longline fisheries managed through the bigeye MP (top row, the tropical longline fisheries including the Hawaiian fleet) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). 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.

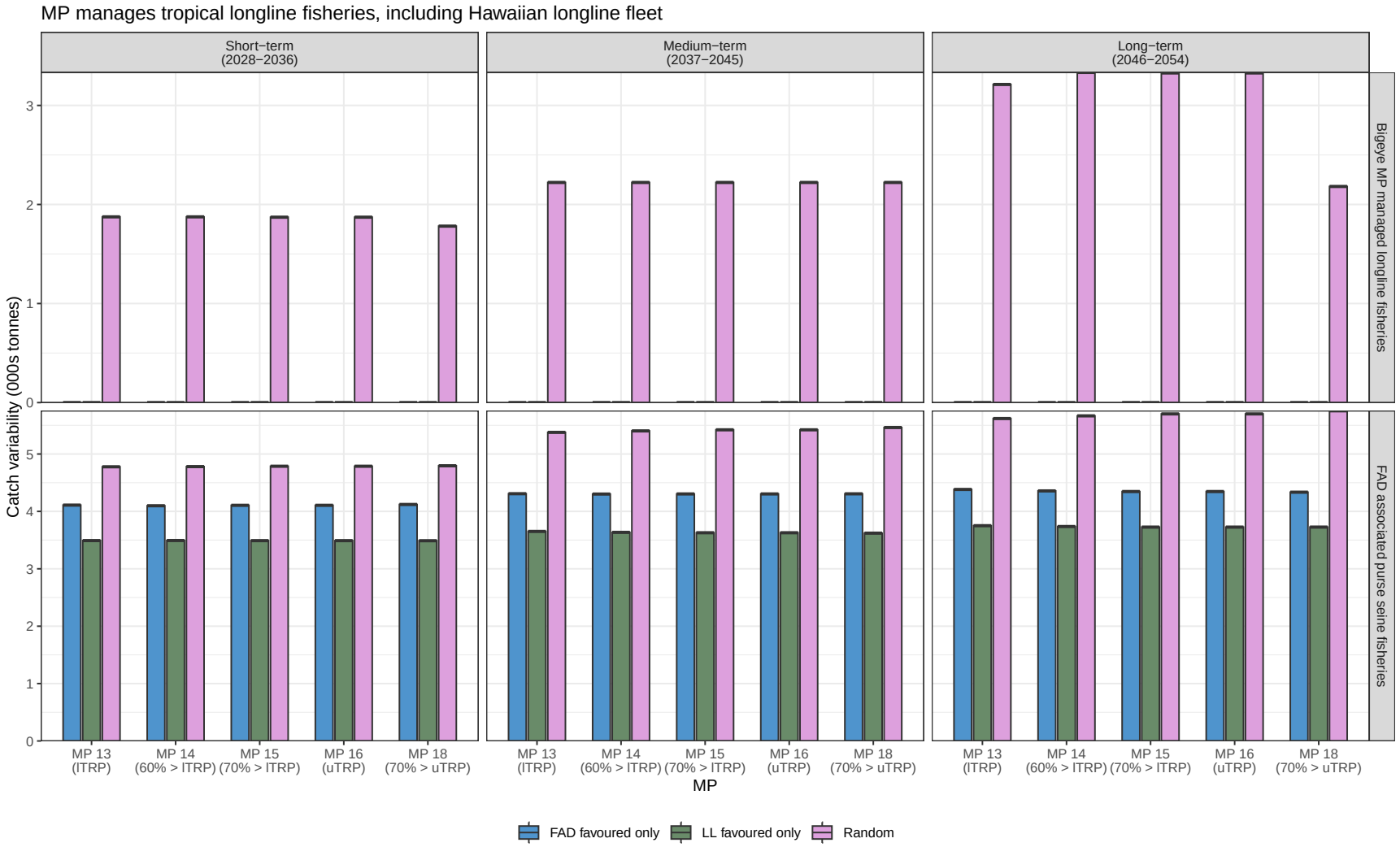

Figure 27: Bar charts of expected median catch variability of the longline fisheries managed through the bigeye MP (top row, the tropical longline fisheries including the Hawaiian fleet) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

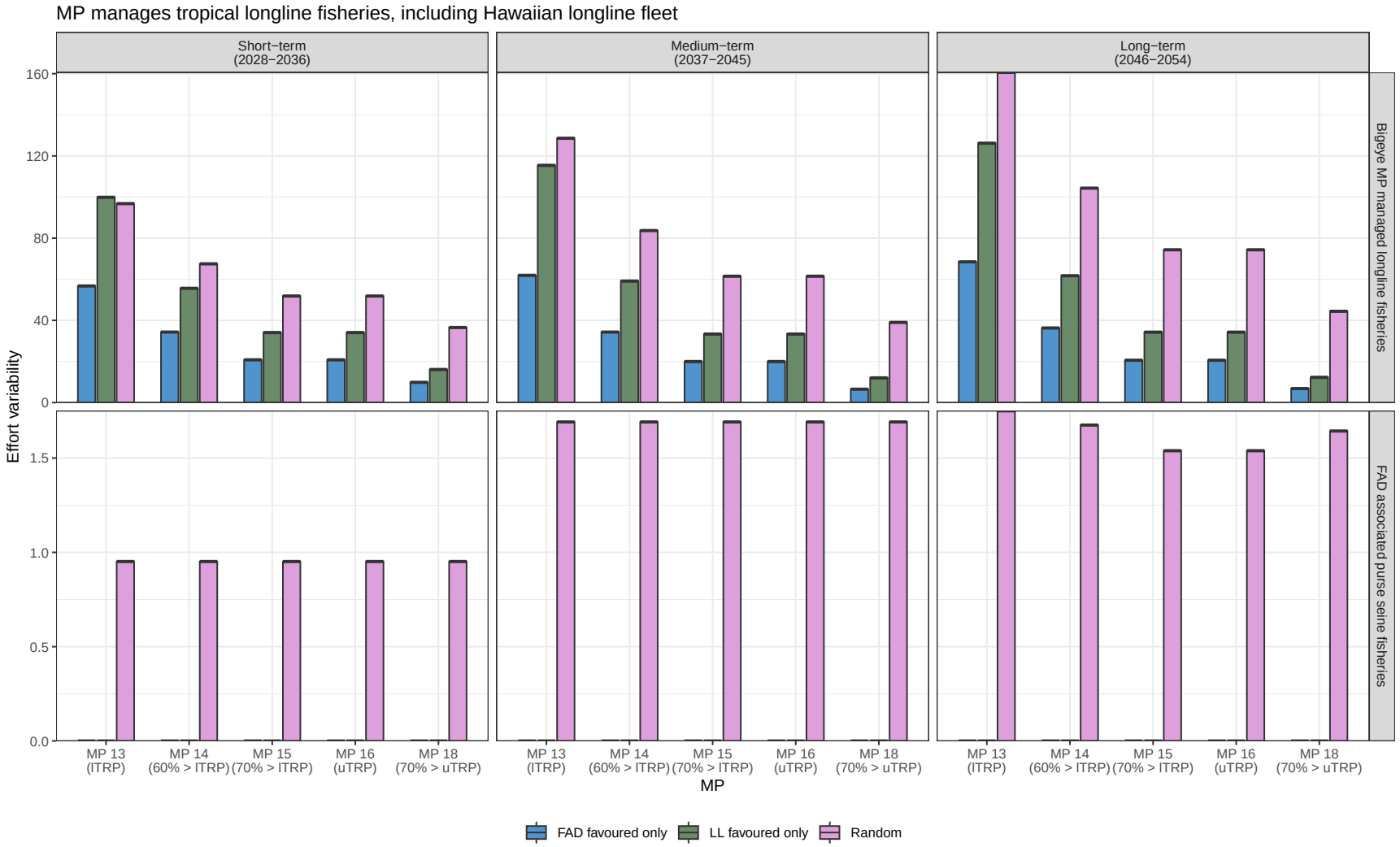

Figure 28: Bar chart of expected median effort variability of the longline fisheries managed through the bigeye MP (top row, the tropical longline fisheries including the Hawaiian fleet, measured as millions of hooks) and the FAD associated purse seine fishery (bottom row, measured in thousands of sets) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

11.2 Bigeye management procedure manages the longline fisheries in the WCPO

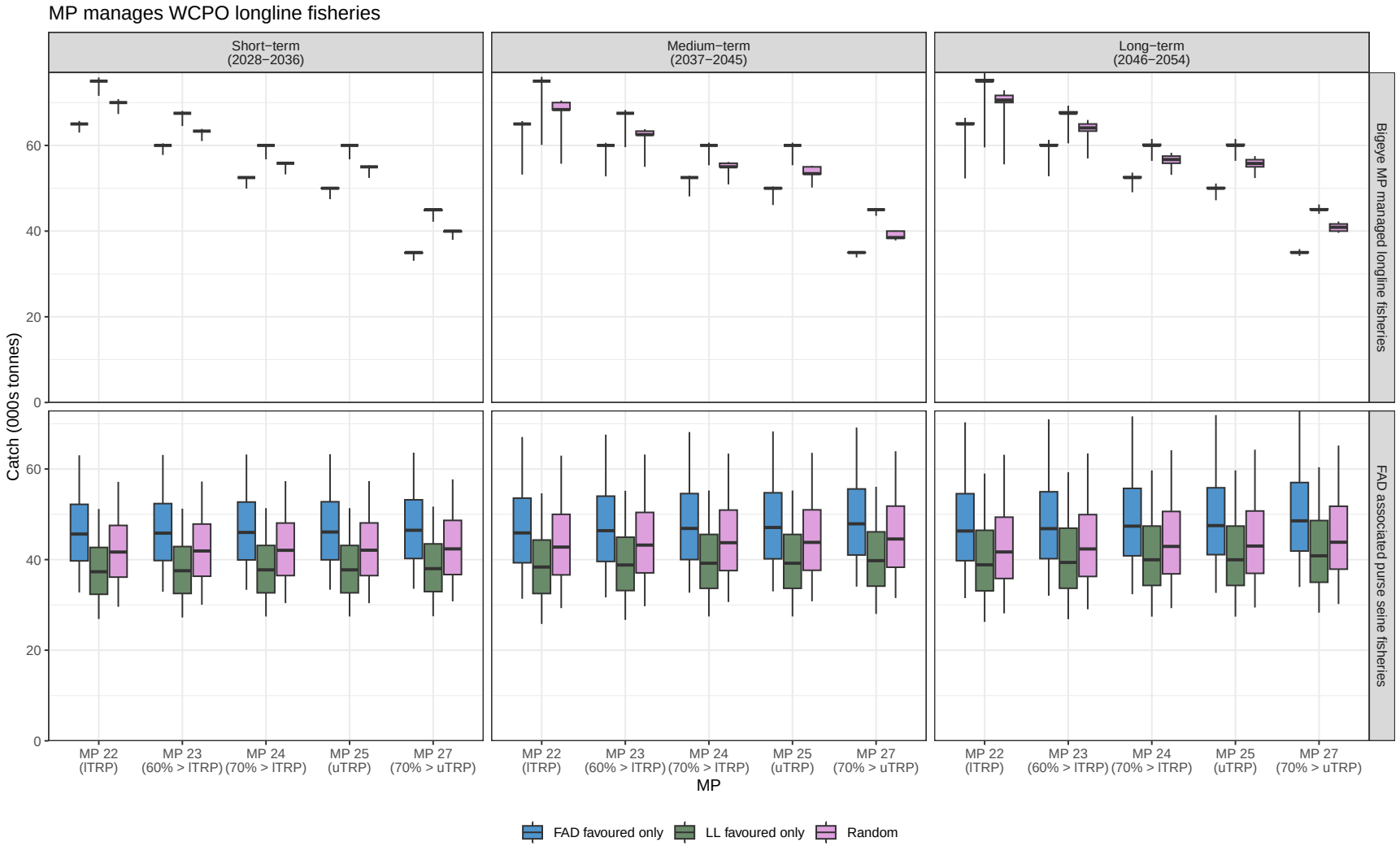

Figure 29: Box plots of expected catch taken by the longline fisheries managed through the bigeye MP (top row, the longline fisheries in the WCPO) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

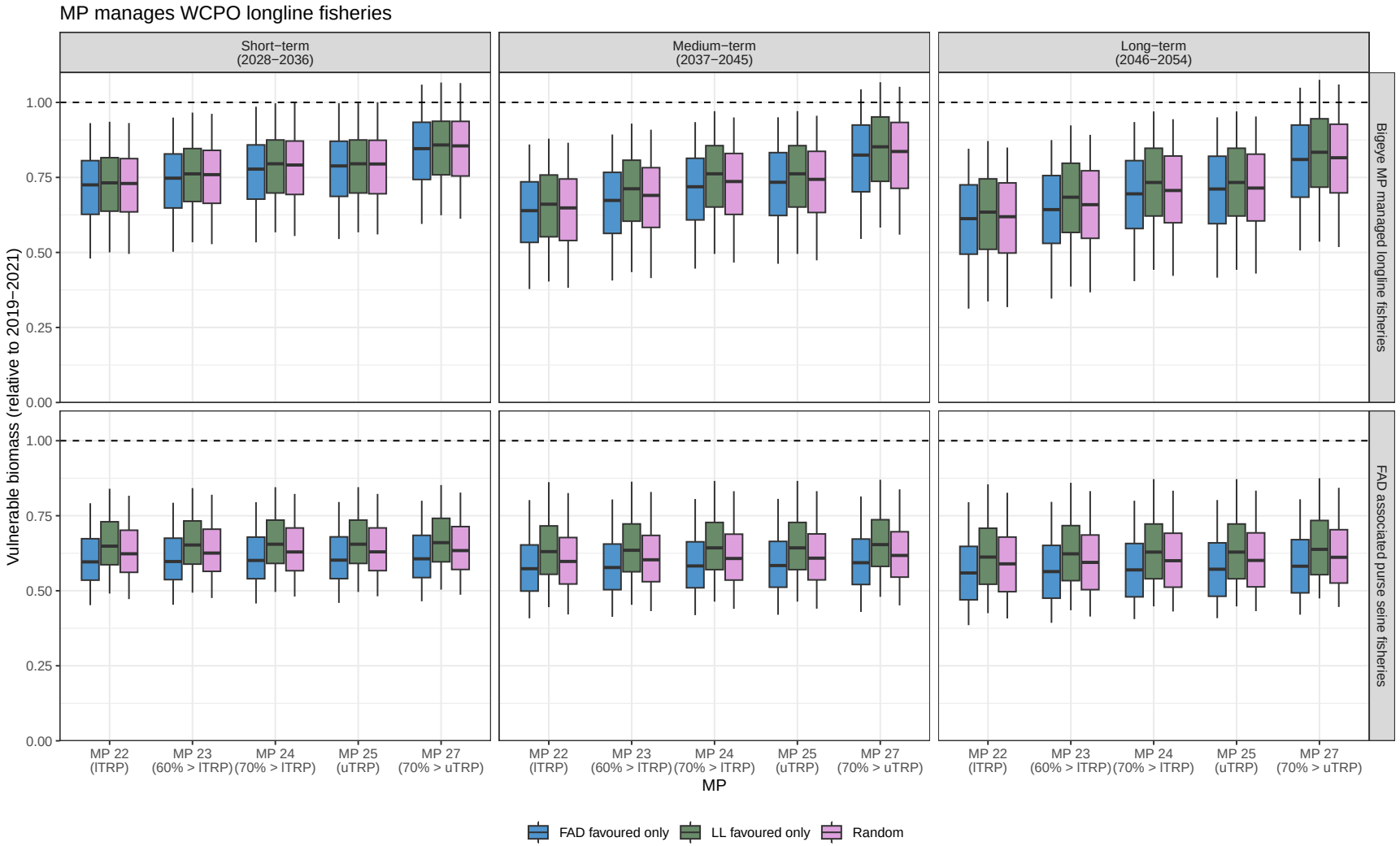

Figure 30: Box plots of expected vulnerable biomass, relative to the average level in 2019-2021, of the longline fisheries managed through the bigeye MP (top row, the longline fisheries in the WCPO) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). 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.

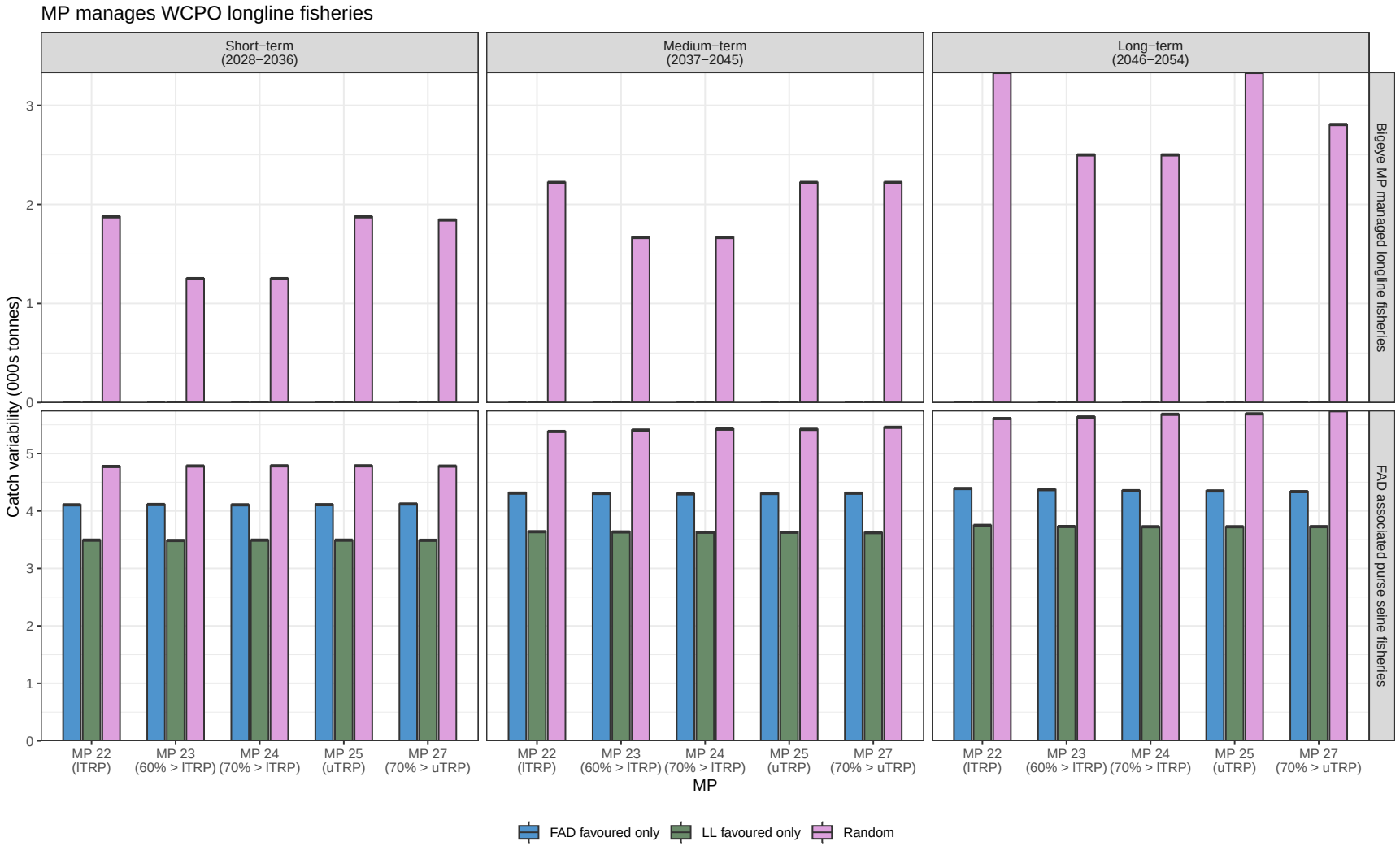

Figure 31: Bar charts of expected median catch variability of the longline fisheries managed through the bigeye MP (top row, the longline fisheries in the WCPO) and the FAD associated purse seine fishery (bottom row) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.

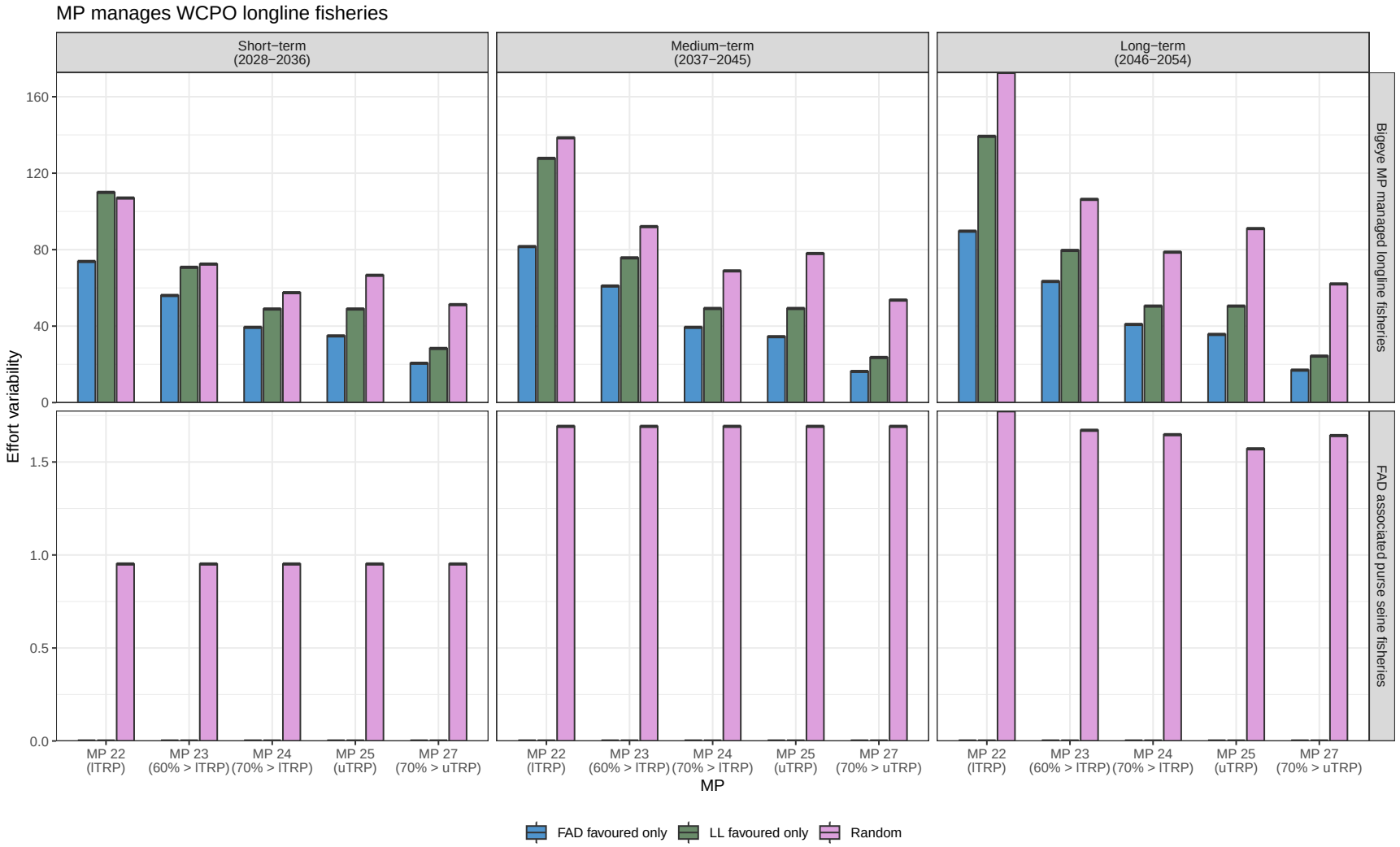

Figure 32: Bar chart of expected median effort variability of the longline fisheries managed through the bigeye MP (top row, the longline fisheries in the WCPO, measured as millions of hooks) and the FAD associated purse seine fishery (bottom row, measured in thousands of sets) in each time period (columns) for each MP. Each MP is evaluated three times under different HCR pair scenarios ('FAD favoured only', 'Longline favoured only' and randomly selecting between the three HCR pairs). The whiskers show the 95th percentile range, the box shows the 60th percentile range, and the solid horizontal line is the median value.