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BIGEYE TUNA MANAGEMENT PROCEDURE DESIGN AND IMPLEMENTATION CONSIDERATIONS

WCPFC-SC22-2026-MI-WP03
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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. This report describes the proposed design of candidate bigeye MPs and some associated implementation considerations.

Following discussions at WCPFC22 and BMW01, 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.

The WCPFC mixed fishery approach proposes that longline fisheries operating between 20°N and 10°S, referred to as the tropical longline (TLL) fishery, will be managed through the bigeye MP. However, three scenarios for the spatial range of longline fisheries managed through the bigeye MP were proposed at BMW01 for evaluation:

- TLL including the Hawaiian longline fleet operating south of 20°N;
- TLL excluding the Hawaiian longline fleet operating south of 20°N;
- All longline fisheries operating within the WCPO.

The design of the HCR pairs is derived from running long-term projections at different levels of future longline catch and different FAD closure periods, similar to those performed for the Tropical Tuna Measure evaluations, known as nuclear grids. To run the nuclear grid projections it is necessary to make assumptions on the future bigeye catch or effort of the fisheries not managed through the bigeye MP. Where relevant, these assumptions are consistent with adopted interim MPs for skipjack and south Pacific albacore, and also depend on the three spatial range scenarios.

An example set of three HCR pairs are presented, along with an explanation of how the shape relates to the objectives (in terms of achieving the candidate target reference points) and the results of the nuclear grid projections.

SC22 is invited to:

- Provide technical advice on the approach used for the overall MP design of a continuum of pairs of HCRs: one that sets the fishing opportunities of the longline fishery managed through the bigeye MP, and one for the FAD closure period;
- Consider the approach used to address BMW01 requests for the alternative spatial extents of longline fisheries under MP control;
- Provide technical advice on the proposed assumptions on the future catch or effort of the fisheries not managed through the bigeye MP, consistent with the mixed fishery framework, noting the assumptions may be different depending on the spatial range of the MP.

1 Introduction

The WCPFC harvest strategy workplan schedules the adoption of the bigeye tuna management procedure (MP) by the end of 2026 (WCPFC, 2025). This report describes the proposed design of candidate bigeye MPs and some associated implementation considerations. Evaluations of candidate MPs are considered in WCPFC-SC22-2026/MI-WP-02 (Scott et al., 2026a).

1.1 The WCPFC mixed fishery harvest strategy approach

An important consideration when developing harvest strategies for tuna stocks in the WCPO is to account for mixed fishery interactions (Table 1).

Table 1: Proportion of mean catch by weight (2020-2022) in the WCPFC-CA (south of the equator for albacore) of the four main tuna stocks by fishery. 'Other' fisheries are the domestic fisheries of Vietnam, Indonesia and the Philippines. The figures include catches in archipelagic waters.

Stock	Tropical longline	Southern longline	Northern longline	Pole and line	Purse seine	Troll	Other
Skipjack	0.00	0.00	0.00	0.09	0.83	0.00	0.08
South Pacific albacore	0.12	0.81	0.00	0.00	0.00	0.07	0.00
Bigeye	0.27	0.05	0.06	0.01	0.45	0.00	0.15
Yellowfin	0.08	0.02	0.01	0.03	0.55	0.00	0.31

Under the proposed WCPFC mixed fishery harvest strategy approach, fisheries would be managed through single stock MPs for skipjack, South Pacific albacore and bigeye (Scott et al., 2023, 2021, 2020). Each single stock MP only considers the status of that stock and sets the fishing opportunities, e.g. catch or effort limits, for one or more fisheries. Additionally, a fishery is only managed through one single stock MP. For example, the effort limits of the tropical purse seine fishery are only managed through the skipjack MP, which only considers the stock status of skipjack.

This mixed fishery approach proposes that longline fisheries operating between 20°N and 10°S, referred to as the tropical longline (TLL) fishery, will be managed through the bigeye MP. Other fisheries that also catch bigeye will be managed through the single stock MPs for skipjack (purse seine total effort, 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). Under this approach the stock status of bigeye is influenced not just by the bigeye MP, but also by the skipjack MP (defining total effort, with bigeye status influenced by the FAD arrangement assumption) and, to a lesser extent, the South Pacific albacore MP.

Preliminary evaluations were presented to SC21 that were consistent with the mixed fishery approach, i.e. the candidate bigeye MPs set the catch limits for the TLL fishery operating between 20°N and

10°S (Scott et al., 2025). In those evaluations the catches of bigeye taken by fisheries not managed through the bigeye MP, or effort of those fisheries, were fixed at recent levels. It was also assumed that the 2024 FAD management measures remained in place, with alternative FAD management measures to be evaluated as sensitivity tests.

1.2 WCPFC 2025 outcomes

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 it only managed the TLL (approximately 27% of 2020-2022 average levels, Table 1) and on the possibility of including the FAD closure period as part of the bigeye MP design (WCPFC, 2025).

The SSP was asked to evaluate a range of HCRs 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, 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.

1.3 BMW01 outcomes

The first WCPFC bigeye management workshop (BMW01) focussed on the design of the bigeye MP, including the spatial range of the MP and the TRPs (WCPFC, 2026).

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 2).

Table 2: 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, 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 alabacore MP (which sets a catch limit of South Pacific albacore for longline fisheries operating south of 20°S.)

Target reference points

Typically, candidate MPs are designed to maintain the biological stock around a TRP on average. WCPFC21 supported a 'sequenced approach' to the TRPs for bigeye and yellowfin, whereby the Commission first addresses the TRP for bigeye and then evaluates its implications for achieving management objectives for yellowfin (WCPFC, 2024). Three candidate TRPs for bigeye were specified at WCPFC21 at 1x, 0.94x and 1.06x the 2012-2015 average spawning biomass depletion. The Commission noted that these candidate TRPs may in future be specified as threshold targets for which associated probabilities of being 'at or above' would need to be specified. The probability associated with a threshold reference point describes the proportion of the simulations that are 'at or above' the reference point.

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 average spawning biomass depletion) 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.
- 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.

Noting the workload defined by BMW01, the candidate TRPs to be prioritized for analysis for SC22 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).

Other outcomes from BMW01 are discussed in the relevant section in this report.

2 Proposed harvest control rule design

An MP comprises three components:

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

The data collection and estimation method are discussed in detail in WCPFC-SC22-2026/MI-WP-02 (Wickens et al., 2026). This section describes the proposed HCR design, following discussions at WCPFC22 and BMW01.

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. 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. See Section 5 for an example of this approach.

Each of the three bigeye MP spatial scenarios described in Table 2, 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 associated TRP in the long-term.

For the purposes of the bigeye MP evaluations, each MP will comprise at least three pairs of HCRs (Scott et al., 2026a). With three bigeye MP spatial scenarios and at least four candidate TRPs, designing and evaluating the HCRs is not a trivial task.

2.1 Shape of the HCRs

SC21 and BMW01 supported a 'Hillary step' type of HCR, consistent with the adopted skipjack and South Pacific albacore HCRs. With this kind of 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 limits 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. 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).

The heights of the steps are derived from running long-term projections at different levels of future longline catch and different FAD closure periods, similar to those performed for the Tropical Tuna Measure (TTM) evaluations (WCPFC21-2024-34, Pilling et al., 2024). This combination of different longline and FAD associated purse seine fishing pressure is referred to as a 'nuclear grid' (see Section 3).

The HCR input is the estimated spawning biomass (SB) relative to the average estimated SB in 2012-2015, as calculated by the estimation method (Wickens et al., 2026).

2.2 HCR output and implementation

Each time the MP is run the estimation method is used to calculate an estimate of stock status. The pairs of HCRs used to set the bigeye MP-managed longline catch/effort limit and the FAD closure period would then be negotiated by the Commission. In this way the proposed bigeye MP does not prescribe the FAD closure period. Instead, that would be a negotiated outcome each time the MP is run.

The output of the selected HCR pairs would be implemented through the Implementing CMM. 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).

BMW01 agreed that bigeye 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. It was 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.

2.3 Meta-rules and constraints

BMW01 did not agree on specific meta-rules or constraints on the maximum change in fishing pressure between management periods. It was suggested that there may not be a need for the constraints to be hard coded into the MP as bigeye MP allocation and implementation arrangements would ultimately involve negotiated outcomes.

3 Running the nuclear grid

The nuclear grid is constructed by running 30 year stochastic projections across the 480 operating models (OM) in the grid (Scott et al., 2026b), with the future catch or effort of each model fishery fixed through time according to the bigeye MP spatial scenario (Table 2).

The $SB/SB_{F=0}$ in the final year of the projection, based on biomass in the WCPO, is then calculated (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).

Each cell of the nuclear grid has different fixed catches for the longline fisheries managed through the bigeye MP, and a different purse seine FAD closure period, consistent with the approach used in the TTM evaluations (WCPFC21-2024-34, Pilling et al., 2024).

The FAD closure period comprises an EEZ and a high seas closure period. A ratio of 3 / 5 between the EEZ and high seas periods is assumed, rounded to the nearest week (quarter month), e.g. a 3 months EEZ with a 5 months high seas closure.

To ensure a sufficiently informative nuclear grid that would cover the range of stock status outcomes desired, the longline catches range from 0 to approximately double the average catch in 2019-2021, and the purse seine FAD closure period ranges from 0 months closure to approximately 7 months EEZ and 12 months high seas closure.

Variability is included in future recruitment through the application of randomly sampled recruitment deviates. Each OM was projected four times for each cell in the nuclear grid, so that each cell summarises the results of 1920 stochastic projections across the entire OM grid, including effort creep.

3.1 Fisheries not managed through the bigeye management procedure

To perform the nuclear grid projections it is necessary to make assumptions about the future catch or effort of the fisheries that are not managed through the bigeye MP (summarised in Table 3 and Table 4), including those managed through other MPs. Note that the assumptions can change between the three bigeye MP spatial scenarios. BMW01 agreed that fisheries not controlled directly by the bigeye MP should generally be assumed to remain at fixed recent catch levels for evaluation purposes.

Fisheries managed through the skipjack interim management procedure

The fisheries that are managed through the interim skipjack MP are: tropical purse seine; pole and line; and the domestic fisheries of Vietnam, Indonesia and the Philippines, excluding those operating in archipelagic waters.

For the nuclear grid projections it is assumed that the estimated future skipjack abundance is such that the skipjack HCR is on the Hillary step. The future effort or skipjack catch of these fisheries is then fixed at their skipjack MP baseline levels (CMM 2022-01, WCPFC, 2022).

Future pole and line fisheries effort is fixed at 2001-2004 average levels (Table 3; Figure 2), noting that recent effort has been lower than the 2001-2004 average level.

Total future purse seine effort is fixed at 2012 levels. This is divided between the FAD associated and unassociated (free-school) purse seine effort, depending on the future FAD closure period in the nuclear grid projection. i.e. if FAD associated purse seine effort increases through a reduction in the FAD closure period, the free-school purse seine effort reduces correspondingly to maintain total purse effort at 2012 levels.

For domestic fisheries operating outside of archipelagic waters, the interim skipjack MP specifies the skipjack catch at the 2016-2018 average level. Here, the future effort of these fisheries is fixed at the 2016-2018 average level, including the fisheries operating in archipelagic waters (Figure 3). Effort data is not always available for each domestic fishery in this time period. For those fisheries where the effort is unavailable, the fishing mortality in this time period estimated during the OM conditioning is used instead. The future fishing mortality of those fisheries is therefore consistent with that estimated in 2016-2018. Projecting on constant effort, or fishing mortality, instead of constant catch ensures that catches of bigeye taken by these fisheries do not become unsustainable if stock abundance decreases in the area in which they operate.

Due to uncertainty in the historical data for the domestic fisheries, additional sensitivity tests around these data will be conducted in the future.

Table 3: Future effort assumptions for the model 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	Future effort fixed at average 2016-2018 levels, including those operating in archipelagic waters.

Longline fisheries

The future catch or effort of the longline fisheries depends on the bigeye MP scenario (Table 4).

The catches of South Pacific albacore taken by the southern longline are managed through the South Pacific albacore MP. In scenarios where the southern longline fishery is excluded from being managed through the bigeye MP, the future effort of this fishery is fixed at a level consistent with South Pacific albacore achieving the TRP under the adopted South Pacific albacore MP (effort approximately 10% higher than 2019-2021 levels, Figure 2) (SPC-OFP, 2025). Otherwise, the future bigeye catch of the southern longline fishery is set by the bigeye MP.

In scenarios where the Hawaiian longline fleet is excluded from being managed through the bigeye MP, including the component operating south of 20°N, the future catches of bigeye of this fleet are fixed at the level consistent with Table 3 in the TTM: 6554 mt per annum. If only the component of the Hawaiian longline fleet operating north of 20°N is excluded, the future bigeye catches of this fleet north of 20°N are fixed at a constant level of 60% of the 6554 mt per annum (3932 mt per annum), based on the average distribution of bigeye catches taken by the Hawaiian longline fleet in the years 2012-2015 (consistent with the TRP baseline year range, as requested by the USA) (Figure 4). The remainder of the Table 3 limit is subject to the MP.

In scenarios where the northen longline fishery is not managed through the bigeye MP, the future catches of the non-US northern longline fishery are fixed at their 2015-2024 average levels, i.e. a long-term average of 6700 mt per annum (Figure 5).

The historical TLL catches of bigeye, with and without the Hawaiian longline fishery, are shown in Figure 6 for reference, noting that the future bigeye catch of the TLL is set by the MP, depending on the scenario.

Table 4: Future bigeye catch and effort assumptions for the longline fisheries under the different bigeye management procedure assumptions.

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.

4 Nuclear grid results

Each cell of a nuclear grid summarises the long-term depletion across multiple iterations across the full OM grid, including the OMs with effort creep.

Following discussions at BMW01, only the lower and upper TRPs are considered. The probabilities of being above the LRP, and the probabilities of being above the lower and upper TRPs (0.94x and 1.06x the 2012-2015 average depletion), at each combination of FAD closure period and MP-managed longline bigeye catch, for each MP scenario are shown in the appendices (Figure 7 to Figure 15).

As noted in the introduction, the TRPs are defined as relative measures, i.e. based on the level of depletion relative to the average depletion in the years 2012-2015. The OMs are different to the grid of stock assessment models presented in 2023. This means that the values of the TRPs, expressed as actual depletion values, will be different to those presented in past WCPFC reports. Additionally, the nuclear grid results are different to those presented under previous TTM evaluations. This is partly because the grid of OMs is different, but also the assumptions underlying the grid are different, e.g. the assumptions made for future fishing levels of fisheries not managed through the bigeye MP.

The WCPFC has a requirement that any adopted harvest strategy must result in a probability of being above the limit reference point (LRP, a depletion level of 0.2) of at least 0.8. Any 'out of bounds' area is coloured red (Figure 7, Figure 10 and Figure 13). These areas of the grid correspond to higher levels of MP-managed longline bigeye catch and shorter FAD closure periods.

The probabilities of being above the lower and upper TRPs with at least 50%, 60% and 70% thresholds are shaded with different colours, noting that having a 50% probability is equivalent to treating the TRP as a 'point' target (Figure 8, Figure 11 and Figure 14). The area of a nuclear grid that has at least a 50% probability of being above a particular target also extends over the 60% and 70% probability regions.

The heights of Hillary steps of the candidate HCRs will be consistent with the probability boundaries. For example, when the lower TRP is considered as a target ('50% threshold'), the possible step heights run along the boundary between the '50% threshold' and 'Below target' areas (e.g. Figure 8). When the lower TRP is considered as a threshold target with a 60% probability, the possible step heights run along the boundary between the '60% threshold' and '50% threshold' areas, etc.

The nuclear grids presented in the appendices can be used to inspect the relative impact of the MP-managed longline and FAD-associated purse seine fishing pressure on the long-term stock status.

5 Example HCRs

An example set of three HCR pairs are shown in Figure 1 for the scenario in which the TLL, excluding the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The HCRs have been designed to achieve the objective of the long-term stock status being above the lower TRP with a probability of 50%. Each HCR pair (with a matching colour) has been specified to achieve the same objective, but through alternative longline and FAD-associated purse seine fishing pressure (Figure 8).

Note that the HCR output for the FAD-associated purse seine fisheries is EEZ FAD open period, not closed period, in months. This is consistent with how HCRs are normally specified, i.e. for higher estimated stock status, higher HCR output is possible. 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.

Ideally, the estimated stock status remains on the 'Hillary step' of the HCR (the step within the HCR input range of 0.73 and 1.14 in this example). The corresponding HCR outputs (the heights of the steps) therefore set the combined FAD closure period and MP-managed longline fishery bigeye catch needed to achieve the objective.

The three HCR pairs correspond to FAD closure periods of 0 months; 1.5 EEZ & 2.5 high seas months closure and 3 EEZ & 5 high seas months closure. The corresponding MP-managed longline bigeye catch along the boundary between '50% threshold' and 'below target' on the nuclear grid for these FAD closure periods is 45,000 t; 50,000 t and 55,000 t (Figure 11).

The three pairs are labelled 'FAD favoured', 'Intermediate' and 'LL favoured' for convenience i.e. the 'FAD favoured' pair (red) sets a shorter FAD closure period and lower longline catch, whereas the 'LL favoured' (blue) pair sets a longer FAD closure period and higher longline catch, for the same level of estimated stock status.

If the estimated stock status is to the left of the Hillary step then the HCR sets a shorter FAD open period (longer FAD closed period) and lower MP-managed longline catches. A minimum FAD open period of 6 months and MP-managed longline bigeye catch of one quarter of the 2019-2021 average catch (10,000 mt in this example) is assumed in this example. If the estimated stock status is higher than the range of the Hillary step, then the FAD open period and MP-managed longline bigeye catch are able to increase.

The HCR pairs shown in Figure 1 are presented as examples and not recommendations. Other pairs of HCRs are possible, i.e. with alternative FAD closure periods and MP-managed longline bigeye catch, so long as their step heights were taken from the boundary between '50% threshold' and 'below target' on the nuclear grid.

Although the results of the nuclear grid projections are used to design the HCR pairs, it is not possible to predict their performance without fulling testing them using Management Strategy Evaluation (Scott et al., 2026a).

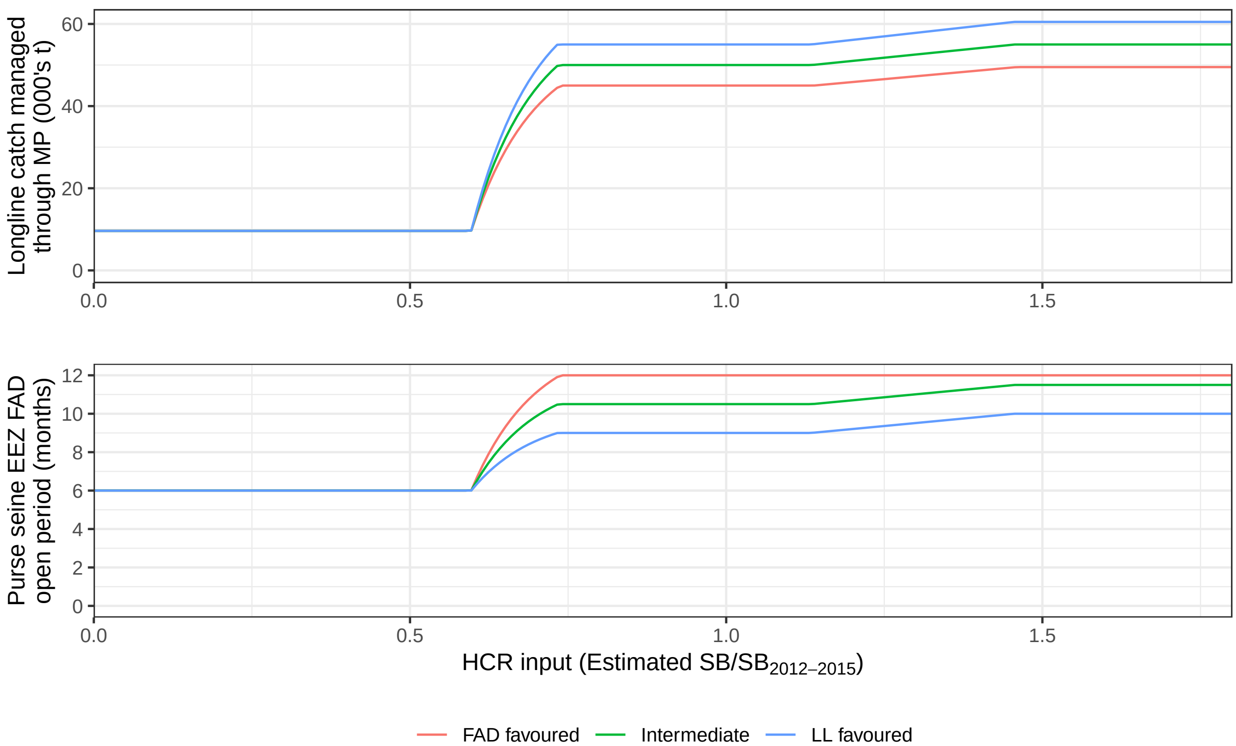

Figure 1: Example of three pairs of HCRs for the scenario in which the TLL, excluding the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The input to the HCRs is the estimated spawning biomass (SB) relative to the average estimated SB in 2012-2015, as calculated by the estimation method. Top panel shows the resulting output bigeye catch for the longline fisheries managed through the bigeye MP. The bottom panel shows the output EEZ FAD open period.

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

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Appendix: Future assumptions for fisheries

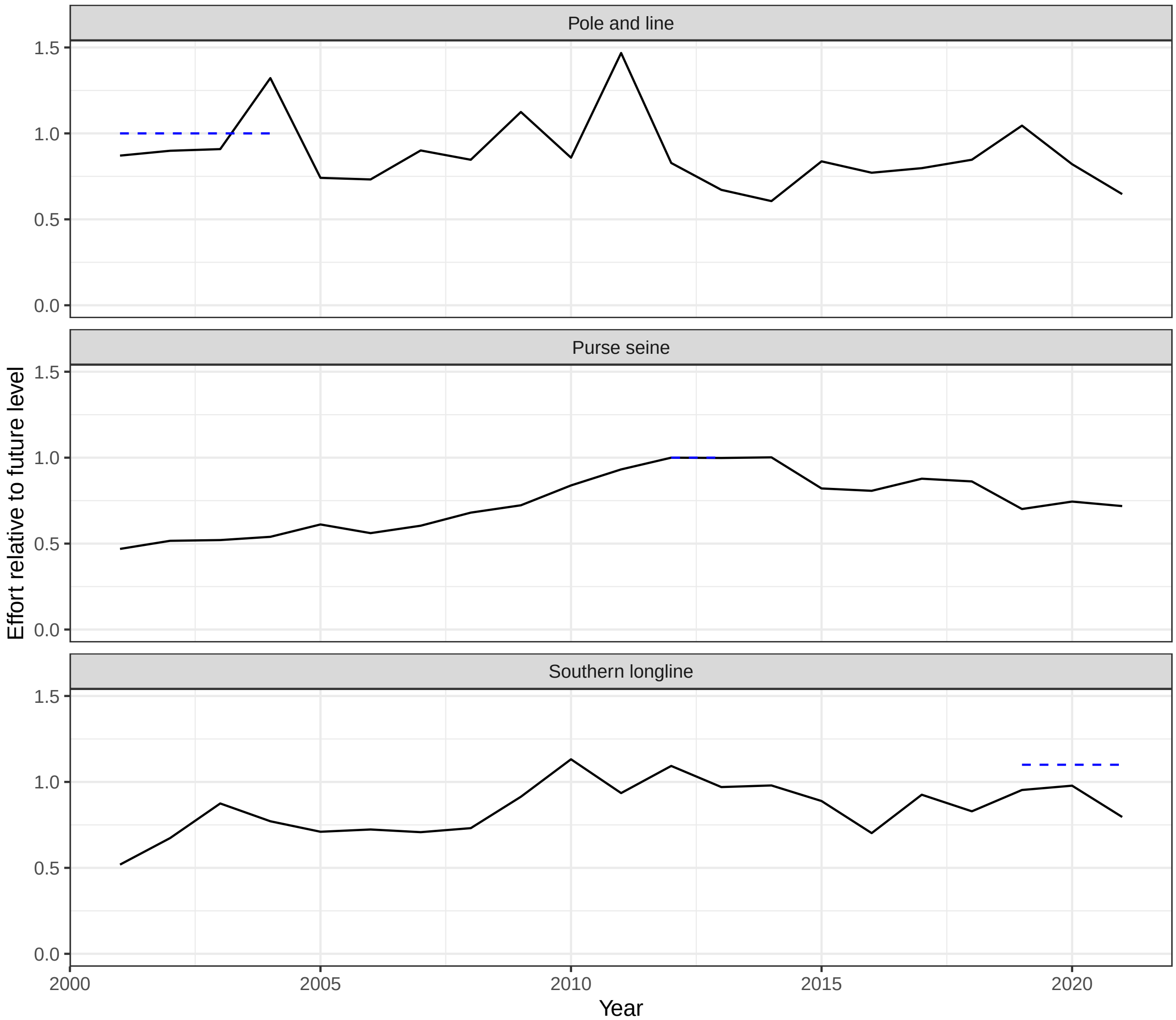

Figure 2: Time series of the effort of the pole and line, tropical purse seine and southern longline fisheries relative to their assumed future levels. The future relative effort of these fisheries is shown as the blue dashed line: pole and line, 2001-2004 average; purse seine, 2012; and southern longline, 2019-2021 average +10%, consistent with the South Pacific albacore MP. The southern longline future effort is only used in the scenarios in which this fishery is not managed through the bigeye MP.

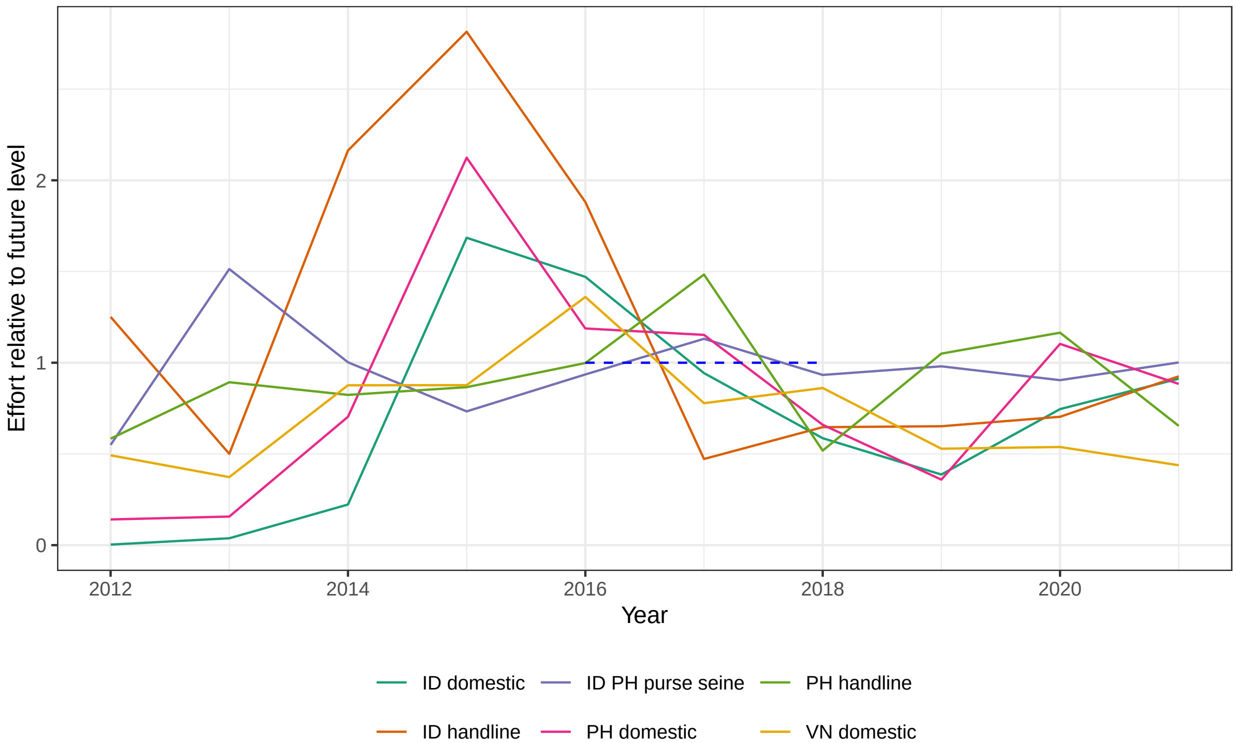

Figure 3: Time series of the effort of the domestic fisheries of Vietnam, Indonesia and the Philippines relative to their assumed future levels (2016-2018 average level, the blue dashed line).

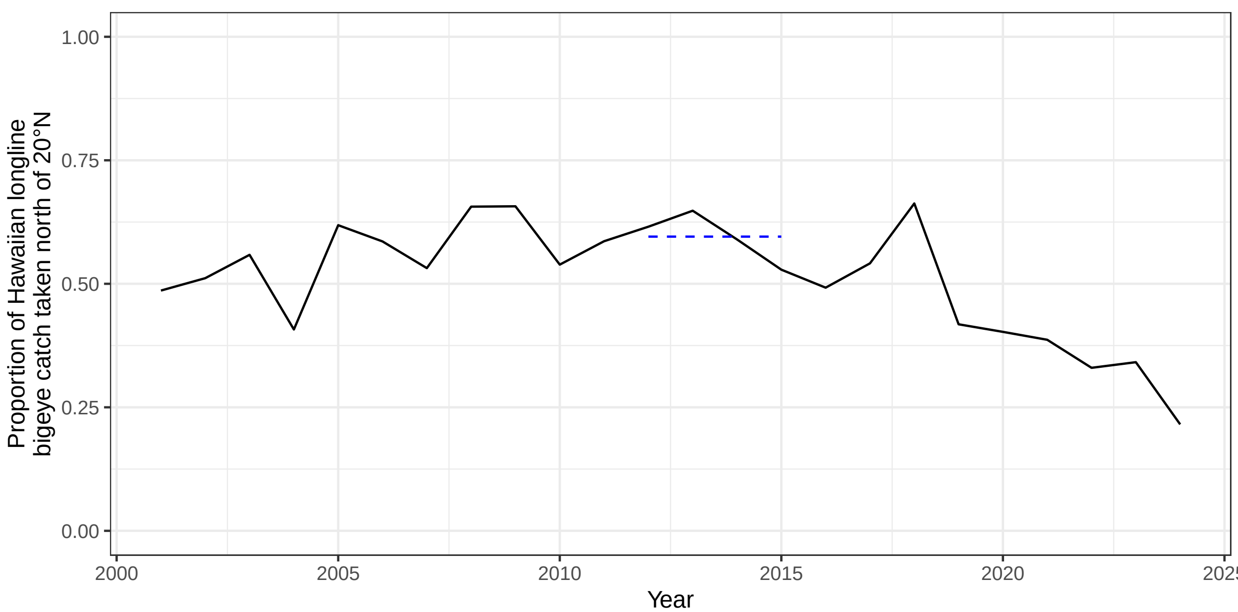

Figure 4: Time series of the proportion of bigeye catches taken by the Hawaiian longline fleet, north of 20°N. The average proportion in the years 2012-2015 (the blue dashed line) is used as the future proportion in the scenarios in which the northern longline fleet is not managed through the bigeye MP.

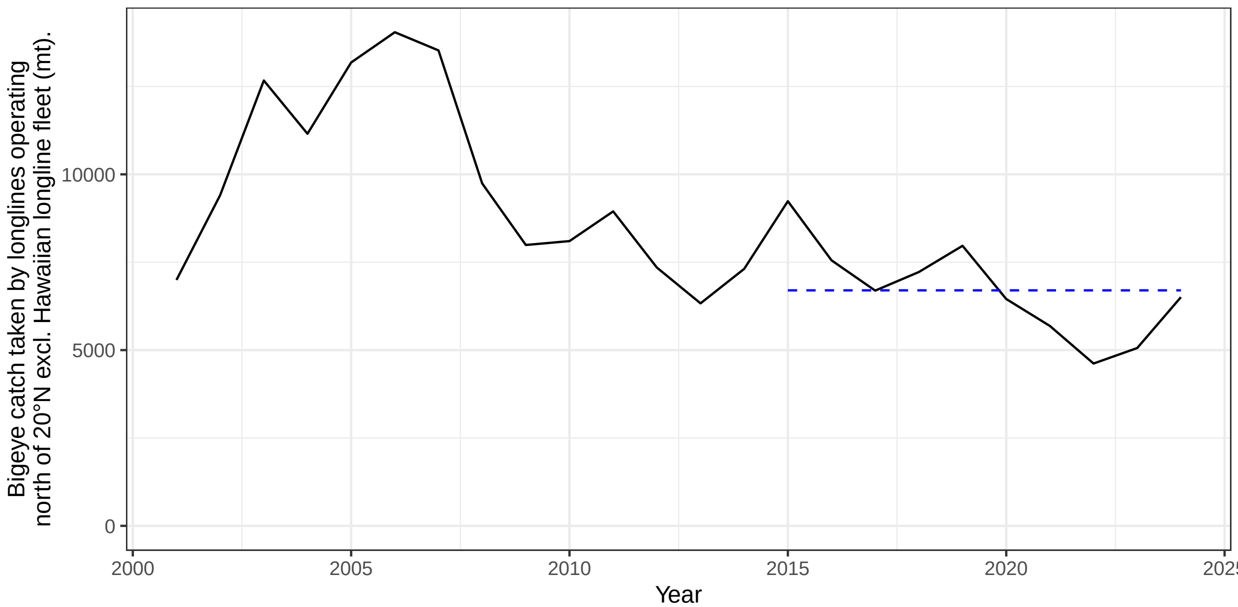

Figure 5: Time series of bigeye catches taken by the northern longline fleet, north of 20°N, excluding the Hawaiian longline fleet. The average catch in the years 2015-2024 (the blue dashed line) is used as the future catch in the scenario in which the northern longline fleet is not managed through the bigeye MP.

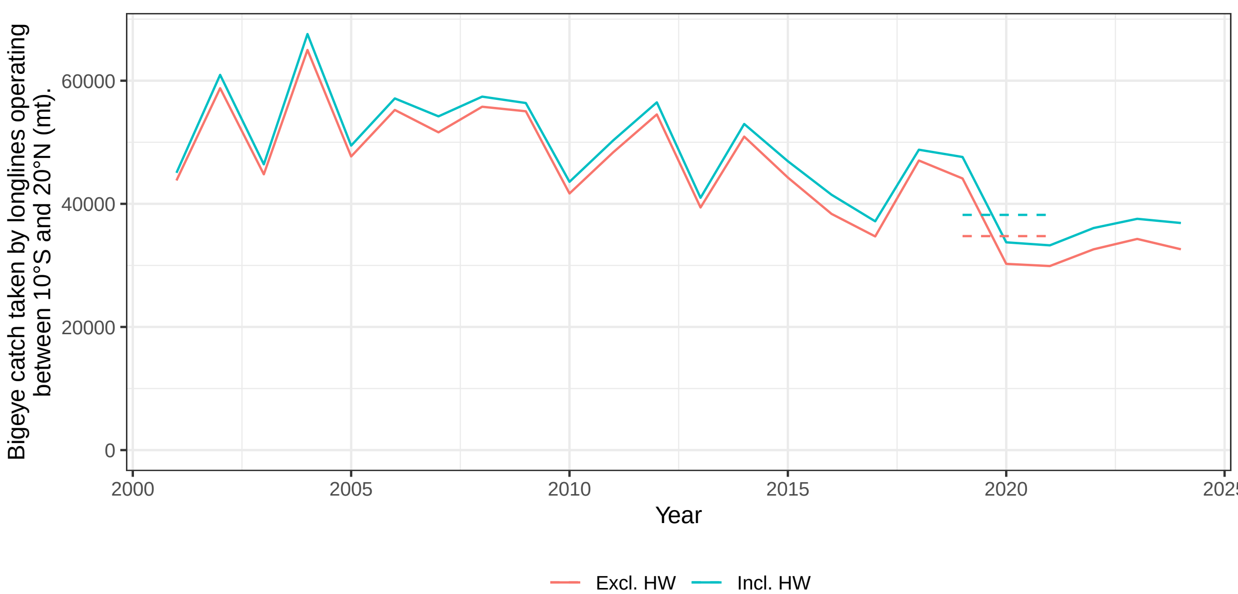

Figure 6: Time series of bigeye catches taken by the tropical longline fleet (operating between 10°S and 20°N), with and without the Hawaiian longline fleet. The average catch in the years 2019-2021 (the dashed lines) are shown for reference.

Appendix: Nuclear grid results

The following plots are the nuclear grid results for each of three bigeye MP scenarios (Table 2). Each scenario has three nuclear grids:

- The probability of being above the LRP.
- The probabilities of being above the lower and upper TRPs with thresholds of 50%, 60% and 70%.

The value in each cell of the nuclear grids is the median long-term depletion. Each cell is coloured according to the probability threshold.

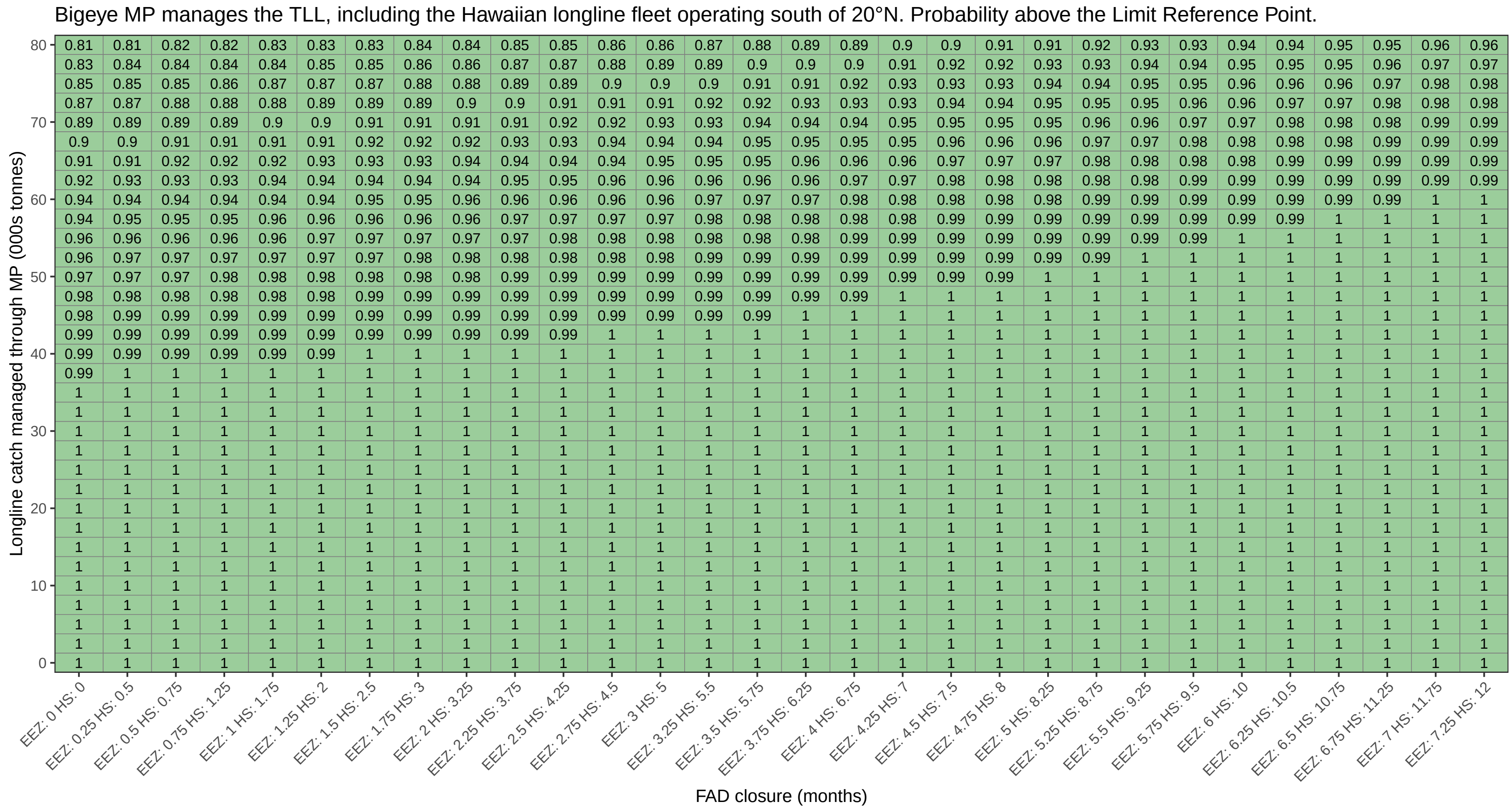

Figure 7: The long-term probability of being above the LRP at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, including the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colour indicates that the probability of being above the LRP is at least 0.8 (green) or lower (red). The value in each cell is the probability of being above the LRP.

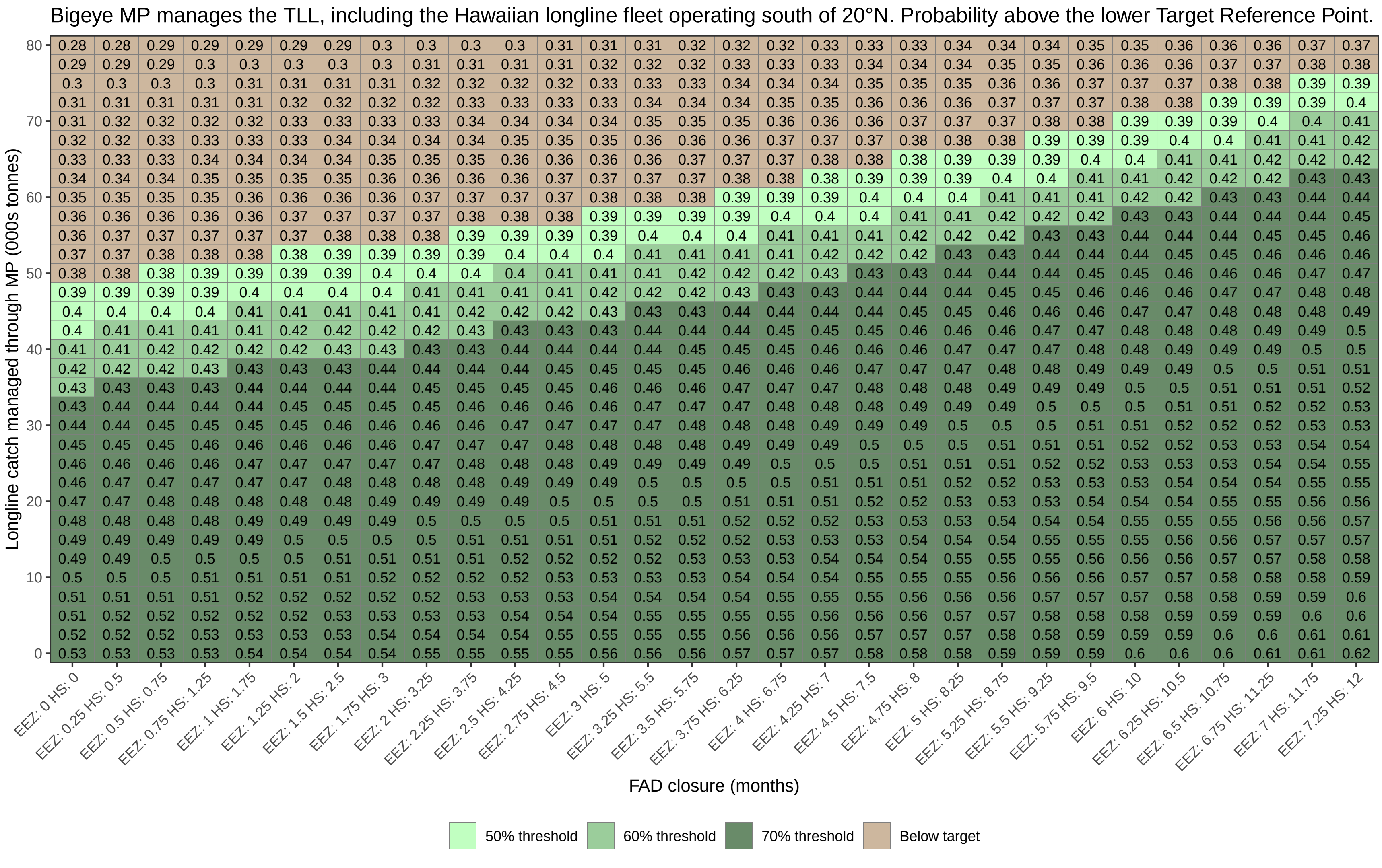

Figure 8: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, including the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colours indicate the probability of a cell being above the lower TRP with different thresholds.

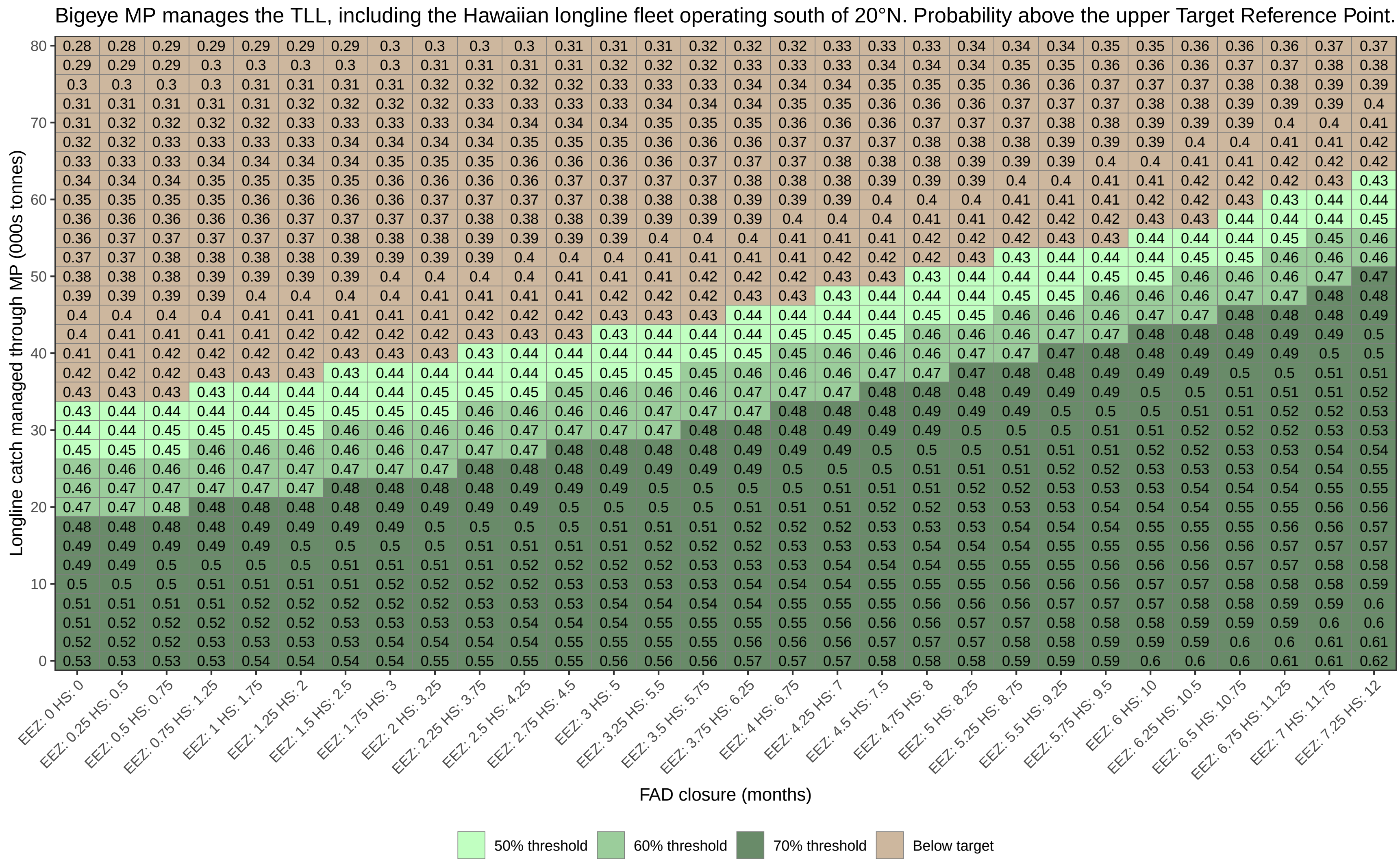

Figure 9: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, including the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colours indicate the probability of a cell being above the upper TRP with different thresholds.

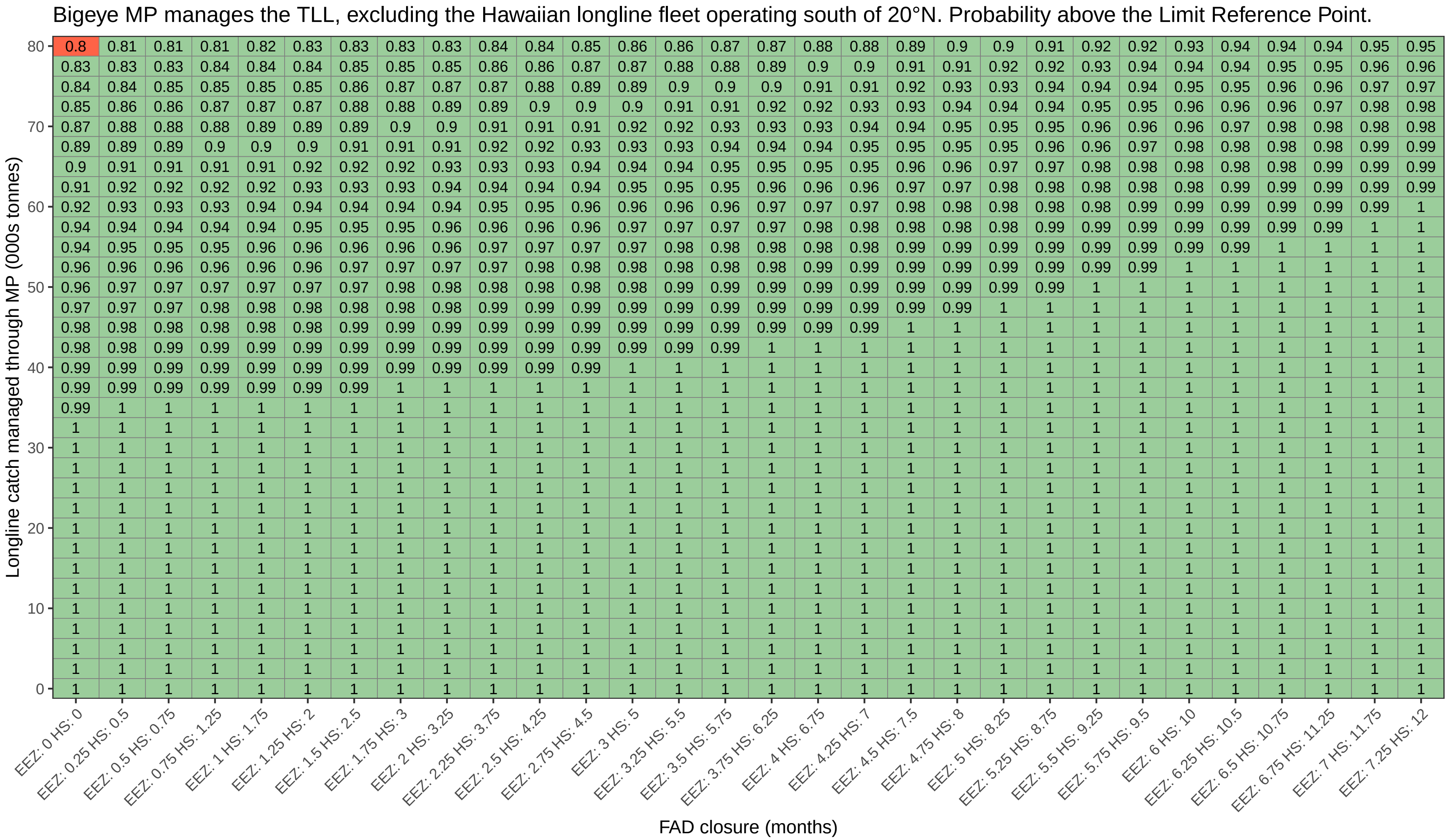

Figure 10: The long-term probability of being above the LRP at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, excluding the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colour indicates that the probability of being above the LRP is at least 0.8 (green) or lower (red). The value in each cell is the probability of being above the LRP.

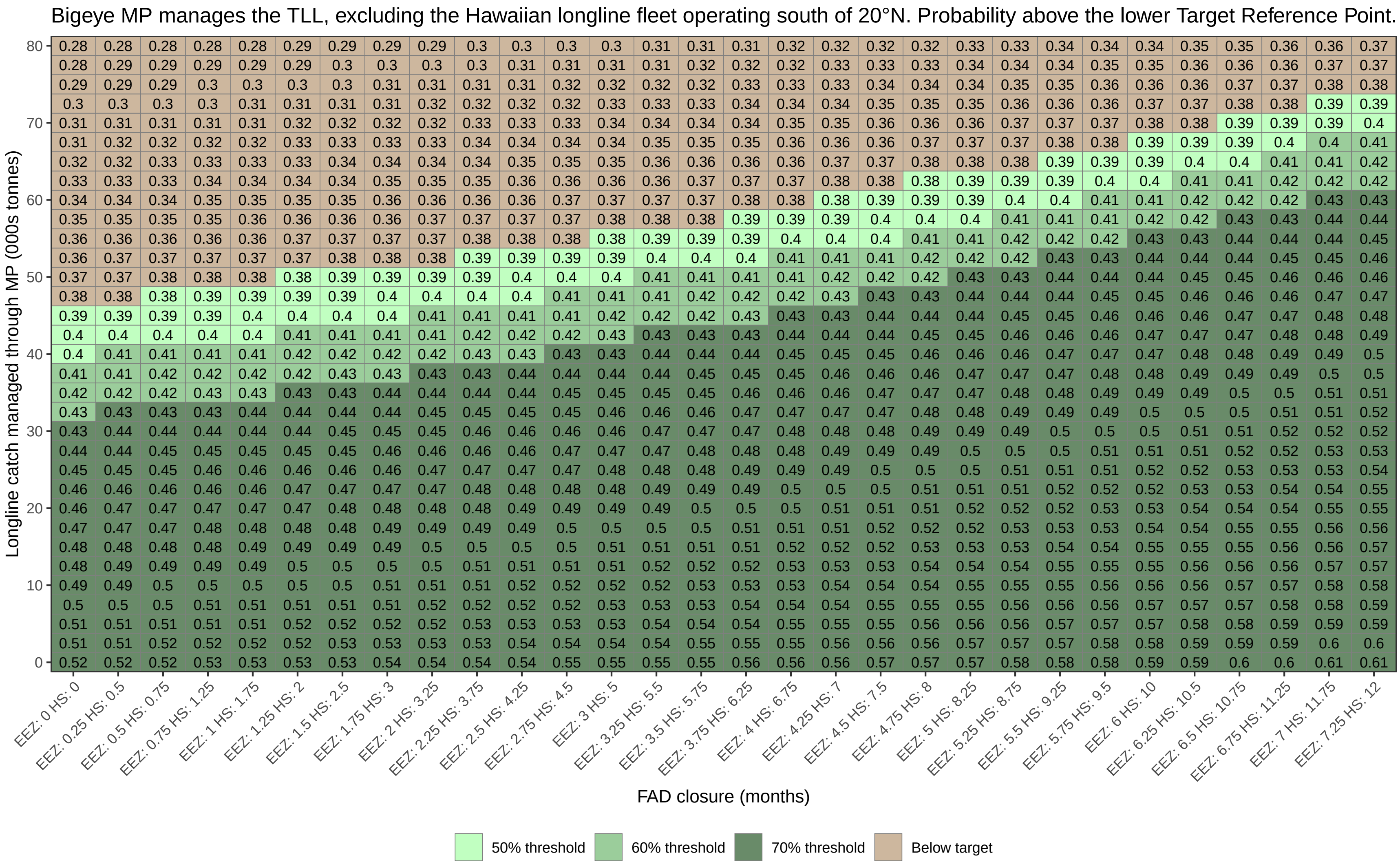

Figure 11: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, excluding the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colours indicate the probability of a cell being above the lower TRP with different thresholds.

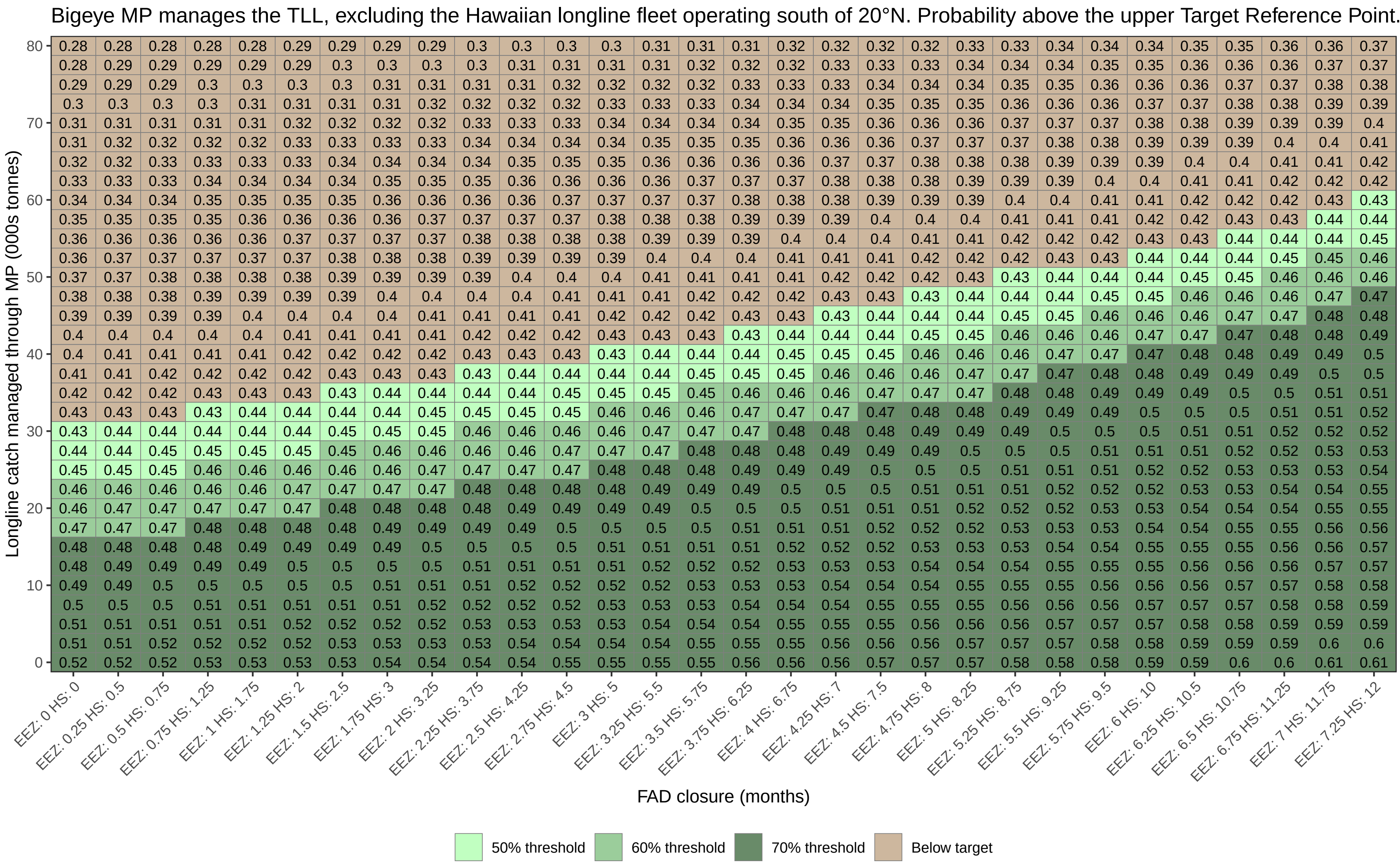

Figure 12: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which the tropical longline, excluding the Hawaiian longline fleet operating south of 20°N, is managed through the bigeye MP. The colours indicate the probability of a cell being above the upper TRP with different thresholds.

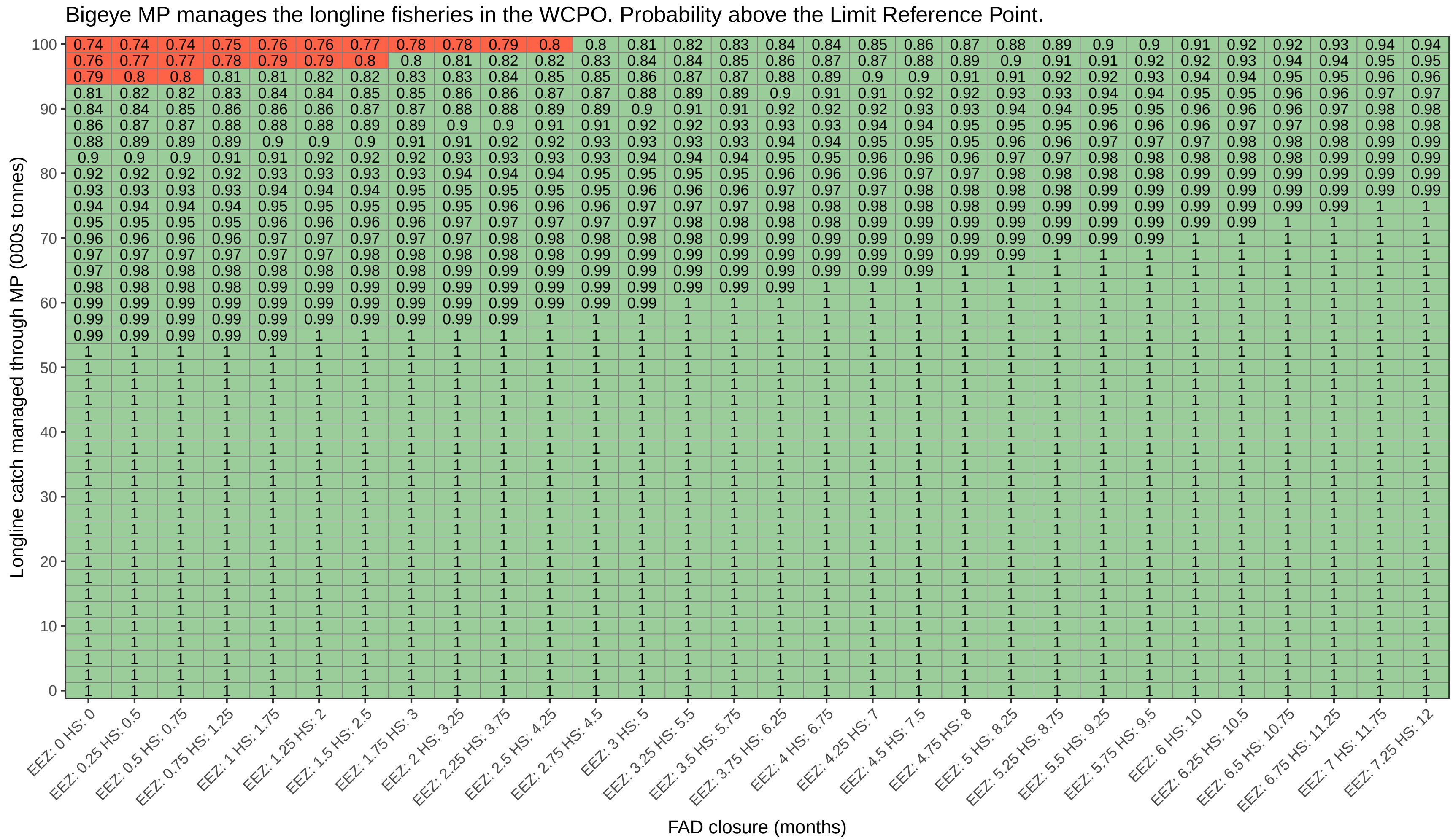

Figure 13: The long-term probability of being above the LRP at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which all longline fisheries in the WCPO are managed through the bigeye MP. The colour indicates that the probability of being above the LRP is at least 0.8 (green) or lower (red). The value in each cell is the probability of being above the LRP.

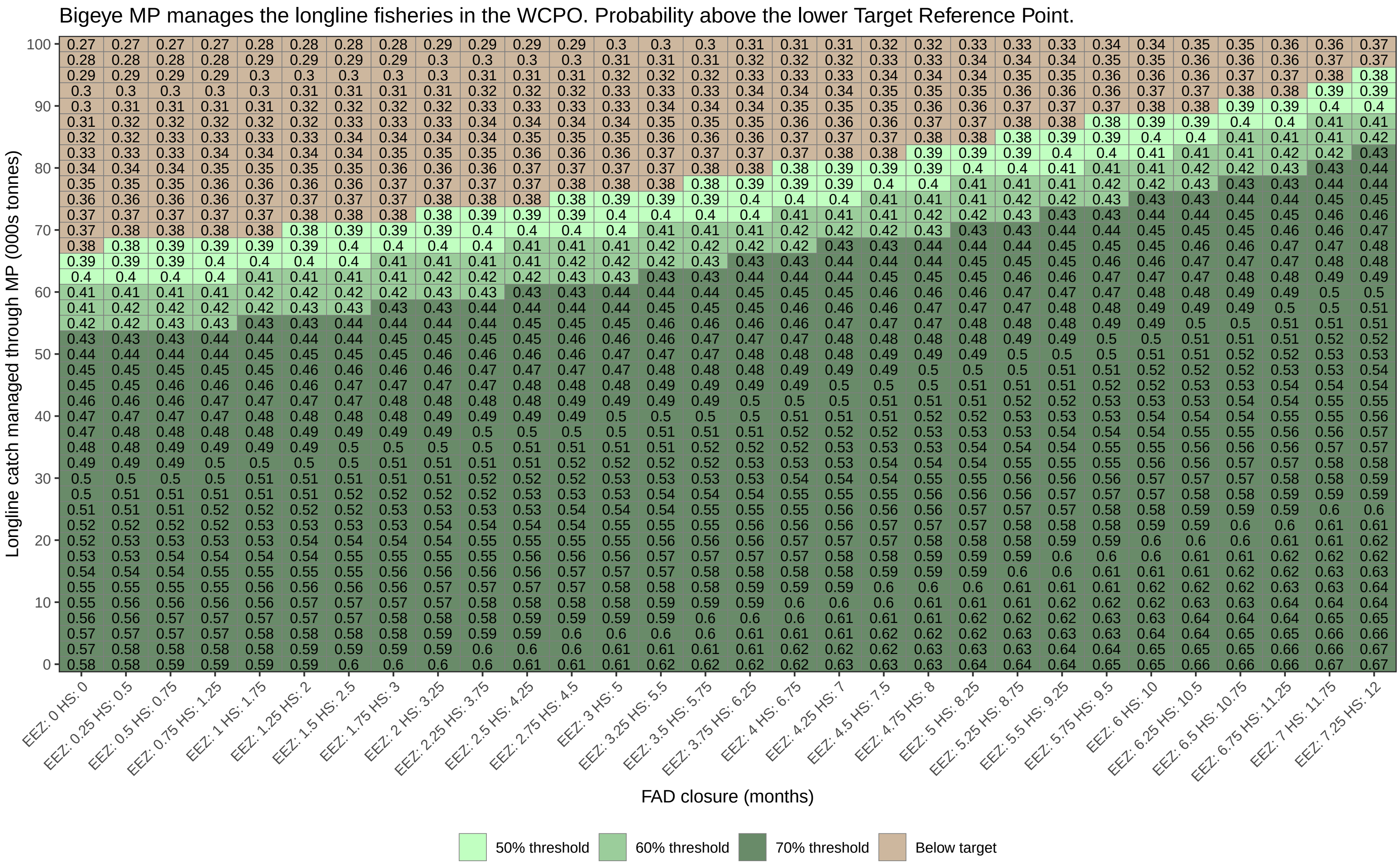

Figure 14: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which all longline fisheries in the WCPO are managed through the bigeye MP. The colours indicate the probability of a cell being above the lower TRP with different thresholds.

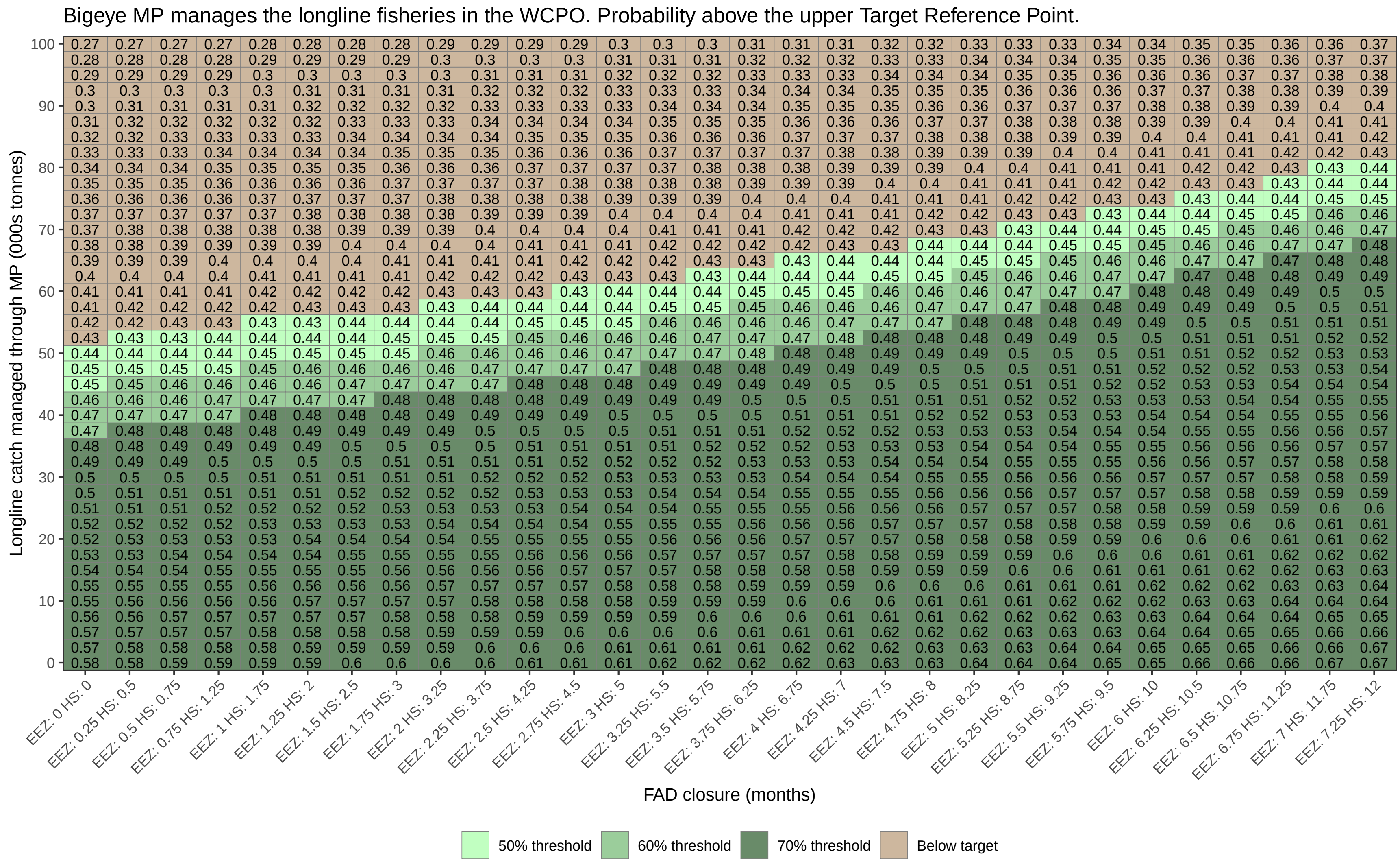

Figure 15: The long-term median depletion value at each combination of FAD closure period and longline catch managed through the bigeye MP for the scenario in which all longline fisheries in the WCPO are managed through the bigeye MP. The colours indicate the probability of a cell being above the upper TRP with different thresholds.

Appendix: Addressing the BMW01 request for fishery impact as a performance measure

At BMW01, a CCM requested additional candidate performance indicators depicting fishery impact for purse seine and longline, separately.

Producing this performance indicator in the style of the 'impact plots' presented within stock assessments for the diagnostic model results is not feasible for the thousands of individual evaluations performed during the MSE process within the technical resources available. In turn, the developed approach of evaluating specific pairs of HCRs setting purse seine FAD closure period and bigeye catch of longline fisheries managed through the bigeye management procedure (MP) pre-defines the relative impacts of the two gears. Therefore, a specific performance indicator of fishery impact is not provided in this paper. Information can be inferred through the performance indicators provided.

However, to address the request as far as possible, two further approaches have been pursued.

In the first, individual impact plots are provided for a sub-set of the bigeye operating models (OMs) within SC22-MI-WP-01 (Scott et al., 2026b).

For the second, the nuclear grid for each bigeye MP spatial scenario (specifying the different longline fisheries managed by the MP) that helped define the levels of the Hillary step for a given TRP, have been used to evaluate relative gear-specific contributions to changes in depletion from baseline levels. This is comparable to the approach used for the tropical tuna CMM evaluations at WCPFC20 (see https://meetings.wcpfc.int/file/14263/download). More details are provided in the first worksheet of the Excel file accompanying this paper (MI-WP-03 Supplementary Material).

The spreadsheet provides the results of the three nuclear grids (in individual worksheets) and uses them to demonstrate the change in average impact of the longline and purse seine components that are specifically being controlled by the HCRs.

We highlight that any impact will need to be viewed carefully, given that the impact will depend upon the MP spatial scenario being considered. For example, the longline impact will be for that specific component under control of the MP, and the impact of the purse seine fishing level will be relative to that component. The utility of the resulting overall 'impact' as a performance indicator will need to be carefully considered.