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Performance indicators for comparing management procedures for South Pacific albacore using the MSE modelling framework.

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Executive Summary

A key element of the harvest strategy approach is the development and use of a range of performance indicators (PIs) for evaluating the relative performance of candidate management procedures. The WCPFC14 Summary Report Attachment K includes an proposed list of PIs for southern longline fisheries for this purpose.

This paper calculates a demonstration set of southern longline fishery PIs from Attachment K. Throughout, we have taken a very similar approach to Scott et al. (2018b) who calculated PIs for the Western and Central Pacific Ocean (WCPO) skipjack stock. The structure of the recent albacore assessment additionally allows PIs to be developed at a fleet-group level. The indicators presented herein are generated from the proof of concept management strategy evaluation (MSE) framework for albacore that is currently under development (Scott et al., 2019) and are not intended for management purposes. They are calculated over three time periods (short-, medium- and long-term). Some indicators are currently challenging to interpret and therefore may need further consideration. In turn, the MSE framework considers multiple sources of uncertainty resulting in a distribution of values for each indicator. This distribution can offer additional information on the performance of a management procedure that is not captured by only considering a single summary value, e.g. the median. Additional indicators can be developed as required as the harvest strategy work progresses.

It is not yet possible to calculate all of the indicators in Attachment K. Noting the comments of CCMs concerning the definition of PIs for South Pacific albacore and the ongoing discussions, we consider the calculation of these outstanding indicators to be a priority concern that will need to be addressed as soon as possible. We stress that the lack of a calculated value for a PI, at this stage does not imply it has reduced priority in the framework.

We invite WCPFC-SC to consider the approach being taken to develop and compare PIs for the development of harvest strategies for South Pacific albacore. Specifically we invite SC15 to:

- Consider and advise upon using a smaller number of PIs to aid in comparing the relative performance of candidate management procedures;
- Agree that the distribution of the indicator values, not just a measure of the central tendency, should be considered;
- Agree that the time periods over which the indicators are calculated should be based on an appropriate number of management cycles, based on the life history of the stock;
- Note that a number of PIs described in WCPFC14 Summary Report Attachment K cannot currently be calculated from the MSE framework and are the subject of ongoing work; and
- Discuss the issues raised within the paper regarding the candidate PIs, in particular those not currently calculated.

	Objective type	Objective Description	Performance Indicator (WP14)	Calculated
1	Biological	Maintain ALB (and SWO, YFT and BET) biomass at or above levels that provide fishery sustainability throughout their range	Probability of $SB/SB_{F=0} > 0.2$ as determined from MSE.	Y
2	Economic	Maximise economic yield from the fishery	Predicted effort relative to E_{MEY} (to take account of multi-species considerations, BET and other spp may be calculated at the individual fishery level). B_{MEY} and F_{MEY} may also be considered at a single species level.	N
3	Economic	Maximise economic yield from the fishery	Average expected catch (may also be calculated at the assessment region level)	Y
4	Economic	Maintain acceptable CPUE	Average deviation of predicted ALB CPUE from reference period levels	Y
5	Economic	Taking Article 30 of the WCPFC convention into account: Maximise SIDS revenues from resource rents*	Proxy: average value of SIDS / non-SIDS catch	N
6	Economic	Catch stability	Average annual variation in catch	Y
7	Economic	Stability and continuity of market supply	Effort variation relative to reference period level (may also be calculated at the assessment region level)	Y
8	Economic	Stability and continuity of market supply	Probability of and deviation from $SB/SB_{F=0} > 0.56$ (ALB) in the short-, medium- and long-term as determined from MSE (may also be calculated at the assessment region level)	Y
9	Social	Food security in developing states (import replacement)	As a proxy: average proportion of CCMs-catch to total catch for fisheries operating in specific regions	N
10	Social	Avoid adverse impacts on small scale fishers	• MSY of ALB, BET, YFT • Possible information on other competing fisheries targeting ALB (may also be calculated at the assessment region level) • Any additional information on other fisheries / species as possible	N
11	Ecosystem	Minimise bycatch	Expected catch of other species	N
12	Economic	Optimise capacity	Vessel numbers targeting ALB	N
13	Social	Maintain/develop domestic fishery	Ratio of domestic catch to total catch	Y
14	Social	Human resource development	Ratio of domestic catch to total catch	N

Table 1: Summary of proposed performance indicators for the southern longline fishery (WCPFC14 Summary Report Attachment K). The *Calculated* column notes whether or not the indicator can be calculated using the current operating models. *Description modified to better reflect the original intent of the PI.

1 Introduction

Performance indicators (PIs) are an important component of a harvest strategy. During the harvest strategy approach, candidate management procedures (MPs) are evaluated using management strategy evaluation (MSE, Figure 1) (Punt et al., 2014; Scott et al., 2018a, 2019). PIs are used to evaluate how well a candidate MP is expected to perform and enable the selection of a preferred option from a range of candidate procedures. They are interpreted in relation to management objectives. The suite of PIs that will be used to evaluate the MPs should be agreed by stakeholders. This is an iterative process and the desired indicators can change as the harvest strategy continues to be developed. An important signal from the indicators is the trade-offs between them i.e. some candidate MPs will score highly on some indicators but less well on others. For example, an MP that results in relatively high catches may have a lower probability of stock sustainability. Another important property of an indicator is that it is easy to communicate and interpret.

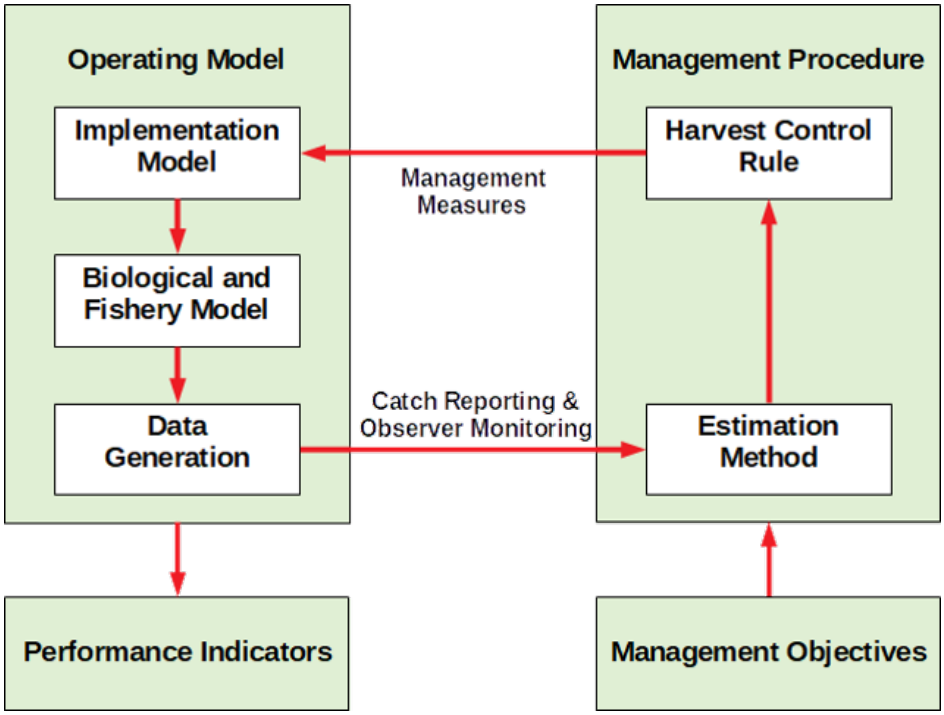

Figure 1: Conceptual diagram of the MSE framework (after Punt et al. (2014)).

In accordance with the timetable for the development of a harvest strategy approach for WCPFC stocks and fisheries, SC14 provided advice to the Commission in 2018 on candidate PIs and monitoring strategies for southern and tropical longline fisheries. During the Commission meeting the proposals for the southern and tropical longline fisheries were further considered and a refined list of prioritised indicators for the various biological, economic, social and ecosystem objectives was produced (WCPFC14 Summary Report Attachment K). The objectives and indicators for the southern and tropical longline fisheries are very similar to those for the tropical purse fisheries

(WCPFC, 2017).

This paper:

- Reviews the initial proposed suite of PIs for South Pacific albacore;
- Presents details on how indicators can be calculated using a demonstration set of results for albacore;
- Identifies proposed indicators which cannot currently be calculated or which provide information that is already captured by other indicators; and
- Identifies recommendations that could be made by SC15 to WCPFC16 to inform the use of PIs to evaluate the relative performance of candidate MPs.

2 Calculation of the Performance indicators

In this section the calculation of each of the proposed PIs in Table 1 is described and discussed. The indicators are calculated using the outputs from the preliminary MSE framework for albacore (Scott et al., 2019). For reasons outlined below it is not possible to calculate all of the proposed indicators at this time (Section 3). Two HCRs are tested in the framework (Scott et al., 2019). It is important to note that the chosen HCRs do not represent actual candidate HCRs for albacore. They have been chosen to demonstrate the MSE framework and the PIs. As requested, indicators are calculated over three time periods: short-, medium- and long-term (WCPFC, 2017). Here these time periods are based on the number of management cycles in each period. In this demonstration the management cycle is 3 years, i.e. the MP is called every 3 years and the resulting future fishing level determined through the harvest control rule (HCR) is fixed for the following 3 years. In this example, projections start in 2017 with the MP first being called also in 2017. Short-term is taken to be the first three management cycles (2017-2019, 2020-2022, 2023-2025), medium-term is taken to be the next three management cycles (2026-2028, 2029-2031, 2032-2034) and long-term is taken to be the final three management cycles (2035-2037, 2038-2040, 2041-2043).

The projections performed within the MSE are stochastic and consider multiple sources of uncertainty (Scott et al., 2019). However, in the list of PIs (Table 1) there is no mention of the distribution of values of the indicator, implying that only the central value, e.g. the median, should be considered. This means that there is limited consideration of uncertainty which is potentially important. For example, two HCRs may produce the same median catches but the distributions of the catch may be different which may influence which HCR was preferred. To illustrate this point the distributions of the indicator values have been considered here by including the 20^{th} and 80^{th} percentiles in the following tables and plots. This builds upon the similar discussions for the presentation of PIs for skipjack management procedures.

The indicators considered below may not represent the final set of PIs. Alternative indicators can

be tested and adopted throughout the process of developing a harvest strategy. In turn, PIs can be excluded where they show information that duplicates that from other PIs. It should be noted that the figures and values presented here are provided only to act as a 'proof of concept' and to illustrate how the PIs may be calculated.

Recommendation:

- Base the short-, medium- and long-term time periods on the number of management cycles (e.g. for albacore each time period is 3 management cycles of 3 years);
- Consider the distribution of indicator values as well as the central measure.

2.1 Indicator 1. Maintain SPA biomass at or above levels that provide fishery sustainability throughout their range

The indicator is the probability of $SB/SB_{F=0} > 0.2$ where 0.2 is the limit reference point(LRP) for albacore. The adult biomass (SB) and the unfished adult biomass ($SB/SB_{F=0}$) are reported from the operating model (OMs) by season and region (Scott et al., 2019). This indicator is based on the mean annual biomass which is calculated by taking the mean biomass over the seasons. Here, we combine the adult biomass from all regions. The unfished adult biomass is taken as the mean of the unfished biomass over a rolling window of 10 years. The equation used to calculate this PI of each simulation over the desired year range (short-, medium- and long-term) is shown in Table 3. This is calculated in the same way as for skipjack (Scott et al., 2018b).

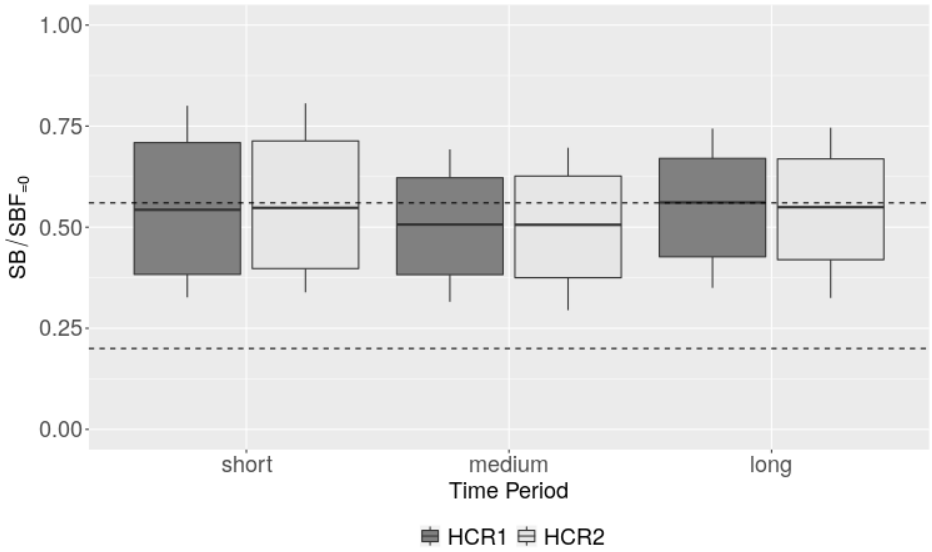

Figure 2: Distribution of $SB/SB_{F=0}$ in the three time periods (short-, medium- and long-term). The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median. The dashed horizontal lines at 0.2 and 0.56 reflect the limit reference point(LRP) and the interim target reference point(TRP) respectively.

The single value of this indicator ranges between 0 and 1. If this indicator results in 1, it means that the $SB/SB_{F=0}$ is always greater than 0.2 for the given period. Meanwhile, if the value of this indicator is 0, it indicates that the $SB/SB_{F=0}$ is always below 0.2. However, we should note that the same value for this PI does not necessary lead to the same $SB/SB_{F=0}$ value. In our examples, both proposed HCRs result in similar values for this indicator.

In Figure 2, we present the actual range of $SB/SB_{F=0}$ values achieved by each HCR within each time period. We recommend that these metrics be included in evaluations, as they provide further information for PI 1 and PI 8.

2.2 Indicator 3. Maximise economic yield from the fishery (average expected catch)

This indicator is calculated based on the average expected catch. Catch is reported at the region and fishery levels from MULTIFAN-CL. It is therefore possible to calculate this indicator for each fishery and each region in the model. However, this would result in a large number of values, making it challenging to understand the overall relative performance of the candidate MPs. Here, we first calculate the average expected catch across all regions and fisheries.

The southern longline fleets are further divided into the Distant-water fishing nation (DWFN) and the Pacific Island Countries and Territories (PICT) domestic longline fleets. Given the different economic interests between these two groups, we also calculate the average expected catch from the DWFN and PICT longline fleets. The indicator is calculated by taking the average catch of each simulation over the desired year range (short-, medium- and long-term) (Table 3). The equation used to calculate this indicator is the same as that used in skipjack (Scott et al., 2018b).

The pattern of results are the same for the total catch and the catch from the DWFN and PICT longline fleets (Figure 3). This is because the output of the HCR (a catch multiplier) applies equally to all fisheries and regions (Scott et al., 2019). In the short- and long-term, HCR1 produces a higher expected catch than HCR2. However, HCR2 produces a higher expected catch than HCR1 in the medium-term. This example highlights the importance of considering all time periods when selecting an HCR.

2.3 Indicator 4. Maintain acceptable CPUE

This indicator is based on the average deviation of predicted albacore CPUE from reference period levels. It is calculated as the CPUE relative to the CPUE in a reference period. The reference period is taken to be 2013 in this preliminary evaluation. This indicator is calculated for all fleets combined, the DWFN and PICT longline fleets across all regions.

This indicator is calculated using equation 4 in Table 3. The average relative CPUE is calculated for each simulation over the desired year range (short-, medium- and long-term). It uses the same equation as skipjack (Scott et al., 2018b).

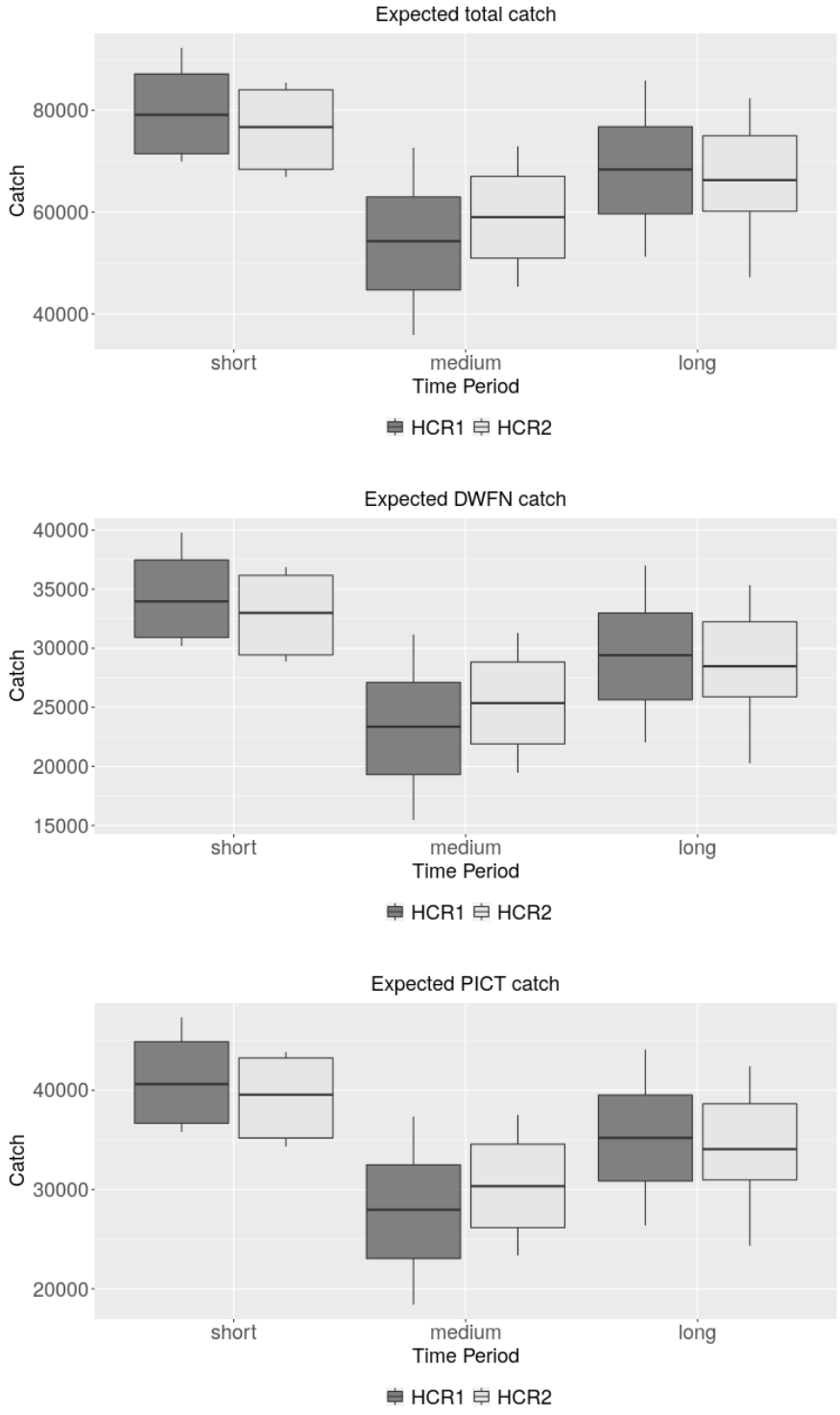

Figure 3: Distribution of performance indicator 3 (average expected catch) in the three time periods (short-, medium- and long-term). The expected catch for the total fisheries, and DWFN and PICT longline fisheries are shown. The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median.

For South Pacific albacore, the noted economic management objectives are aligned with longline CPUE. Therefore, this indicator provides important information on the economic performance of the fisheries. The pattern of results are similar for the relative CPUE from total, the DWFN and PICT longline fleets (Figure 4). Both HCRs yield similar relative CPUE in all three periods.

2.4 Indicator 6. Catch stability

This indicator is concerned with the average annual variation in catch. As with indicator 3, it is possible to calculate this indicator by fishery and region. Similar to indicator 3 and 4, it is calculated over the entire fisheries and region, and for the DWFN and PICT longline fleets.

The indicator is calculated by taking the absolute annual difference of the catch for each simulation and in each year. The absolute annual difference is then averaged over the short-, medium- and long-term year range (Table 3). This indicator is calculated the same way as for skipjack (Scott et al., 2018b).

Indicator 6 measures the variation in catch, i.e. the higher the value of the indicator, the less stable the catch is. It is assumed that an MP that produces a lower catch variation, i.e. a low value of the indicator, would be preferred. This could be scaled by the mean catch so that it reflects the average stability in relative catch.

As with indicator 3, there is a similar pattern of results when looking at the total catch variation and only the catch variation from DWFN and PICT longline fleets. HCR1 produces lower variations in the short- and medium-term. Both HCRs produce similar levels of variation in the long-term (Figure 5).

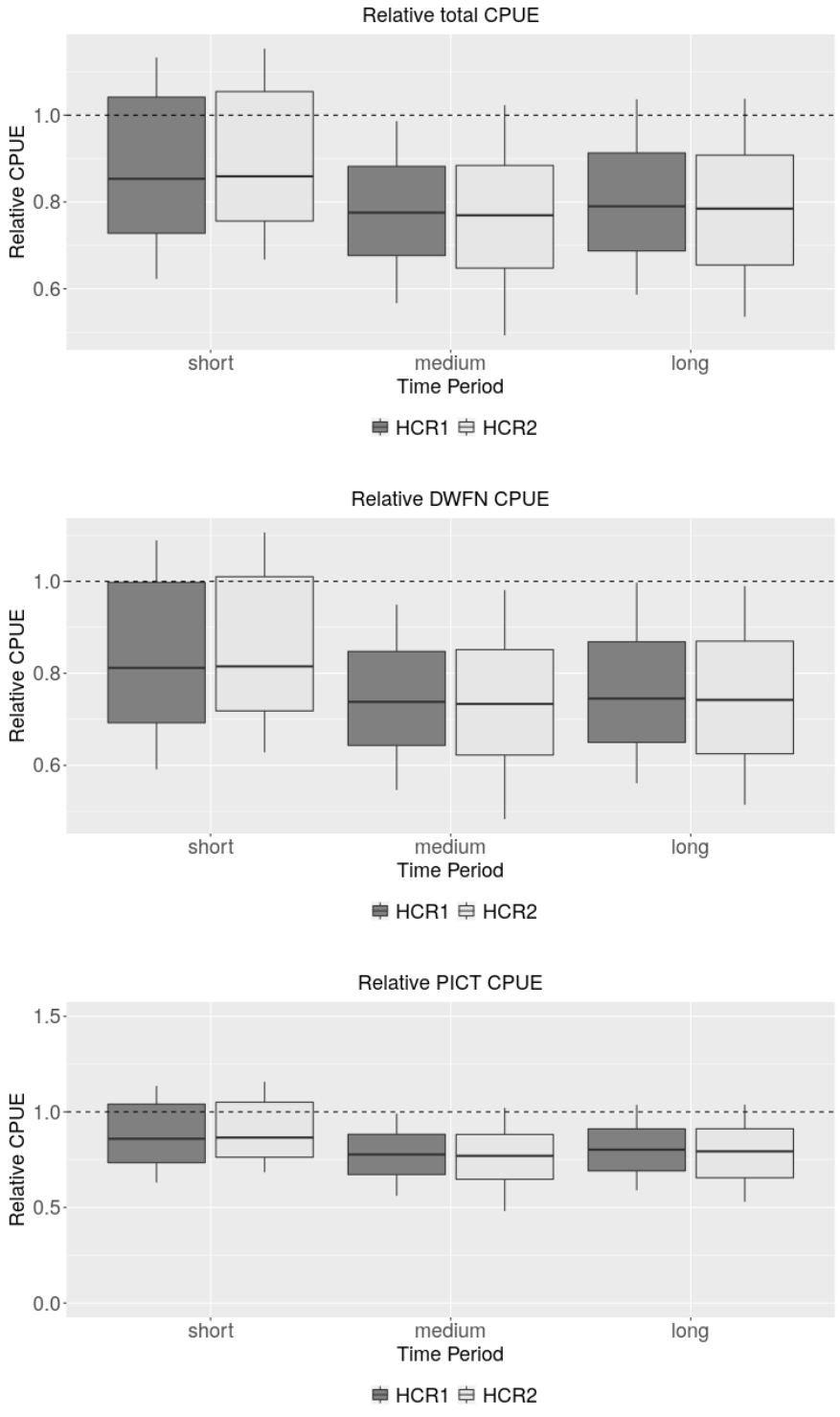

Figure 4: Distribution of performance indicator 4 (maintain acceptable CPUE relative to reference CPUE) in the three time periods (short-, medium- and long-term). Only the CPUE across all fisheries and DWFN and PICT longline fisheries across all regions are considered. The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median. The dashed horizontal lines at 1 reflect reference CPUE.

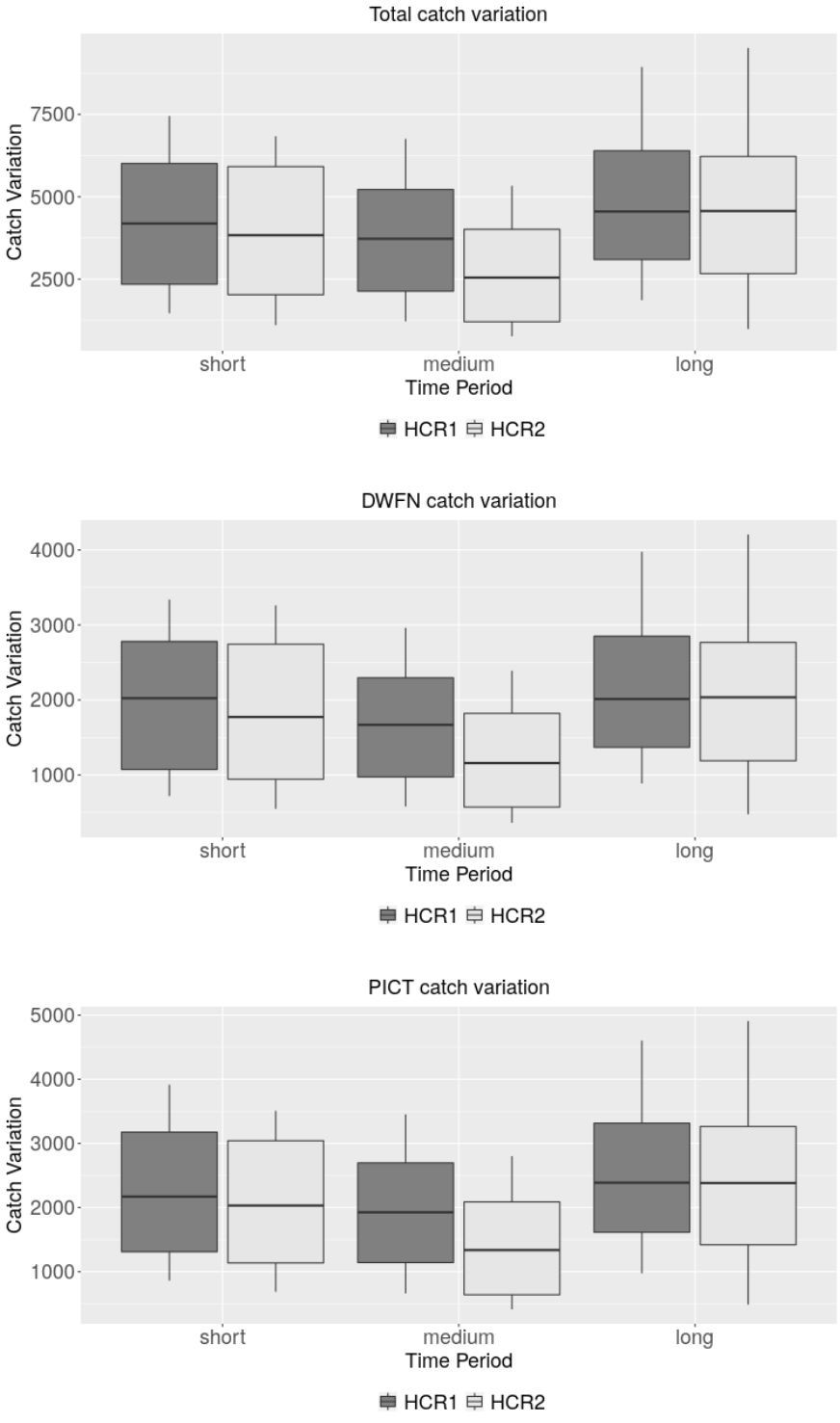

Figure 5: Distribution of performance indicator 6 (catch variation) in the three time periods (short-, medium- and long-). The catch variation of all fisheries, and DWFN and PICT fisheries across all regions are considered. The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median.

2.5 Indicator 7. Stability and continuity of market supply (effort variation relative to a reference period)

This indicator is concerned with effort variation relative to the effort in a reference period, i.e. stability of the relative effort. For albacore, the reference period is taken to be 2013. As mentioned above, the OM reports effort at the fishery level which means this indicator could be calculated at the fishery, region and total level. Similar to indicator 6, this indicator is calculated for total, DWFN and PICT longline fleets.

The absolute annual difference of the effort relative to the base effort (in 2013) is calculated for each simulation in each year. Then, the absolute annual difference is averaged over the desired year range (short-, medium- and long-term) (Table 3). This indicator is calculated using the same equation as skipjack (Scott et al., 2018c).

Like indicator 6, this indicator measures the variation in the relative effort, i.e. the higher the value of the indicator, the less stable the relative effort is. It is assumed that MPs that produce a low value of this indicator are considered to perform better. Similar to the results of indicator 6, the two HCRs produce similar results in the medium- and long-term. Meanwhile, HCR2 produces slightly less variance in the short-term (Figure 6).

2.6 Indicator 8. Stability and continuity of market supply (deviation from target reference point(TRP))

This indicator is concerned with maintaining the stock size around the TRP levels (where the interim TRP for albacore is $SB/SB_{F=0} = 0.56$). This indicator measures the deviation from $SB/SB_{F=0} = 0.56$. It is assumed that the further away $SB/SB_{F=0}$ is from 0.56, the worse the MP can be thought of as performing, i.e. it is better to have $SB/SB_{F=0}$ close to 0.56 on average.

This indicator is calculated as the absolute difference between $SB/SB_{F=0}$ /0.56 and 1, for each simulation in each year, i.e. the further away $SB/SB_{F=0}$ is from the TRP (in either direction, higher or lower) the higher the value (Table 3). The lower the value the better the MP is considered to be performing at maintaining $SB/SB_{F=0}$ at the TRP, i.e. a value of 0 means that $SB/SB_{F=0}$ is always exactly equal to the TRP and never deviates from it. In the initial calculation, this indicator has two parts: the probability and the deviation from $SB/SB_{F=0} = \text{TRP}$ (Scott et al., 2018c). However, an indicator should be easy to communicate and interpret. When considering PIs for skipjack, SC 14 recommended to only calculate the deviation from $SB/SB_{F=0}$ for this indicator. The direction of the deviations can be observed in the depletion plot (Figure 2).

In Figure 7, both HCRs tend to have the same values indicating that both HCRs result in similar distances from the TRP in all time periods. Indicator 2 suggests that the stocks under both HCRs tend to be consistently below the TRP. As indicator 8 only presents absolute deviation, this is a good example where PIs must be evaluated together in order to gain the full picture.

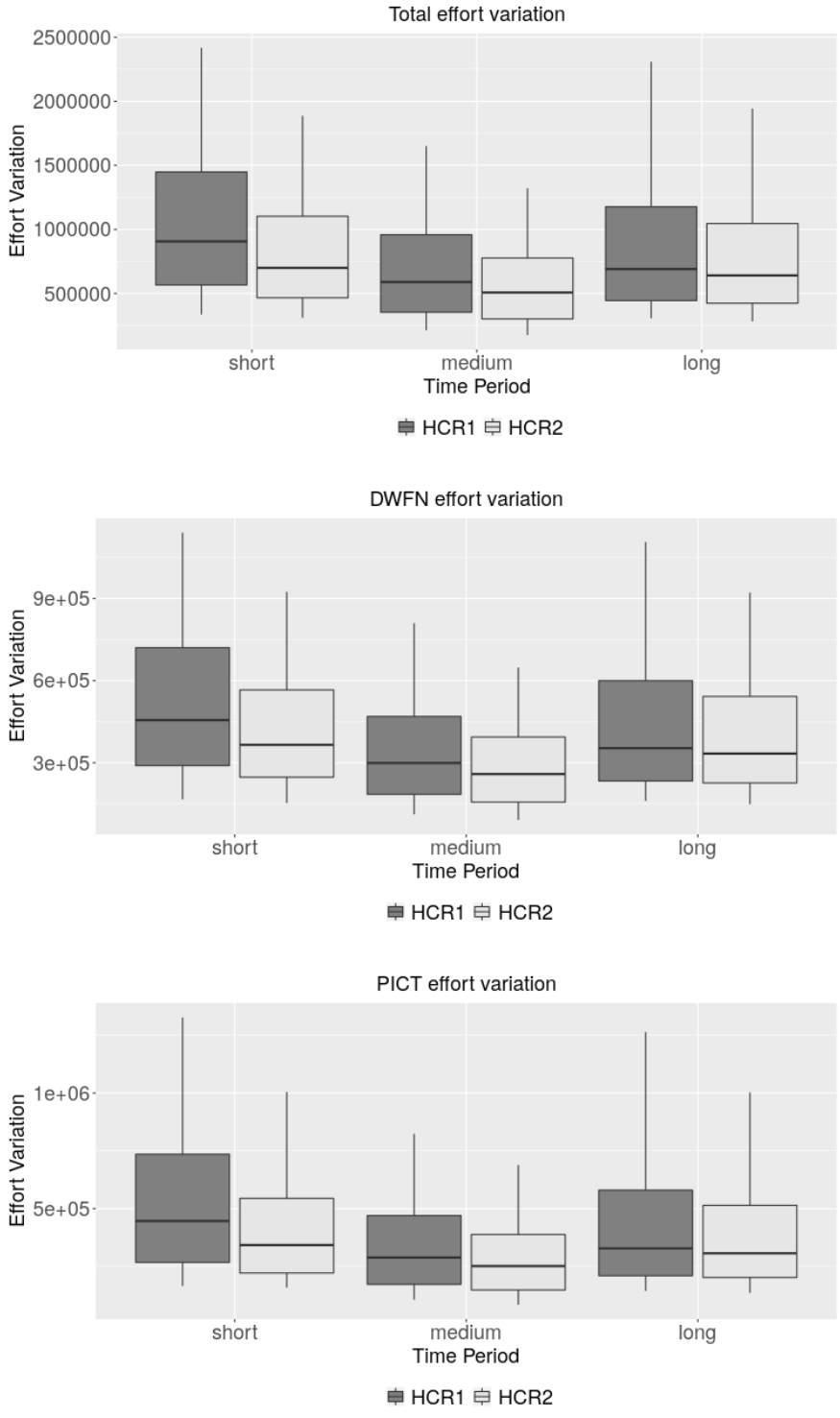

Figure 6: Distribution of performance indicator 7 (effort variation) in the three time periods (short-, medium- and long-term). The effort variation of all fisheries, and DWFN and PICT fisheries across all regions are considered. The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median.

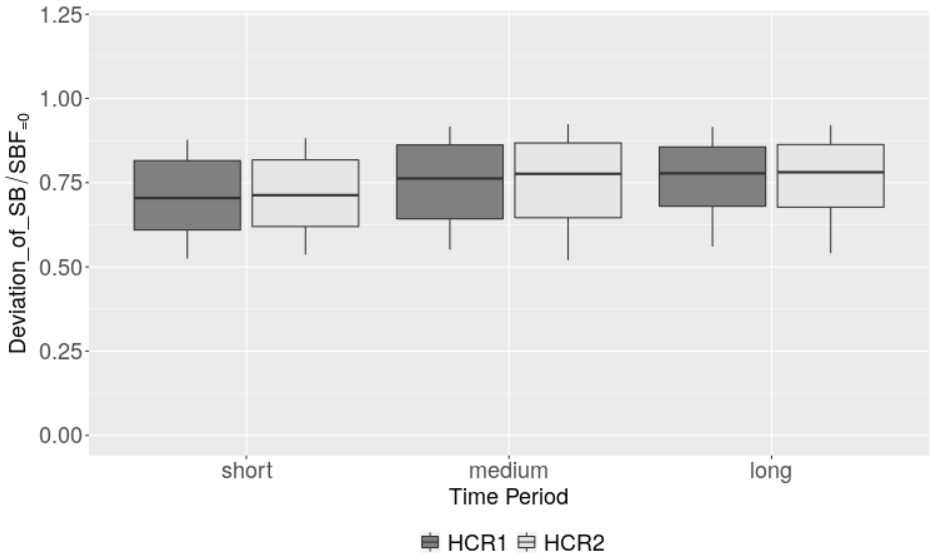

Figure 7: Distribution of performance indicator 8 (deviation from $SB/SB_{F=0} = 0.56$) in the three time periods (short-, medium- and long-term). The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median.

2.7 Indicator 13. Maintain/develop domestic fishery

This indicator is based on the ratio of the average expected domestic catch to the average expected total catch. As mentioned above, the catch is reported at the region and fishery levels from MULTIFAN-CL. Here, we only calculate the ratio between the expected PICT longline fleet catch and the total catch across all regions.

The indicator is calculated by taking the ratio of the average catch of PICT fleets to the total average catch in each simulation over the desired year range (short-, medium- and long-term) (Table 3). This indicator could not be calculated in the skipjack MSE framework, but can be calculated here due to the fleet structure used in the South Pacific albacore assessment.

This indicator ranges between 0 and 1. If this indicator is 1, it means that the domestic catch represents 100% of the total catch. Meanwhile, if the value of this indicator is 0, it indicates that there is no domestic catch within the total catch.

The results suggest that both HCRs achieved a similar ratio of domestic catch (Figure 8) and that the ratio does not change over time. This is unsurprising because, for the current set of evaluations, all fisheries were subject to the HCR and have been scaled equally by it throughout the evaluation period. This indicator may be more informative in instances where only a subset of fisheries are subject to the HCR.

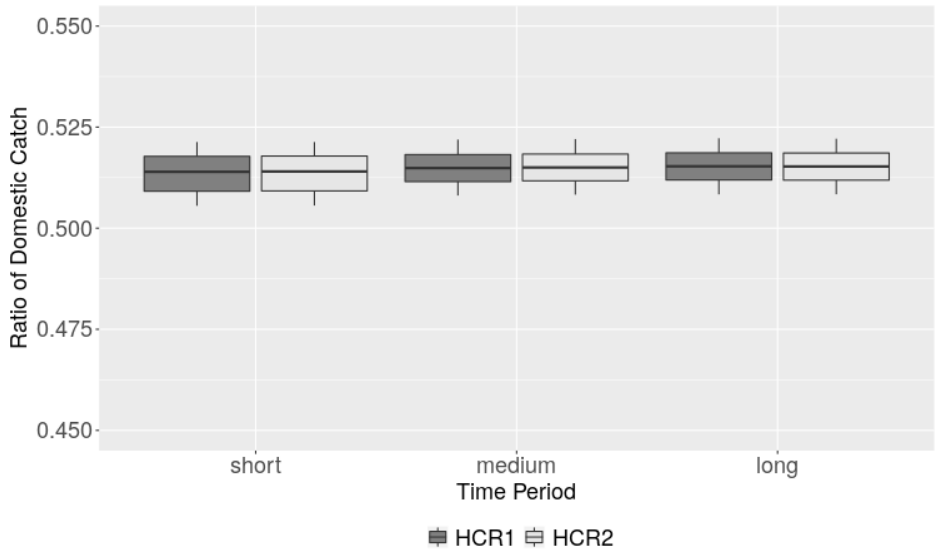

Figure 8: Distribution of performance indicator 13 (ratio of the domestic catch to the total catch) in the three time periods (short-, medium- and long-term). The boxes capture the 20-80th percentiles, the vertical lines capture the 5-95th percentiles and the horizontal line is the median.

3 Performance indicators that are not currently calculated

Not all of the indicators listed in Table 1 can currently be calculated from the operating model (OM). However, the information provided by a specific indicator may be provided by other indicators.

3.1 Indicator 2. Maximise economic yield from the fishery (predicted effort relative to E_{MEY})

This indicator is based on the predicted effort, E, relative to E_{MEY}. Additionally, the predicted SB relative to SB_{MEY} and fishing mortality, F, relative to F_{MEY} may also be considered. Calculating this indicator requires values for E_{MEY}, B_{MEY} and/or F_{MEY}. However, the results of previous analyses of the southern longline fishery suggest that MEY and its associated values of E_{MEY} and B_{MEY} may not be appropriate targets when determining management options for South Pacific albacore (Pilling et al., 2018) and that alternative less 'optimal' measures of the profitability of the fishery should be considered.

We therefore defer calculation of PI 2 pending further discussion on appropriate economic targets for the southern longline fishery, noting that calculations for PI 3 are presented which also considers the maximisation of economic yield from the fishery. In turn, the TRP level has been selected based on considerations of profitability, and hence indicator 1 and 8 provide further information for this indicator.

3.2 Indicator 5. Taking Article 30 of the WCPFC convention into account: Maximise SIDS revenues from resource rents

We note the importance of this indicator and are currently working with members to develop methods to calculate it. This PI is intended to take into account the special requirements of developing states and territories. It has been suggested that the proxy for this indicator is the ratio of the average value of SIDS to non-SIDS catch (Table 1). As DWFN and PICT fisheries are specified in the OMs, separate catches can be estimated, allowing a simple ratio of PICT catches to total catches to be calculated (as for indicator 13). However, as shown for PI 13, the PI calculated in this way provides very little information, especially when the HCR is applied equally to all fisheries.

We defer calculation of this PI pending further discussion on how it might best be calculated or approximated, noting that, in the case of skipjack, members have previously requested that this PI be retained. We note that the lack of a calculated value for a PI, at this stage, does not imply it has reduced priority in the framework.

3.3 Indicator 9. Food security in developing states (import replacement)

A proxy for this indicator is the average proportion of the catch of CCMs to total catch for fisheries operating in specific regions (Table 1). It is not currently possible to calculate this indicator as the information for attributing the catches to individual CCMs is not available in the OM. It may be possible to make some assumptions about attributing catches to CCMs (e.g. based on historical distributions) but the value of the indicator would be very strongly influenced by these assumptions, making it potentially misleading.

There is an additional issue with the indicator in that it is calculated using a proportion. This may not be appropriate and could give misleading results. For example, if the total catch for the fisheries strongly increases and the catch of CCMs also increases but not by as much, the proportion will show a negative outcome despite there being an increase in the catch of CCMs.

It is worth noting that there is overlap between this indicator and other indicators. Indicator 9 is specifically concerned with food security in developing states. If $SB/SB_{F=0}$ is sustainable (as measured by indicators 1 and 8) then it could be assumed that there may be less concern with food security for developing states.

3.4 Indicator 10. Avoid adverse impacts on small scale fisheries

This indicator is concerned with how small scale fisheries may be affected by management plans, including information on other fisheries. However, there are a number of challenges in calculating this indicator.

One challenge is that it is not clear what is meant by 'small scale fisheries' in the indicator de-

scription. As mentioned above, individual fishing fleets are not modelled in the OM. If small scale means artisanal fisheries then it is not possible to calculate this indicator as this information is not available in the OM. However this does not preclude CCMs managing these fisheries under local/domestic management arrangements.

If the MP and HCR apply equally to all fisheries, then the output of the HCR will affect the catch of all fisheries by the same proportion. This would mean the performance of all fisheries are likely to respond in a similar same way to the MP. In this example, the expected total catches of all the fisheries show a similar pattern to the expected catches of only the DWFN and PICT fisheries (Table 2).

Indicator 10 also includes the MSY of the stocks. However, this could be interpreted in a number of ways e.g. catches relative to MSY, SB relative to SB_{MEY} etc. We defer calculation of this PI pending further discussion of these issues but note that, in the case of skipjack, members have previously requested that this PI be retained.

3.5 Indicator 11. Minimise bycatch

This indicator considers the number of longline sets and the expected catch of other species. Only the main tuna species are considered in the OMs at this time (and in this case the OM for albacore is a single species model) and so it is not possible to directly model the bycatch of other species. We defer the calculation of this PI pending further developments in the modelling framework to include mixed fishery and multi-species considerations, or alternative methods of determining the level of bycatch in the southern longline fishery but note that, in the case of skipjack, members have previously requested that this PI be retained.

3.6 Indicator 12. Optimise capacity

This indicator is based on the number of vessels targeting South Pacific albacore. It is not currently possible to calculate this indicator from the current OMs. As mentioned before, the fisheries in the biological and fishery model component of the OM are classified by region and gear type but not in terms of vessel numbers. In addition it is difficult to calculate a PI to measure the optimisation of capacity without some indication of what the optimum capacity might be.

We defer the calculation of this PI pending further discussion and clarification of optimum capacity.

3.7 Indicator 14. Human resource development

This indicator also considers the ratio of the domestic catch to the total catch as for indicator 13. It is possible to calculate this indicator from the current OMs. However, this indicator is calculated in exactly the same way as indicator 13. Pending discussion, this indicator could be moved to the monitoring strategy and elements such as training and participation in the fishery; or PICT crew employment levels on DWFN vessels; or vessel reflagging to PICTs could be monitored.

4 Conclusions

PIs are used to compare candidate MPs and measure how well each MP achieves the management objectives of the fishery. An indicator is not considered in isolation but as part of a suite of indicators that collectively describe the performance of an MP. The MP which is judged to have the 'best' values overall for the indicators can be thought of as having the best overall performance in terms of meeting the management objectives. There may be trade-offs between the indicators in which case a decision will have to be made as to which indicators are more important, possibly using a pre-agreed weighting based on the prioritised objectives for the fishery.

We note the comments of CCMs concerning the definition of the PIs for South Pacific albacore (WCPFC14 Summary Report Attachment K) and the ongoing discussions around their calculation, in particular for those outstanding indicators for which values cannot yet be calculated. We consider the calculation of these outstanding indicators to be a priority concern that will need to be addressed as soon as possible. We stress that the lack of a calculated value for a PI, at this stage, does not imply it has reduced priority in the framework.

We continue to seek feedback from members on the definition and calculation of PIs.

We invite WCPFC-SC to consider the approach being taken to develop and compare PIs for the development of harvest strategies for South Pacific albacore. Specifically we invite SC15 to:

- Consider and advise upon using a smaller number of PIs to aid in comparing the relative performance of candidate management procedures;
- Agree that the distribution of the indicator values, not just a measure of the central tendency, should be considered;
- Agree that the time periods over which the indicators are calculated should be based on an appropriate number of management cycles, based on the life history of the stock;
- Note that a number of PIs described in WCPFC14 Summary Report Attachment K cannot currently be calculated from the MSE framework and are the subject of ongoing work; and
- Discuss the issues raised within the paper regarding the candidate PIs, in particular those not currently calculated.

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A Performance indicator summary table

PI	Description	Period	HCR1	HCR2
1	Prob. of $SB/SB_{F=0}$ >0.2	short	0.980	0.986
1	Prob. of >0.2	medium	0.981	0.982
1	Prob. of $SB/SB_{F=0}$ >0.2	long	0.992	0.989
3a	Expected total catch	short	79108 (71457,87125)	76695 (68407,84025)
3a	Expected total catch	medium	54297 (44724,62992)	59024 (50967,67027)
3a	Expected total catch	long	68370 (59652,76777)	66277 (60167,74995)
3b	Expected DWFN catch	short	33961 (30906,37472)	32959 (29432,36166)
3b	Expected DWFN catch	medium	23359 (19312,27105)	25355 (21901,28830)
3b	Expected DWFN catch	long	29411 (25639,32978)	28472 (25885,32242)
3c	Expected PICT catch	short	40622 (36671,44898)	39555 (35193,43257)
3c	Expected PICT catch	medium	27965 (23060,32486)	30345 (26164,34573)
3c	Expected PICT catch	long	35201 (30860,39520)	34069 (30972,38642)
4a	Relative total CPUE	short	0.85 (0.73,1.04)	0.86 (0.76,1.05)
4a	Relative total CPUE	medium	0.78 (0.68,0.88)	0.77 (0.65,0.88)
4a	Relative total CPUE	long	0.79 (0.69,0.91)	0.78 (0.65,0.91)
4b	Relative DWFN CPUE	short	0.81 (0.69,0.99)	0.82 (0.72,1.01)
4b	Relative DWFN CPUE	medium	0.74 (0.64,0.85)	0.73 (0.62,0.85)
4b	Relative DWFN CPUE	long	0.75 (0.65,0.87)	0.74 (0.63,0.87)
4c	Relative PICT CPUE	short	0.86 (0.73,1.04)	0.87 (0.76,1.05)
4c	Relative PICT CPUE	medium	0.78 (0.67,0.88)	0.77 (0.65,0.88)
4c	Relative PICT CPUE	long	0.80 (0.69,0.91)	0.79 (0.66,0.91)
6a	Relative total catch variation	short	0.56 (0.37,0.75)	0.60 (0.38,0.78)
6a	Relative total catch variation	medium	0.61 (0.45,0.78)	0.73 (0.58,0.87)
6a	Relative total catch variation	long	0.53 (0.33,0.68)	0.52 (0.35,0.72)
6b	Relative DWFN catch variation	short	0.52 (0.34,0.74)	0.58 (0.35,0.78)
6b	Relative DWFN catch variation	medium	0.60 (0.45,0.77)	0.72 (0.57,0.86)
6b	Relative DWFN catch variation	long	0.52 (0.32,0.67)	0.52 (0.34,0.72)
6c	Relative PICT catch variation	short	0.56 (0.36,0.73)	0.57 (0.38,0.77)
6c	Relative PICT catch variation	medium	0.78 (0.67,0.88)	0.77 (0.65,0.88)
6c	Relative PICT catch variation	long	0.52 (0.33,0.67)	0.52 (0.34,0.71)
7a	Relative total effort variation	short	0.63 (0.40,0.77)	0.71 (0.55,0.81)
7a	Relative total effort variation	medium	0.76 (0.60,0.85)	0.79 (0.67,0.88)
7a	Relative total effort variation	long	0.72 (0.51,0.82)	0.74 (0.57,0.83)

7b	Relative DWFN effort variation	short	0.61 (0.38,0.75)	0.68 (0.51,0.79)
7b	Relative DWFN effort variation	medium	0.74 (0.59,0.84)	0.78 (0.66,0.86)
7b	Relative DWFN effort variation	long	0.69 (0.48,0.80)	0.71 (0.53,0.80)
7c	Relative PICT effort variation	short	0.64 (0.45,0.70)	0.74 (0.59,0.83)
7c	Relative PICT effort variation	medium	0.78 (0.65,0.87)	0.81 (0.71,0.89)
7c	Relative PICT effort variation	long	0.75 (0.56,0.84)	0.77 (0.61,0.85)
8	Deviation of SB from TRP	short	0.705 (0.700,0.815)	0.712 (0.620,0.818)
8	Deviation of SB from TRP	medium	0.763 (0.642,0.862)	0.776 (0.646,0.868)
8	Deviation of SB from TRP	long	0.778 (0.680,0.856)	0.781 (0.781,0.863)
13	Maintian/develop domestic fishery	short	0.514 (0.509,0.518)	0.514 (0.509,0.518)
13	Maintian/develop domestic fishery	medium	0.515 (0.512,0.518)	0.515 (0.512,0.518)
13	Maintian/develop domestic fishery	long	0.515 (0.512,0.519)	0.515 (0.512,0.519)

Table 2: Proposed performance indicators for the southern longline fishery (WCPFC14 Summary Report Attachment K).

B Performance indicator equations

	Performance Indicator	Equation
1	Probability of $SB/SB_{F=0} > 0.2$.	$PI1_y = \sum_{n=1}^{N} SB/SB_{F=0,n,y} > 0.2/N$ $PI1 = \sum_{y=y_1}^{y_2} PI1_y/Y$
3	Average expected catch	$PI3_n = \sum_{y=y_1}^{y_2} C_{n,y}/Y$
4	Average deviation of predicted ALB CPUE from reference period levels	$PI4_{n,y} = CPUE_{n,y}/CPUE_{ref}$
6	Average annual variation in catch	$PI6_{y,n} = \lvert C_{y+1,n} - C_{y,n} \rvert$
7	Effort variation relative to reference period level	$PI7_{y,n} = \lvert E_{y+1,n}/E_{ref} - E_{y,n}/E_{ref} \rvert$
8	Deviation of $SB/SB_{F=0}$ from 0.56	$PI8_{n,y} = \lvert SB/SB_{n,y,F=0}/0.56 - 1 \rvert$
13	Maintian/develop domestic fishery	$PI13_{n,y} = Cn, y, pict/Cn, y, total$
PI 2,4,5,6,7,8,13 are summarised over the different time periods: $PIX_n = \sum_{y=y_1}^{y_2} PIX_{n,y}/Y$		

Table 3: Equations for calculating the the proposed performance indicators for the southern longline fishery (WCPFC14 Summary Report Attachment K). SB is the adult biomass, E is the effort, C is catch, CPU is the catch per unit of effort, N is the number of simulations, n an individual simulation, y_1 and y_2 are the start and end years of the time period, Y is in the number of years in the time period, y is an individual year.