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Performance statistics and monitoring strategies for skipjack and South Pacific albacore commensurate with: candidate management objectives for the Tropical Purse Seine and Southern Longline Fisheries

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Abstract

The report of the second WCPFC Management Objectives Workshop (WCPFC10-2013-15b 'straw person') provides a candidate list of management objectives for WCPO fisheries, including those for the tropical purse seine and southern longline fisheries. WCPFC-SC12 was requested to develop advice on a monitoring strategy to assess performance against reference points and management objectives; and a range of performance statistics to evaluate the performance of candidate harvest control rules for WCPO skipjack and South Pacific Albacore.

The management objectives identified in WCPFC10-2013-15b are framed at the fishery level, however, the performance statistics and monitoring strategies considered here have been translated to the stock level (i.e. WCPO skipjack and South Pacific albacore).

We use specific definitions for *performance statistics*, which are used to evaluate how well a candidate management procedure is expected to perform and which enable the selection of a preferred option from a range of candidate procedures; and a *monitoring strategy* which tracks the actual performance of the selected management procedure, once it has been implemented, to see if it is performing as expected.

The performance statistics and monitoring strategies identified in this document are based on the information presented in WCPFC10-2013-15b but additionally take account of recent experience of analyses to evaluate candidate harvest control rules for skipjack (SC12-MI-WP06) and recent discussions on an MSE framework for WCPFC (SC12-MI-WP05). We note that the ultimate choice of performance statistics and monitoring strategies will be dependent on the decisions of managers on their objectives for the fishery. The examples of corresponding performance statistics and monitoring strategies presented here are for discussion by the Scientific Committee and should not be seen as definitive.

We invite the Scientific Committee to

1. Note that these are draft performance statistics and monitoring strategies for discussion by the Scientific Committee and may be further developed as the MSE work progresses and as WCPFC continues to refine its fishery management objectives.
2. Consider whether the suggested performance statistics are appropriate and likely to provide the necessary information to enable managers to choose a preferred management procedure from a range of candidates.
3. Consider what information is currently available to support the monitoring of management procedures and what additional information may be required.

Introduction

The report of the second WCPFC Management Objectives Workshop (WCPFC10-2013-15b) provides a candidate list of management objectives, performance indicators and target reference points for each of the five major fisheries (tropical longline, purse seine, southern longline, Pacific bluefin tuna and North Pacific albacore). WCPFC-SC12 is requested to develop advice on a monitoring strategy to assess performance against reference points and management objectives; and a range of performance statistics to evaluate the performance of candidate harvest control rules for WCPO skipjack and South Pacific Albacore. The management objectives identified in WCPFC10-2013-15b are framed at the fishery level, however, the performance statistics and monitoring strategies considered here have been translated to the stock level (i.e. WCPO skipjack and South Pacific albacore).

Performance Statistics and Monitoring Strategies: Definitions

The recent expert consultation workshop on MSE (SC12-MI-WP05[1]) stressed the importance of developing a consistent terminology for the various components of the harvest strategy approach and recommended the use of formally agreed definitions such as those provided in the ISSF Technical Report 2013-03 (WCPFC-SC9-2013/MI-IP-01). In this regard, the workshop recommended the use of the term performance statistic (or performance measure) instead of performance indicator to distinguish the statistics from actual indicators. Throughout this document we use the term performance statistic[2] in the MSE context.

Performance statistics are interpreted in relation to reference points and management objectives. A reference point often implies that a specific target value is desired or limit should be avoided. Reference points may not be available for all management objectives since very often you want to maximise something relative to some other objective rather than achieve a specific value. In this case performance is measured relative to other management objectives rather than against a defined reference point. For example, performance measures under a given management strategy could measure the probability that the limit reference point is exceeded over a defined period (i.e. against a reference point), and/or the expected long-term yield (i.e. relative to some other objective).

With reference to the **monitoring strategy**, we note that there are two aspects to monitoring the performance of a management strategy once implemented (see SC12-MI-WP-05). For the purpose of this exercise we consider only the process of tracking the actual performance of the management strategy to determine whether the actual outcomes are consistent with expected performance of the management procedure and are within the range of values predicted by the MSE. For example, in the case of a management strategy that was designed to maintain catch rates at a specific level it would be desirable/necessary to check that, once implemented, actual catch rates are indeed maintained close to or at the desired level.

[1] Please refer to **SC12-MI-WP05** for background information on the technical terminology used throughout this paper.

[2] **Performance Statistics**: Measures of performance used during management strategy evaluations. These are interpreted in relation to reference points and management objectives. In the MSE context, they are used to summarize different aspects of the simulation results and to evaluate how well a specific strategy achieves some or all of the general objectives for management for a particular scenario.

We therefore make an important distinction between performance statistics, which are used to evaluate how well a candidate management procedure is expected to perform and which enable the selection of a preferred option from a range of candidate procedures; and a monitoring strategy which tracks the actual performance of the selected management procedure, once it has been implemented, to see if it is performing as expected.

Performance Statistics and Monitoring Strategies: Limitations

As a basis for this report we have used the candidate management objectives for purse seine and southern longline fisheries provided in WCPFC10-2013-15b. That report also suggests potential performance statistics and target reference points for each of the objectives. As noted above, target reference points may not be defined, or indeed appropriate, for all objectives and we note the difficulty encountered by MOW2 in defining reference points for all objectives in the strawperson document. Furthermore it may not be possible to generate informative performance statistics for all objectives, particularly for those social and ecosystem aspects that will be technically difficult to represent in operating models and which may depend on policy decisions made outside the control of the management procedure. For example, it will be extremely difficult to predict metrics such as local market prices, average national per-capita fish consumption and employment in catching and processing sectors. Although the calculation of performance statistics for such metrics may be difficult, it should be relatively easy to monitor them provided that the necessary data are collected, from the actual fishery, at the appropriate scale and frequency. In the case of ecosystem objectives, we consider that both the calculation of performance statistics and the choice of metrics for monitoring are challenging.

The performance statistics and monitoring strategies identified in this document are based on the information presented in WCPFC10-2013-15b but additionally take account of recent experience of analyses to evaluate candidate harvest control rules for skipjack (SC12-MI-WP06) and recent discussions on an MSE framework for WCPFC (SC12-MI-WP05). We note that the ultimate choice of performance statistics and monitoring strategies will be dependent on the decisions of managers on their objectives for the fishery. The examples of corresponding performance statistics and monitoring strategies presented here are for discussion by the Scientific Committee and should not be seen as definitive.

Management objectives, performance statistics and monitoring strategies

We present here some potential performance statistics and monitoring strategies for each of the candidate management objectives identified in WCPFC10-2013-15b for the tropical purse seine fishery (Table 1) and the southern longline fishery (Table 2).

Table 1. Candidate management objectives for the tropical purse seine fishery and proposed performance statistics and monitoring strategies.

Objective Type	**Objective Description**	**Performance Statistic**	**Monitoring Strategy**
Biological	Maintain SKJ (and YFT & BET) biomass at or above levels that provide fishery sustainability throughout their range.	Probability of $SB/SB_{F=0} > 0.5$ (SKJ) in the short- medium-long-term as determined from MSE (may also be calculated at the assessment region level). Probability of $SB/SB_{F=0} > 0.2$ in as determined from MSE.	Current median adult biomass, as determined from the reference set of Operating Models. Probability of $SB/SB_{F=0} > 0.2$ in the long-term as determined from the reference set of operating models
Economic	Maximise economic yield from the fishery	Predicted effort relative to E_{MEY} (to take account of multi-species considerations, SKJ, BET and YFT; may be calculated at the individual fishery level). B_{MEY} and F_{MEY} may also be considered at a single species level.	Observed rent from the fishery relative to MEY. Observed effort in the fishery relative to E_{MEY}.
	Increase fisheries-based development within developing states (SIDS) economies, especially on-shore processing capacity.	As a proxy: Average proportion of SIDS-catch to total catch for fisheries operating in specific regions.	Percentage contribution of fisheries to GDP. Proportion of total catch processed by SIDS Value of product exported from SIDS.
	Maintain acceptable CPUE.	Average deviation of predicted SKJ CPUE from 2012 levels.	Observed CPUE maintained at or greater than specified levels.
	Optimise fishing effort	E_{MEY} (as for Maximise economic yield). Effort consistent with specified level	Annual monitoring through logbook/VMS
	Maximise SIDS revenues from resource rents	Proxy: Average proportion of SIDS-effort or catch to total effort or catch for fisheries operating in specific regions	Observed proportion of SIDS-effort/catch to total effort/catch from SIDS waters from logsheet or VMS data
	Catch stability	Average annual variation in catch in the short-, medium- and long- term (may also be calculated at the assessment region level).	Observed variation in catch from logsheet data
	Stability and continuity of market supply	Average annual variation in catch in the short-, medium- and long- term (may also be calculated at the assessment region level).	Observed variation in catch From logsheet data Observed variation in market prices

			Market throughput of tuna products
Social	Affordable protein for coastal communities	As a proxy: Average proportion of CCMs-catch to total catch for fisheries operating in specific regions.	Average fish consumption per year per person relative to some target.
	Food security in developing states (import replacement)	As a proxy: Average proportion of CCMs-catch to total catch for fisheries operating in specific regions.	Ratio of locally marketed fish to imported fish products.
	Avoid adverse impacts on small scale fishers		Monitoring of fisheries in CCMs
	Employment opportunities	As a proxy: Average proportion of CCMs-catch to total catch for fisheries operating in specific regions as determined from stochastic projections.	Monitoring of fishing and processing sector in CCMs
Ecosystem	Minimise bycatch		Ratio of target species catch to catch of non-target species from observer program
	Minimise ecosystem impact	Size or age structure of population	From observer based size sampling and stock assessment outputs

Table 2. Candidate management objectives for the southern longline fishery and proposed performance indicators and monitoring strategies.

Objective Type	**Objective Description**	**Performance Indicators**	**Monitoring Strategy**
Biological	Maintain albacore (and SWO, YFT & BET) biomass at or above levels that provide stock sustainability throughout their range.	Probability of $SB/SB_{F=0} > ??$ in the short- medium- long-term as determined from MSE (may also be calculated at the assessment region level). Probability of $SB/SB_{F=0} > 0.2$ in as determined from MSE.	Current median adult biomass, as determined from the reference set of Operating Models. Probability of $SB/SB_{F=0} > 0.2$ in the long-term as determined from the reference set of operating models
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.	Observed rent from the fishery relative to MEY. Observed effort in the fishery relative to E_{MEY}.

	Increase fisheries based development within SIDS.	As a proxy: Average proportion of SIDS-catch to total catch for fisheries operating in specific regions.	Percentage contribution of fisheries to GDP. Proportion of total catch processed by SIDS Value of product exported from SIDS.
	Maintain acceptable CPUE.	Average variation of predicted biomass and effort levels from 2012 levels.	Observed biomass and effort levels have been maintained at or greater than defined levels.
	Optimize capacity.		Vessel numbers targeting SPA
	Catch stability.	Average annual variation in catch in the short-, medium- and long- term (may also be calculated at the assessment region level).	Observed variation in catch from logsheet data
	Maximise SIDS revenues from resource rents.	Average proportion of SIDS-catch to total catch for fisheries operating in specific regions	Observed proportion of SIDS-catch to total catch in SIDS waters from logsheet data.
	Stability and continuity of market supply.	Average annual variation in catch in the short-, medium- and long- term (may also be calculated at the assessment region level).	Observed variation in catch from logsheet data Observed variation in market prices
Social	Affordable protein for coastal communities.	As a proxy: Average proportion of CCMs-catch to total catch for fisheries operating in specific regions.	Average fish consumption per year per person relative to some target.
	Employment opportunities	As a proxy: Average proportion of CCMs-catch to total catch for fisheries operating in specific regions.	Numbers employed in fishing and processing sector relative to some target or relative to previous years
	Maintain/develop domestic fishery.	Ratio of domestic catch to total catch	Monitoring of fisheries in CCMs
	Human resource development.	As a proxy: Ratio of domestic catch to total catch	Monitoring of fisheries in CCMs
	Avoid adverse impacts on subsistence and small scale fishers.		Monitoring of fisheries in CCMs
Ecosystem	Minimise fishery impact on the ecosystem		Ratio of target species catch to catch of non-target species
	Minimise catch of non-target species.	Size or age structure of population	From observer-based size sampling and stock assessment outputs

Discussion

Performance Statistics

Although the biological management objectives are typically species specific, many of the economic and social objectives are expressed at the fishery level and, in some cases, encompass a range of target and non-target species. The calculation of informative performance statistics for these fishery level objectives will depend on the extent to which multi-species operating models can be developed and on the availability of data for both target and non-target species. Similarly, the calculation of economic performance statistics for particular components of the fishery (e.g. specific CCM fleets) will depend on the fishery groupings used in the operating model. This is discussed further in SC12-MI-WP-06

With reference to the development of performance statistics for ecosystem objectives, we note the considerable complexity involved in developing ecosystem models and the recommendation of the MSE expert consultation workshop (SC12-MI-WP-05) that ecosystem components of an MSE framework are something to consider much later in the development process. We further note the recent work in developing and testing metrics for ecosystem indicators (Fulton et al. 2005) which recommend the simultaneous use of a variety of simpler indicators to detect the impact of fishing.

We note that since the strawperson document was developed (in 2013) the dialogue on economic objectives from fisheries has moved away from 'MEY' to more sophisticated considerations of profit levels. While we retain the objectives specified within the strawperson document, these may not reflect the latest thinking.

Monitoring Strategy

It is recommended that monitoring be conducted on a frequent basis. However, monitoring of a management procedure will require different types of data to monitor the different objectives and these data are likely to be available at different time scales. For example, information on fish prices or the number of vessels operating in the fishery may be available in real time, whereas information on stock status will require some form of stock assessment to be conducted. This currently operates on an approximate 3 year schedule and even then is likely to provide estimates of stock status only up to the year prior to the year in which the assessment is performed, at best.

An important consideration when determining the frequency of monitoring of a particular objective will be the expected variability of the metric over time and the extent of auto-correlation. Short term measurement of highly variable or auto-correlated metrics can be misleading and should be treated with caution. On the other hand, long-term monitoring is also potentially difficult because a single management procedure may not be in place for a long period of time. Although the management procedure may be evaluated over a 30 year time frame it may only be applied for a relatively short period (5 years for example) in the "real world" before being replaced with a new and improved version.

The monitoring strategy tracks the performance of the management procedure and checks that observed values are within the range of values predicted by the MSE. In the event that outcomes are not consistent with expected performance and future observations fall outside of the range predicted by the MSE it may be necessary to invoke rules for exceptional circumstances. We note that such rules (or meta-rules) will require clearly defined bounds for the extent of acceptable future

variation in key variables as well as an agreed procedure to follow in order to determine alternative management action. We consider that meta-rules are an important topic for discussion to be held later in the MSE process and have not considered them in detail here.

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References

ISSF (2013) 2013 ISSF stock assessment workshop: Harvest control rules and reference points for tuna RFMOs. ISSF Technical Report 2013-03, San Diego, California, USA. March 6-8, 2013

Fulton, E. A., Smith, A. D. M., and Punt, A. E. (2005). Which ecological indicators can robustly detect effects of fishing? ICES Journal of Marine Science, 62: 540-551.

Scott, R., Pilling, G., M., Brouwer, S. and Hampton, J. (2016) Evaluation of candidate harvest control rules for the tropical skipjack purse seine fishery. WCPFC SC12-MI-WP-06.

Scott, R., Pilling, G,. M., Hampton, J., Reid, C. and Davies, N. (2016) Report of the expert consultation workshop on management strategy evaluation. WCPFC SC12-MI-WP-05