**SCIENTIFIC COMMITTEE**
**THIRTEENTH REGULAR SESSION**

Rarotonga, Cook Islands
9-17 August 2017

# Performance indicators and monitoring strategies for bigeye and yellowfin Tuna compatible with candidate management objectives for the Tropical Longline Fishery

**WCPFC-SC13-2017/MI-WP-03**

Robert Scott, Graham Pilling and John Hampton[1]

[1] Oceanic Fisheries Programme, The Pacific Community (SPC)

## Abstract

In accordance with the timetable for the development of a harvest strategy approach for WCPFC stocks and fisheries (WCPFC-13 Summary Report Attachment N), SC13 is scheduled to provide advice to the Commission on a range of performance indicators for bigeye and yellowfin tuna that can be used to evaluate the performance of harvest control rules.

We present here a list of proposed performance indicators based on the candidate management objectives for the tropical longline fishery provided in the MOW2 report (WCPFC10-2013-15b) as well as the considerations of the 2016 WCPFC13 small working group on management objectives. These candidate management objectives and their associated performance indicators provide the necessary initial guidance for development of the MSE framework which will allow the Commission to assess the performance of candidate harvest control rules and to objectively consider the resulting trade-offs between objectives.

Tropical longline fisheries for bigeye and yellowfin comprise many individual fleets that target a range of species such that no one species can be identified as being of primary importance. We discuss the implications of this for the construction of informative performance indicators; the design of the harvest control rules; and construction of the modelling framework that will be used for the evaluations.

No performance indicators have yet been identified for either of the two ecosystem objectives outlined in Table 1, or for the social objective to avoid adverse impacts to small scale fishers. We note that performance indicators for similar objectives in other fisheries (tropical purse seine fishery and the southern longline fishery) have also proven difficult to identify. In the absence of multi-species or ecosystem based operating models for tuna stocks in the WCPO it is unlikely that any performance indicators for these objectives can be calculated directly from the operating model. Although it may be possible to derive proxy based metrics, it remains to be seen whether these can provide sufficiently reliable information for selecting a HCR based on these specific objectives.

We invite WCPFC-SC13 to:

- Consider the list of performance indicators and monitoring strategies for the tropical longline fishery, noting these are consistent with those for the tropical purse seine fishery and the southern longline fishery.
- Provide feedback on the proposed list with any additions, deletions or amendments as appropriate.
- Provide advice to WCPFC14 on this range of performance indicators to evaluate the performance of harvest control rules.

## Introduction

An important component of the harvest strategy approach is the identification of management objectives. Pascoe et al. (2017) note that, in a lot of fisheries legislation, management objectives are often loosely defined and represent relatively high level, "conceptual" objectives. These need to be transformed into more specific "operational" objectives so that quantifiable metrics (performance indicators) can be developed that will allow candidate harvest control rules (HCRs) to be evaluated. Whilst there may not be unanimous agreement amongst all stakeholders on the list of management objectives, it is important that they broadly cover the overall aims of the participants in the fishery.

**Performance indicators** measure how well a specific harvest strategy achieves some or all of the general objectives for management. They also enhance communication and transparency in the management process. A good indicator should:

- be directly relevant to the management objective to which it relates;
- be appropriate to the species and fishery under management;
- be reliably estimated;
- be simple to interpret.

Ideally there should be indicators for all management objectives although for some objectives it may be difficult to identify and generate an informative indicator that satisfies all of the above requirements. This may be the case for some social and ecosystem objectives that will be technically difficult to represent in the MSE framework (operating model) given that they may depend on policy decisions made outside the control of the management procedure. For example, it will be extremely difficult to calculate performance indicators for local market prices, average national per-capita fish consumption or employment in catching and processing sectors, which in the real world depend not only on fishery performance, but government decisions and global market conditions.

To the extent possible, the metrics used to calculate the performance indicators (which are derived from the simulation framework) should be the same as those used for the monitoring strategy (which are derived from real world observations). However, the source of the data used to calculate those metrics may be different. An example is a biological management objective to maintain adult biomass at or above a given level. For this objective, the performance indicator might be based on predictions of future biomass derived from the MSE simulations, whilst the monitoring strategy may be based on estimates of current biomass derived from WCPO stock assessments.

The **monitoring strategy** tracks the actual performance of the selected management procedure, once it has been implemented, for a particular fishery, to see if it is performing as expected and that the actual outcomes are within the range of values predicted by the MSE simulations. For example, in the case of a management strategy that was designed to maintain catch rates at a specific level it would be necessary to monitor that, once implemented, actual catch rates are indeed maintained close to or at the desired level.

In accordance with the timetable for the development of a harvest strategy approach for WCPFC stocks and fisheries (WCPFC-13 Summary Report Attachment N), SC13 is scheduled to provide advice to the Commission on a range of performance indicators for bigeye and yellowfin tuna that can be used to evaluate the performance of harvest control rules.

The examples of corresponding performance statistics and monitoring strategies presented here should not be seen as definitive. We note that the ultimate choice of performance indicators and monitoring strategies will be dependent on managers' decisions on fishery objectives and that those objectives for the tropical longline fishery have yet to be formally agreed. We have used the candidate

management objectives for the tropical longline fishery provided in the MOW2 report (WCPFC10-2013-15b) together with the considerations of the 2016 WCPFC13 small working group on management objectives. These candidate management objectives provide the necessary initial guidance for development of the MSE framework, including identification of potential performance indicators. The MSE will allow the Commission to assess the performance of candidate harvest control rules and to objectively consider the trade-offs.

### *WCPO Longline fisheries*

Longline fisheries in the WCPO involve two main types of operation. Large distant-water freezer vessels that undertake long voyages and operate over large areas of the region, targeting either tropical (yellowfin, bigeye tuna) or subtropical (albacore tuna) species, and smaller offshore vessels that are typically domestically-based, undertaking trips of less than one month, and serving fresh or air-freight sashimi markets.

Williams and Terawasi (2016) identified seven broad categories of longline fishery that are currently active in the WCPO. The categorisation was based on type of operation, area fished and target species. For the purpose of this paper we are specifically concerned with the following three fishery groupings.

1. **Tropical offshore bigeye/yellowfin-target fishery** includes "offshore" sashimi longliners from Chinese-Taipei, based in Micronesia, Guam, Philippines and Chinese-Taipei, mainland Chinese vessels based in Micronesia, and domestic fleets based in Indonesia, Micronesian countries, Philippines, PNG, Hawaii and Vietnam, for example.
2. **Tropical distant-water bigeye/yellowfin-target fishery** comprises "distant-water" vessels from Japan, Korea, Chinese-Taipei, mainland China and Vanuatu. These vessels primarily operate in the eastern tropical waters of the WCP–CA (and into the EPO), targeting bigeye and yellowfin tuna for the frozen sashimi market. The EU/Portuguese fleet (one vessel) started fishing in 2011.
3. **Longline fisheries in the sub-tropical and temperate WCP–CA** comprise vessels targeting different species within the same fleet depending on market, season and/or area. These fleets include the domestic fishery of Australia, Japan, New Zealand and distant water fleets including EU/Spanish vessels targeting swordfish.

We note that bigeye and yellowfin tuna are also caught in purse seine fisheries. Catches of yellowfin tuna in purse seine fisheries contributed less than 20% of the total purse seine catch in 2015 (Williams and Terawasi, 2016). Catches, by weight, of bigeye tuna in purse seine fisheries are relatively low (2-5%) and are predominantly taken in FAD associated sets (SPC-OFP 2016). These catches are small in relation to total catches of the tropical purse seine fishery that targets the much larger skipjack stock, but can represent a significant impact, particularly for bigeye for which the majority of purse seine catches comprise small juvenile fish. Consequently, management action applied to the purse seine fishery in relation to skipjack may have implications for the performance of management procedures for yellowfin and bigeye.

## Management objectives, performance indicators and monitoring strategies for the Tropical Longline Fishery

We present here a list of potential performance indicators and monitoring strategies for the tropical longline fishery (Table 1). To develop this table, the approach used by the small working group on Management Objectives at WCPFC13 was used. Where objectives for these fisheries/stocks were identical to those of skipjack and south Pacific albacore, the corresponding performance indicators were used.

## Discussion

For both purse seine/skipjack and southern longline/south Pacific albacore, the primary target species is relatively mono-specific[1]. In contrast, a key challenge for the development of harvest strategies for the tropical longline fisheries/bigeye and yellowfin is the multispecies nature of the fishery; the tropical longline fishery primarily targets yellowfin and bigeye tuna but catches can comprise a range of commercially valuable species. This has implications for the construction of informative performance indicators, the design of the harvest control rules, and construction of the modelling framework that will be used for the evaluations.

Life histories vary between fish species. Typically, faster growing species that reach sexual maturity early in life are able to withstand higher exploitation rates than slower growing species that take longer to become sexually mature and reproduce at a slower rate. This has implications for the biological and economic stock and fishery objectives.

Biological objectives are expressed in terms of maintaining the stock at levels that will ensure long term sustainability and have corresponding performance indicators based on the risk of falling below the limit reference point. Where the optimal rate of exploitation varies between species, the choice of target yield for one species may have important consequences for the risk of falling below the LRP for another species. Those species that are more susceptible to stock depletion as a consequence of fishing and are therefore among the first to reach their limit reference points are sometimes referred to as "choke species". The acceptable risk of falling below the limit reference point – a management decision - may vary for the different target species.

Optimum exploitation rates can also differ markedly between species. As an example, the use of MSY as a management goal is not straightforward when multi-species and ecosystem concerns are included in management objectives (Mace, 2001) and in fisheries that target a range of species, management to precise optimal yield targets may prove impossible. Recently the concept of pretty good yield (Hilborn, 2010) and pretty good multispecies yield (Rindorf et al., 2017) has been proposed as an approach for developing management targets that will deliver acceptably good yields (though not necessarily maximum yields) over a range of stock sizes that might exist simultaneously for a collection of target species. These explicitly aim to incorporate the trade-offs between biological objectives for different stocks.

For the evaluation of tropical fishery/bigeye and yellowfin harvest strategies, therefore, it may be insufficient to employ only a single species operating model. A potential approach in this instance would be to develop an operating model that uses several single species models that run in parallel. A minimum set might be a bigeye tuna model and a yellowfin tuna model. This would not constitute a full multi-species approach because each of the models would in effect be running independently from the others (i.e. the dynamics of one stock would be unaffected by the abundance of another), but it would allow multi-species harvest control rules to be developed and tested and it would provide the necessary information to calculate performance indicators that rely on a range of target species. This is consistent with the approach used for the 'regional bio-economic model' (Kirchner et al., 2014). In addition, we note that management action applied to the purse seine fishery in relation to skipjack

[1] We note, however, that the economic objectives of all fisheries must incorporate consideration of the multispecies nature of the catch. For an example of how this has been considered in WCPFC activities, see Pilling et al. (2016).

will have implications for the performance of management procedures for yellowfin and bigeye. To some extent the impacts of the purse seine fishery on non-target species, such as bigeye tuna, can be mitigated through the allocation of effort controls between FAD associated and free-school purse seine fishing (SPC-OFP, 2014).

No performance indicators have yet been identified for either of the two ecosystem objectives outlined in Table 1, or for the social objective to avoid adverse impacts to small scale fishers. We note that performance indicators for similar objectives in other fisheries (tropical purse seine fishery and the southern longline fishery) have also proven difficult to identify. In the absence of multi-species or ecosystem based operating models for tuna stocks in the WCPO it is unlikely that any performance indicators for these objectives can be calculated directly from the operating model. Although it may be possible to derive proxy based metrics, it remains to be seen whether these can provide sufficiently reliable information for selecting a HCR.

Table 1. Candidate management objectives for the tropical longline fishery and proposed performance indicators and monitoring strategies for bigeye and yellowfin tuna for the purpose of evaluation of HCRs. Light shaded boxes correspond to those objectives and performance indicators that were also within the sub-set of objectives selected by the WCPFC13 SWG on Management Objectives for the tropical purse seine fishery/skipjack. Darker shading shows indicators that were not originally identified for the tropical longline fishery within the MOW2 'strawperson' document, but were recently selected as performance indicators for the tropical purse seine fishery by the WCPFC13 SWG.

| **Objective Type** | **Objective Description** | **Performance Indicators** | **Monitoring Strategy** |
|---|---|---|---|
| | | | |
| Biological | Maintain YFT and BET (and SWO) biomass at or above levels that provide stock sustainability throughout their range. | Probability of $SB/SB_{F=0} > 0.2$ as determined from MSE | 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; may be calculated at the individual fishery level).<br>$B_{MEY}$ and $F_{MEY}$ may also be considered at a single species level. | Observed effort in the fishery relative to $E_{MEY}$. |
| | Maintain acceptable CPUE. | Average deviation of predicted CPUE from reference period levels. | Observed CPUE maintained at or greater than specified levels. |
| | Increase fisheries-based development within developing states economies | Amount and proportional contribution of SIDS fleet catch/catch in SIDS waters | Amount and value of product exported from SIDS |
| | Optimize fishing effort | $E_{MEY}$ (as for Maximise economic yield)<br><br>Effort consistent with specified level. | Annual monitoring through logbook/VMS |
| | Maximise SIDS revenues from resource rents. | Average value of SIDS/non-SIDS catch | Observed proportion of SIDS-effort/catch to total effort/catch in SIDS waters from log-sheet or VMS data. |
| | Catch stability<br>[Stability and continuity of market supply] | Average annual variation in catch. | Observed variation in catch from log-sheet data |
| | Effort predictability | Effort variation relative to reference period level (may also be calculated at the assessment region level). | Observed effort levels from log-sheet or VMS data |
| | Maintain BET, YFT (and ALB & SWO) stock sizes around the TRP (where adopted) | Probability of and deviation from $SB/SB_{F=0} > X$ in the short-medium- long-term as determined from MSE (may also be calculated at the assessment region level). | Current median adult biomass, as determined from the reference set of operating models. |

Table 1. cont.

| | | | |
|---|---|---|---|
| Social | Food security in developing states (import replacement) [affordable protein for coastal communities] | 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. |
| | 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 |
| | 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 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. | | Ratio of target species catch to catch of non-target species from observer program |

## References


Australia (2016) Proposal for adopting interim acceptable levels of risk for breaching limit reference points of four key tuna species in the WCPO WCPFC-SC12-2016/ MI-WP-03

Cartwright, I., Allen, R. and Ianelli, J. (2013) Report of the expert working group: Management objectives, performance indicators and reference points. WCPFC10-2013-15b.

Hilborn, R. (2010) Pretty good yield and exploited fishes. Marine Policy, 34: 193-196.

Kirchner, C. H.; Berger; Banks, R. & Reid, C. (2014) Developing a bioeconomic model for WCPO tuna fisheries to assess potential economic outcomes under alternative management options. WCPFC-SC10-2014/MI-IP-04

Mace PM. (2001) A new role for MSY in single-species and ecosystem approaches to fisheries stock assessment and management. Fish and Fisheries 2: 2–32.

Pascoe, S.D., Plaganyi, E.E. and Dichmont, C.M. (2017) Modelling multiple management objectives in fisheries: Australian experiences. ICES Journal of Marine Science. 74(2), 464-474.

Pilling, G.M., Skirtun, M., Reid, C., and Hampton, J. (2016) Biological and economic consequences of alternative trajectories to achieve a candidate south Pacific albacore target reference point. WCPFC-SC12-2016/ MI-WP-01

Pilling, G.M., Reid, C., Harley, S. and Hampton, J. (2015) Compatibility and consequences of alternative potential Target Reference Points for the south Pacific Albacore stock. WCPFC-SC11-2015/ MI-WP-04

Punt, A.E. (2017) Strategic management decision-making in a complex world: quantifying, understanding, and using trade-offs. ICES Journal of Marine Science. 74(2), 499-510.

Rindorf, A., Dichmont, C.M., Levin, P.S., Mace, P., Pascoe, S., Prellezo, R., Punt, A.E., Reid, D.G., Stephensen, R., Ulrich, C., Vinther, M. and Clausen, L.W. (2017) Food for thought: pretty good multispecies yield. ICES Journal of Marine Science. 74(2); 475-486

Scott, R., Pilling, G.M. and Hampton, J. (2016) 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 WCPFC-SC12-2016/ MI-WP-04

Scott, R., Pilling, G.M. and Hampton, J. (2016a) 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 WCPFC13-2016-14

SPC-OFP (2014) Multi-species implications of reference points: what might a target reference point of 50% SBF=0 for skipjack tuna mean for bigeye and yellowfin tuna. MOW 3/WP-05

SPC-OFP (2016) Evaluation of CMM 2015-01 for bigeye tuna. WCPFC13-2016-15.

Williams, P. and Terawasi, P. (2016) Overview of tuna fisheries in the Western and Central Pacific Ocean, including economic conditions – 2015. WCPFC-SC12-2106/GN-WP-01.