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Report on the Harvest Strategy Workshop (MOW4)

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1. Introduction

MOW4 was opened by the WCPFC Chair Rhea Moss-Christian. The Chair welcomed participants, noting that given the amount of work ahead in the upcoming Commission, it was hoped that the workshop would provide an opportunity to highlight areas of agreement and difference in relation to the CMMs and other issues to be considered. Participants were urged to be fully engaged during the workshop. The facilitator for the workshop, Mr Ian Cartwright was introduced.

The Harvest Strategy Workshop (Management Objectives Workshop - MOW4) was the fourth in a series of informal workshops convened by the Commission to facilitate and support the development of harvest strategies by Commission Members (CCMs). The key outcomes of the previous workshops are summarised as below;

- **MOW1 – 2012.** Increased the understanding of the use and application of management objectives, indicators and reference points. Preliminary discussions on management objectives for key fisheries
- **MOW2 – 2013.** Considered a 'Strawman', which was candidate list of management objectives, performance indicators (PIs) and Target Reference Points (TRPs) for each major fishery. Provided advice to the Commission on maintaining viable fisheries across the extent of the stocks, management strategies for skipjack and albacore tuna, and options to address bigeye tuna overfishing
- **MOW3 – 2014** Discussed and provided support for the development of harvest strategy-based management framework as outlined in the harvest strategy CMM proposed by FFA and adopted by the WCPFC 11 as CMM 2014-06. Preliminary advice on a proposal for a TRP for skipjack tuna and a management framework/ harvest strategy for the south pacific albacore fishery.

In reviewing this past work of the MOW, the Facilitator noted that the focus had originally been on capacity building, awareness raising and identification and discussion of a broad range of objectives for key fisheries. Over time, the workshop had partly changed emphasis and was now more focused on options to advance harvest strategy approach and discussion of draft CMMs, while retaining elements of awareness raising. The workshop had provided an opportunity for the fisheries managers of all CCMs to exchange views on key management issues. Participants were asked to consider the future of the MOW process during the meeting, and consider how best to progress the considerable workload that would be generated though the implementation of the harvest strategy workplan.

2. Practical applications of the harvest strategy approach.

2.1 Recap of WCPFC management framework

Dr John Hampton (SPC) provided a brief recap of the management framework/harvest strategy approach (see Figure 1 below). It was noted that subsequent papers and presentations would focus on various elements of the framework, including target reference points (for skipjack and South Pacific albacore, risk and harvest control rules.

The aim of current harvest strategies and harvest control rules (HCRs) is to maintain the stock at the TRP, on average. This would mean that around 50% of the time the stock would be above the TRP and 50% below.

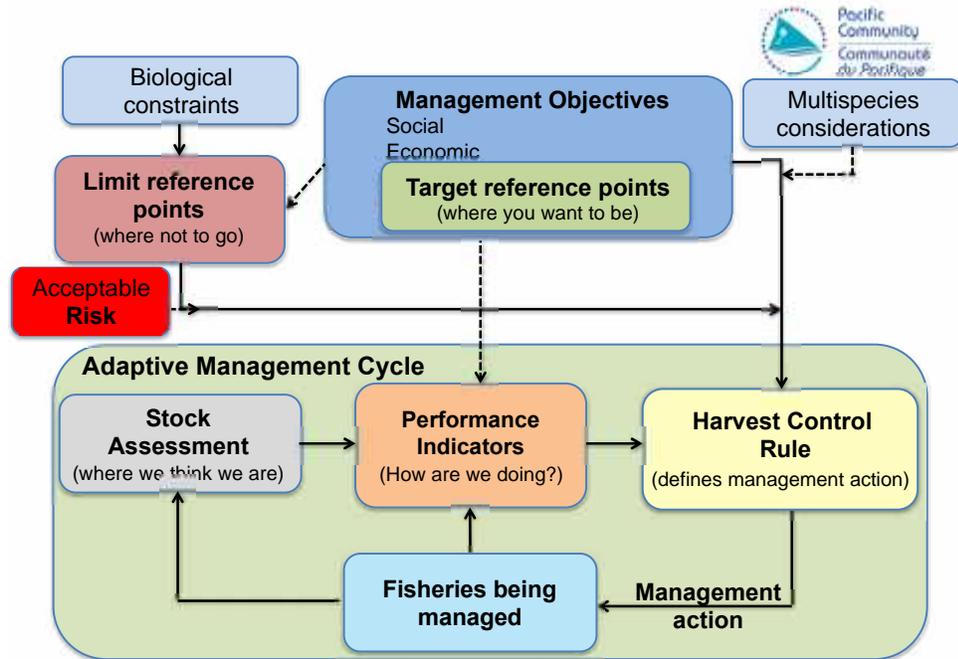


Figure 1: Fisheries management framework

The need to consider the entire ecosystem, including all target species was emphasised by one participant. In response, it was noted that, for instance, in the case of bigeye tuna, efforts are being made to reduce catches through the current tropical tuna measure, while developing a harvest strategy for skipjack tuna.

The benefits of being pro-active to avoid becoming close to an LRP, which necessitates reactive responses, was highlighted. Measures, including TRPs and HCRs should be designed to prevent stocks/fisheries from going where 'we don't want to be'. Dr Hampton noted that an appropriate HCR, with explicit actions related to stock status, was a proactive approach, which should keep stock around the target level, on average.

2.2 Application of Harvest Strategies in ICCAT

Dr Gorka Merino (EU- AZTI) outlined the general objectives (desired outcomes) for ICCAT under requirement to aim for Maximum Sustainable Yield (MSY) and the generic ICCAT HCR, which prescribes actions for stocks in various quadrants of the Kobe Plot.

Under a draft recommendation, ICCAT intends to implement MSE for stocks including north Atlantic albacore, bluefin tuna, north Atlantic swordfish, and tropical tunas. Inputs into the process to be developed and agreed include management objectives, acceptable quantitative level(s) of probability of achieving and/or maintaining stocks in the green zone of the Kobe plot and avoiding limit reference points.²

A further ICCAT recommendation³ provides guidance on a management objective for the north Atlantic

² Draft ICCAT recommendation on harvest control rules and management strategy evaluation. ICCAT Doc, No. PLE-124C/2015.

³ Draft Recommendation by ICCAT to establish harvest control rules for the North Atlantic Albacore Stock. Doc. No. PA2-602B / 2015

albacore stock i.e. to maintain the stock in the green zone of the Kobe plot, with at least a 60% probability, while maximizing long-term yield from the fishery, and where the spawning stock biomass (SSB) has been assessed as below the level capable of producing MSY (SSB_{MSY}), to rebuild SSB to or above SSB_{MSY} , with at least a 60% probability, and within as short time as possible, by 2020 at the latest, while maximizing average catch and minimizing inter-annual fluctuations in TAC levels.

In 2016, the Standing Committee on Research and Statistics (SCRS) will identify and test candidate reference points and associated HCRs that will support the management objective above and any other management objectives agreed by the Commission.

Some preliminary MSE projections using combinations of F_{tar} , B_{hresh} and B_{lim} were presented by Dr. Merino.

The workshop noted the commonality between the work currently under development at ICCAT with that to be pursued at the WCPFC under the harvest strategy workplan.

2.3 Development of SBT MPs/HCRs

Dr John Annala (NZ MPI) provided a presentation outlining the development of harvest strategy arrangements, including a management procedure (MP) for southern Bluefin tuna (SBT).

The primary driver behind development of the SBT MP/HCRs was the status of the SBT stock. Following indications of low recruitment and many years of competing and contentious stock assessments at SC no agreement on management actions to address stock status had been achieved prior to 2010. At this point the spawning stock biomass was around 5.5% (3.5-7.7%) and F/F_{MSY} was 77% (50-107%).

In 2011 a MP (the “Bali” MP) and a revised stock assessment were agreed, based on a pragmatic approach following extensive consultation and with the following operational management objectives:

- Rebuild stock to the interim TRP/rebuilding target of 20% SB_0 by 2035 with a 70% probability
- Minimum TAC change of 100 t
- Maximum TAC change of 3000 t
- TAC to be set for 3 year periods

National TAC allocation to Members was set by resolution.

The MP was extensively tested using a range of indicators (including SSB/SSB_0 ratios over time, average catch; lower 10% of catch ever attained; inter-annual variation in catch, maximum TAC decrease from model; and proportion of years with TAC changes up or down. Two candidate MPs (MP1 and MP2) developed in 2010 and both were evaluated against a reference set of indicators and five pessimistic robustness trials. Neither MP failed the robustness trials.

Following extensive discussion and testing, a combined MP (“Bali Procedure”) was selected. This MP chose the “best” characteristics of each of the MPs and achieved an intermediate behaviour between MP1 (a biomass-model based approach) and MP2 (empirical (data based) approach). To set the TAC for SBT, two candidate TACs are calculated, based on key aspects of each of MP1 and MP2, and the (arithmetic) mean of the two TACs are taken.

In 2011 the CCSBT also adopted the meta-rule process as the method for dealing with exceptional circumstances in the SBT fishery. The meta-rule process describes:

- the process to determine whether exceptional circumstances exist

- the process for action; and
- the principles for action

The meta-rule⁴ process was applied in 2015 in the context of a range of circumstances including an absence of stock assessment data and unaccounted for mortality.

Dr Annala highlighted the following ‘lessons learned’ from the SBT MP/HCR process:

- The need for extensive consultation with member countries/stakeholders foster shared responsibility
- The need for HCRs/MPs to be responsive to bad things happening; robustness tests as part of MSE important in this respect
- Good adult abundance and juvenile indices important
- An agreed MP/HCR process reduces (but does not eliminate) contention in decision making.
- MPs/HCRs allows an objective way of increasing the TAC for a depleted stock while it is rebuilding with very low risk of future stock decline
- Essential to have agreed process (meta-rule) to deal with exceptional circumstances

2.4 Progress with harvest strategies in other RFMOs

Dr Victor Restrepo provided an overview of the development of harvest strategies in tuna RFMOs (see Table 1 below).

Table 1 Harvest Strategies in tRFMOs

Element/RFMO	CCSBT	IATTC	ICCAT	IOTC	WCPFC
Limits		YFT, BET,SKJ	SWO-N, ALB-N	YFT, BET,SKJ, ALB, SWO	YFT, BET,SKJ, ALB-S, ALB-N
Rebuilding targets	SBT		BFT-E, BFT-W		BET, PBF
Long term Targets		YFT, BET,SKJ	ALB-N	YFT, BET,SKJ, ALB, SWO	
Harvest Control Rule	SBT	YFT, BET,SKJ			

It was noted that there is a wide range of specifics relating to the values chosen for reference points and HCRs and the examples of adopted biomass LRPs and LRPs relative to B_0 were described. Dr Restrepo made the following key observations in relation to general progress with harvest strategies:

- All RFMOs are making progress, at different speeds. Dialogue and understanding can be slow and tedious
- In several RFMOs, adopted Limits and Targets are “interim”, awaiting MSE results

⁴ A rule governing the content, form, or application of other rules.

- HS should reduce the amount of negotiations through pre-agreed decisions. Understanding the boundaries of flexibility in management is a part of the dialogue
- The performance of any HS should be explored by simulation (MSE) and scored against performance indicators chosen by managers in consultation with scientists and
- The degree to which HCRs are 'hard wired' varies between RFMOs and it is possible to vary the degree of management intervention input into the process.

Discussion

A number of amendments to Table 1 above were made on advice from participants. The table in this report reflects these.

3. Role of MSE in the development of harvest strategies/control rules

3.1 MSE in the context of N. Pacific albacore

Dr John Holmes (Can.-DFO) provided background to the development of a harvest strategy for north Pacific albacore using MSE. NC10 requested that the ISC-ALBWG conduct analysis evaluating the range of options for TRP; using a Management Strategy Evaluation (MSE) approach, if appropriate. The ISC and the Japan Fisheries Agency sponsored a MSE workshop for fishery managers in April 2015, and the ALBWG reported on implementing a MSE process at NC 11. NC11 also agreed to use a template developed by the ALBWG to provide preliminary input to the process of identifying management objectives for north Pacific albacore.

MSE is new to many (including scientists) considerable education is needed; one reason why many find it hard to understand is because it has its own jargon/terminology (and also because it is highly technical). The following main observations concerning the use of MSE were made:

- Scientists can play a role in developing a harvest strategy approach for tuna stocks using management strategy evaluation (MSE) as identified in the NC NPALB management framework
- Scientists could make all the necessary choices for MSE ...if the sole objective is to maximize annual yield
- Otherwise, a structured approach is needed to:
 - * Define objectives, harvest control rules, and acceptable risk from stakeholders;
 - * Define working hypotheses for ecological and fishery dynamics; and
 - * Evaluate consequences of alternative management procedures (relative to the objectives).

The process of MSE was described, including the respective potential roles for fishery managers and scientists, the development of objectives and simulation testing. The specific case of north Pacific albacore was used to explore the relationship between policy goals and operational objectives.

Moving forward, Preliminary NC member input will be sought at WCPFC12 based on the templates provided. This will be followed by a hands-on Management Strategy Evaluation Workshop for Managers/ Stakeholders in April 2016. The goals of the MSW workshop will be to develop:

- operational objectives (threshold values, time horizon for measurement, probabilities or acceptable risk);

- performance Indicators for each objective;
- HCRs - model-based rely on quantities estimated by assessment model so evaluated every 3 simulated years; data-based rules using catch/effort data so evaluated every year; and
- operating model (OM) scenarios (states of nature) – e.g., recruitment regimes, fishery dynamics

3.2 MSE approaches in the WCPFO

Dr Robert Scott referencing Punt et al⁵ provided the following description of MSE:

A process of applying a proposed management strategy to a model of the fishery and projecting the model into the future under various scenarios to account for likely variation to see how well the strategy is likely to perform in achieving its objectives

“The evaluation of management strategies using simulation is widely considered to be the most appropriate way to evaluate the trade-offs achieved by alternative management strategies and to assess the consequences of uncertainty for achieving management goals.”

Clearly defined management objectives and harvest control rules built on agreed target and limit reference points are essential inputs into the MSE process. The MSE process can model each step of the management process and thereby allow managers to better evaluate the likely long-term performance of the fishery under alternative management strategies. This, in turn, provides managers with the necessary information with which to make decisions based on longer-term trade offs between management objectives, rather than using only short-term considerations. It is essential, as highlighted by previous presenters, to ensure that an effective consultative approach is used in developing and adopting a harvest strategy.

The links between management objectives and performance measures in the context of the overall management framework (Figure 1) were described. Uncertainty and dealing with risk was illustrated using Figure 2 below:

⁵ Punt et al 2014 MSE: best practices, Fish and Fisheries. DOI 10.1111/faf.12104

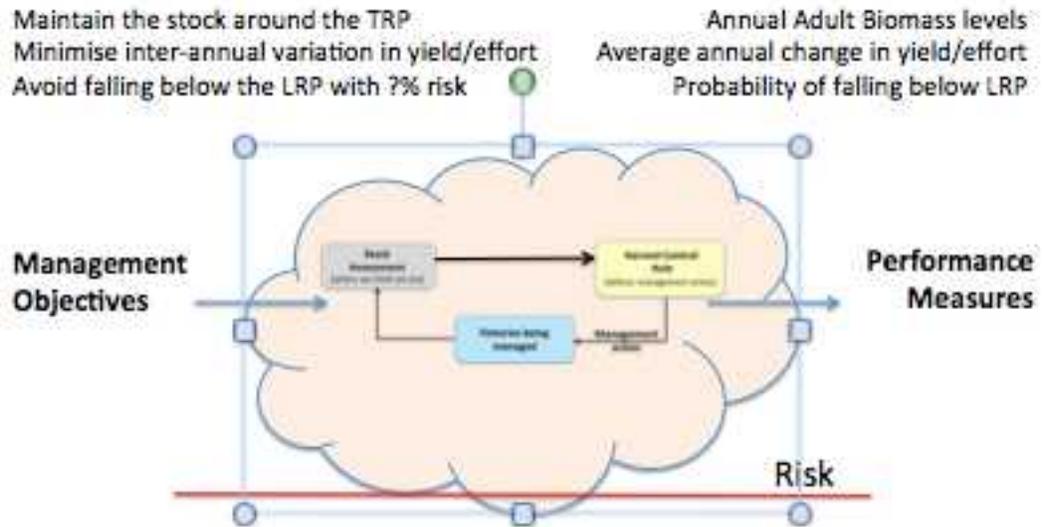


Figure 2: Management measures, performance measures and risk

4. Panel Discussion – Applying harvest strategies to the WCPO: lessons learned from other RFMOs

Discussion

The north Atlantic albacore and southern bluefin tuna fisheries were characterised in further detail.

North Atlantic albacore is a monospecific fishery with almost no bycatch, which was experienced some overfishing from local fleets, but was recovering; it is a good candidate for MSE noting that the total quota wasn't being caught so there was some room for management action. As detailed in the presentation, the current intent is not to achieve a target reference point, but rather ensure that the stock is safely in a 'green' target area ($F < F_{MSY}$ and $SB > SB_{MSY}$).

For SBT, there are seven members of the Commission of which six are actively fishing; they are also all members of the WCPFC. Most of the fishing is currently in the Indian Ocean, where fishing is carried out by distant water longliners. In Australia, the fishery is primarily based on purse seining for small Bluefin, which are subsequently grown out (ranching) on tuna farms. As with Australia most of the NZ fishery is within its EEZ. For the SBT fishery it is planned to develop target and reference points in the future after the stock had already undergone some recovery.

LRPs are generally based on biomass levels, reduction beyond which recruitment would be impaired. Although limit reference points are biologically based, there is some difference between the various tRFMOs for the same species. This is partly because some biological elements differ spatially, e.g. growth, although the overall population dynamics should not vary greatly between the W and E Pacific. However, in addition to differences in biological data, analysts use different assumptions, a large one being the stock-recruitment relationship. IATTC and WCPFC SC make quite different assumptions about the stock recruitment relationships; hence perceived productivity is also quite different. There may not be harmonization between the bodies, and that is why it is very important that MSE takes into account the possibility that these assumptions are wrong so as to ensure that the HCR is robust.

SBT is a species based on an assessment and management on a global basis whereas for the WCPFC, assessments are more spatially disaggregated. It was suggested that it might be possible to have varying harvest strategies in different areas. In response, the panel explained that southern bluefin tuna is very different from the tropical tunas, in that it has discrete and relatively small spawning area, is widely distributed and roaming. Whereas skipjack for example is less mobile and there may be spatial heterogeneity, which is recognized in the current stock assessment. SPC noted that it is technically possible to have spatial harvest strategies, but they would have to be equitable and consistent between CCMs and compatible with an overall vision/objective for the stock.

Acknowledging the difficulties tRFMOs have with conflicting gear types (e.g. PS vs LL), and the unique geo-political circumstances of the region in respect of reliance by SIDs on tuna, it was asked how other RFMOs deliver capacity building mechanisms to enable discussion and resolution of fisheries management issues. ICCAT has a standing working group for scientists & managers and covers the cost for developing members who wish to attend those meetings, though uptake and attendance has been low. IOTC has a similar arrangement. It was noted that the ABNJ project has an element of funding for capacity building, including workshops etc., some funds of which are already allocated, for example to WWF to hold a capacity building workshop in region. However, it was also noted that the consultation process is always long term, so for the sake of consistency and real capacity building it is important to not to keep changing the players.

A statement from the floor recognised that the elements of a harvest strategy are closely linked, and should in principle be considered holistically. In general this is reflected in the management framework, which is an integrated approach.

Whilst LRPs have been agreed by the WCPFC, there remains the question of agreeing an acceptable level of risk of breaching the LRP. Risk had been discussed in earlier presentations and it was noted that uncertainty is linked to risk. Where there is more uncertainty in the methodology then that is reflected in a greater risk of hitting or breaching the reference point. In the south Pacific albacore TRP proposal to WCPFC 12, uncertainty is touched upon and a level of risk of breaching a LRP is proposed. Establishing risk across species is not a simple decision for managers; there is a need for considerable dialogue and MSE work to inform the debate and ensure good outcomes.

When probabilities and risk are presented to managers it is important to show how uncertainty is included in the stock assessment, and what is the probability of falling below the LRP in a range of scenarios, including, for example, where there is no fishing.

An additional useful output from MSE is how the results may inform managers about effects of a particular management measure/HS among different CCMs and across fisheries. However this issue is related closely to allocation, which is contentious. In the example of north Atlantic albacore, testing HCRs is easier because allocation has already been decided with TAC shares agreed for each member. If the WCPFC were to try to discuss HCRs and allocation together, allocation would dominate and there would be little or no progress towards HCRs. Although it is advantageous for allocation to have been decided in advance of developing a harvest strategy, it is not, however, always considered to be a prerequisite. PNA for example could have a PNA-only HCR for skipjack, assuming that WCPFC effectively limits skipjack catches in non-PNA waters.. MSE testing could be useful in informing the debate on trade-offs and allocation across gear types, but not national allocations, which is primarily a management/political issue.

5. Developing acceptable levels of risk for breaching an LRP

James Larcombe presented on the issue of acceptable risk, providing a brief background to the issue. A summary of scientific information to assist WCPFC in adopting acceptable levels of risk for breaching limit reference points for the key tuna species in the WCPO was described. Risk in this context was defined as the combination of the likelihood and the consequence of breaching the limit reference point.

Establishing acceptable levels of risk of breaching a limit reference point is something that needs to guide all management decisions, according to the UN Fish Stocks Agreement (UNFSA) and the WCPFC Convention. UNFSA only specifies that this risk shall be “very low”, but in order for MSE to work as a quantitative process, a numerical value needs to be put on that risk. As SC has pointed out several times, establishing this risk value for each stock is a management decision, and WCPFC needs to make a decision before the scientific work can advance much further.

The Scientific Committee (SC) has provided advice to help the Commission define the acceptable levels of risk for the key tuna stocks. The role taken by the SC (and the science services provider) has been to provide answers to technical questions, but the SC has not made a recommendation on a particular risk level because this is regarded as a management decision to be taken by the Commission.

Some progress has been made with both LRPs and TRPs. Under CMM 2014-06 TRPs are required to be conservative and separated from LRPs with an appropriate buffer, ensuring that the target reference points are not so close to the limit reference point that the chance that the limits are exceeded is greater than the agreed level of risk.

Progress on defining these required buffers has been made in recent years (papers MOW3-WP-02 and HSW-WP-05). The concept of a ‘buffer’ as well as the size of the buffer required at different risk levels was illustrated for each of the four key tuna stocks (see Figure 2 below). This was also compared with the target reference point range under consideration. The impact of increased uncertainty was illustrated by the large buffer required for albacore compared with skipjack.

A range of biological, social and economic consequences of breaching LRPs were described. A range of acceptable levels of risk has been adopted in other fisheries (CCAMLR - 10%, New Zealand - 10%, Australia - 10% and ICES/EU - 5-20%).

Bigeye tuna was used as an example to illustrate how perceived uncertainty will impact consideration of risk provided as scientific advice.

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In summary, the following points were made:

- Establishing acceptable levels of risk is important for guiding management decisions (UNFSA, CMM 2014-06).
- The lowest risk tolerance (5%) requires a larger buffer and implies minimum targets of greater than $\sim 30\% SB_{F=0}$ for SKJ, YFT and BET and greater than $37\% SB_{F=0}$ for ALB.
- However, these are below the candidate target levels under consideration for SKJ and ALB, and it was noted that those higher levels better meet other management objectives for these fisheries.

- There are biological, economic and social consequences of breaching the LRP. More severe consequences would suggest lower probabilities would be desirable.
- There is an inevitable link between estimated risk and how uncertainty is characterised.

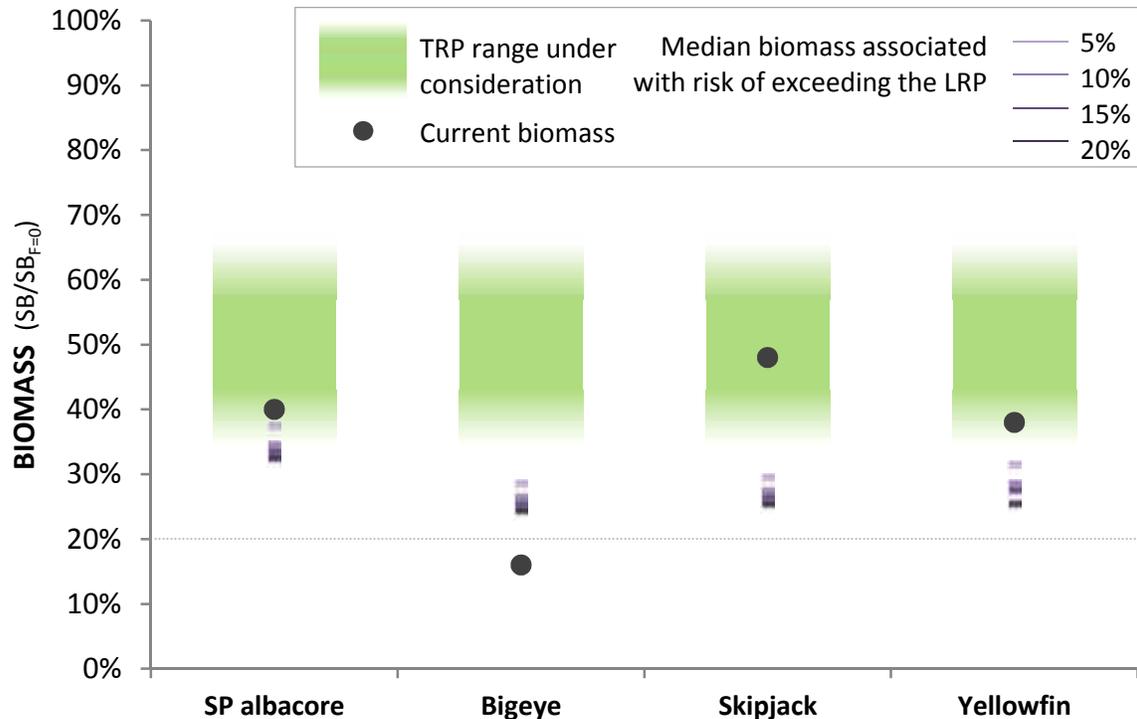


Figure 2. Relationship between the limit reference point (grey dashed line), median levels of spawning biomass depletion at different risks of exceeding the limit reference point (purple lines, as per Table 1), the current biomass (black dot) and the target reference point range under consideration (green band) (Sources: MOW3 WP-02, except for south Pacific albacore which were derived from HSW-WP-05; most recent stock assessments as at August 2015)

Discussion

- In considering risk for WCPFC fisheries, perceptions of risk are particularly influenced by i) recruitment assumptions (e.g. should recent high recruit for bigeye or long term recruitment be used?) and ii) assumptions about the status of the stock at the commencement of model runs (projections. SPC currently estimates risk based on the status at the end of projection period.
- It was queried whether, when selecting a TRP, it was necessary to consider the risk of breaching the LRP. Given that the goal of the action would be to stay close to the TRP, was this simply a 'box ticking' exercise in the case of skipjack tuna?
- In response it was explained that the south Pacific albacore assessment has more uncertainty compared with other stock assessments, and consequently this is more than a box ticking exercise. The case of skipjack is somewhat different, noting that with a TRP set a 50% is relatively far from the 20% LRP.

- South Pacific albacore data are mostly for large fish taken on longlines and so there isn't exploitation, and therefore data, across the full size range of the stock, nor is there much tagging data and this reality should be reflected in the MSE.
- A key uncertainty for albacore is the range of assessment runs selected by the WCPFC Scientific Committee. Albacore uncertainty includes an assumed natural mortality, which is less important for tropical tunas where the assessment relies more on steepness. Other sources of uncertainty would affect buffer zones and the greater the level of uncertainty the closer to the limit we might get.
- Following the Commission's agreement on a level of acceptable risk, that risk would be used by the model to determine the eligibility of any given harvest control rules. Clearly any rules that would allow the fishery to breach the limit reference point with high probability should be unacceptable.
- At the levels of current fishing effort skipjack would not approach the limit reference point. A multiplier of 2.8 would have to be applied for skipjack to breach the limit reference point. SPC recognise that the fact this represents a state of the stock that has not been previously seen and this contributes to the uncertainty.
- It was clarified that smaller size classes of fish are not considered separately, rather, noting that spawning stock biomass is the key metric, it is how small fish impact the spawning stock biomass that is important. It is possible, however, to have performance indicators related to smaller sizes of fish.
- It was noted that, in the case of SBT, developing HCRs that avoid the LRP and achieve the TRP was a difficult process.
- It was noted that, with a well-designed harvest control rule that responds to stock assessments over time, the projected risks of breaching the LRP may be lower, projected into the future.. Within an MSE framework the risk of exceeding LRP is a key consideration. Candidate HCRs that regularly exceeded the LRP may not be acceptable. It is recognized that SPC in developing their approach to MSE are seeking external advice from international experts.
- Where early historical data is included then the results indicating the risk of breaching the LRP would change. The WCPFC Science Committee decided to use recent higher levels of recruitment and apply them to project future recruitment. The early low recruitment may be unreliable, due to the way the fisheries and increased data have affected the estimates of recruitment over time.

6. Developing a skipjack harvest strategy

Proposed CMM for skipjack tuna

Les Clark, on behalf of PNA/FFA provided a presentation outlining the draft skipjack CMM to be considered by the Commission. It was noted that the draft CMM was the result of a stream of work over several years. The current draft has been through SC11 and TCC12, with comments now incorporated. Additional work on purse seine CPUE dynamics and HCRs as been completed and there is now widespread support with the FFA and Japan proposals broadly aligned.

The draft CMM was presented as meeting a range of objectives, in common with those developed at MOW1/2. These include resource sustainability, economic goals, stability, being risk averse and avoiding additional impacts on other species.

The proposed stock level under the CMM is 50% of the estimated recent spawning biomass without fishing, where recent means established over last ten years using the most recent assessment.

A comparison table between alternative TRPs (40, 50 and 60%) was presented, and it was noted that a TRP of 50 maintained the fishery in close to current condition going forward. The following observations on the 50% TRP were made:

- The CMM proposed TRP is interim/initial;
- Will be used in assessment of the stock and in reporting on management advice and implications by the SC
- Will provide a basis, with the adopted LRP for skipjack, for the Commission to proceed with the development of HCRs related to skipjack
- Expected to require moderate reductions in purse seine effort over time, at least to adjust for effort creep.
- Is nearly double BMSY
- “Around current levels” generally meets objectives
- Will improve decision making

A number of outstanding text issues were highlighted, which it was hoped that a small working group could resolve.

Discussion

It will be important to consider impacts of the skipjack fisheries and species, including the effects of FADs.

In deciding on a TRP there is a need to be cautious, since skipjack is a global stock of great significance in terms of economic benefits and food supply..

Alternative CPUE-abundance dynamics in purse seine fisheries

Robert Scott (SPC) provided results from an initiative to implement a non-linear CPUE to abundance relationship ('hyper-stability') within MULTIFAN-CL. These results were used to demonstrate some of the potential impacts of hyper-stability in the context of potential TRPs for skipjack. Consideration of this information could inform the skipjack TRP decision and future work on harvest control rules.

Three levels of hyper-stability were examined (zero, and where a non-linear CPUE/biomass relationship is assumed, moderate and extreme levels). Under status quo conditions (i.e an effort scaler of 1.0) the stock is estimated to remain at 48% $SB_{F=0}$ throughout the projection period.

When hyper-stability exists, a smaller effort reduction is required to increase the stock to 60% and a smaller effort increase is required to reduce the stock to 40%. However, those reference points still implied notable changes in effort.

The SPC-developed and Pew-funded R-shiny application for disseminating the results of the hyperstability work was demonstrated and participants were asked to try the application and provide feedback as to its utility as an extension tool (<https://ofp-sam.shinyapps.io/cpue-dynamics>).

Harvest Control Rules –skipjack focus

Graham Pilling (SPC) highlighted the MSC definition of a harvest strategy:

“well-defined pre-agreed rules or actions that determine a management action in response to changes in indicators of stock status with respect to reference points”

Before selecting a suitable HCR it is necessary to evaluate many different HCR options/shapes to determine which gives the best trade-offs between fishery objectives E.g.:

- Achieving the TRP on average & avoiding the LRP with high probability (low risk)
- Catch/effort stability
- Achieving profitability

It is also necessary to ensure that the HCR is robust to uncertainties, in the best case using MSE analysis. The example discussed at MOW2 of two example HCRs developed for skipjack using effort-based control of fishing/harvest was presented (see HSW-IP-03 and Figure 3 below).

- **HCR1** allows for lower fishing effort in good times (‘banking’ stock) and resulted in a slower response to decline (wider ‘plateau’ area). If the aim is to achieve the TRP, while minimising change in effort, the more conservative HCR1 performs better.
- **HCR2** allows for higher fishing effort in good times and resulted in a faster response to decline (narrower ‘plateau’ area). If the aim is to achieve the TRP, while maximising catch and there is less concern about lower CPUE and more frequent effort changes, then the less conservative HCR2 performs better.

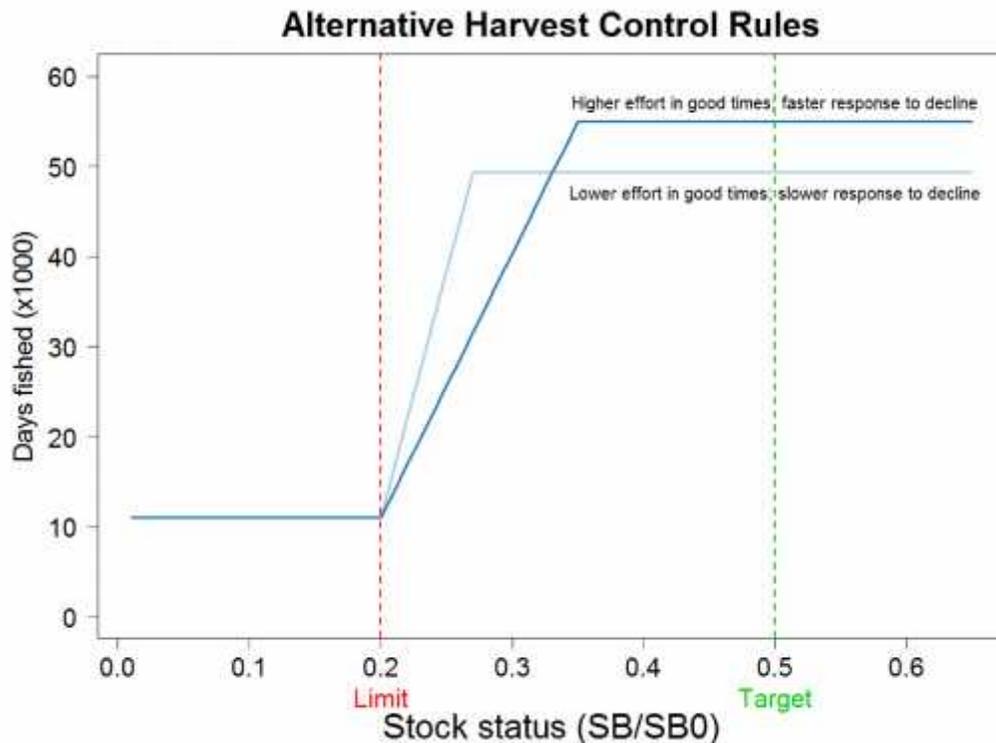


Figure 3. Two simple Harvest Control Rules (1 – light blue; 2 – dark blue) used in the example. Based on the outcome of the stock assessment, future fishing effort (days fished) is determined from the lines above. Both rules have been designed to keep the stock around the target reference point level on average.

The robustness of the two example HCRs to uncertainty in stock assessment results, and to effort creep, was presented.

Skipjack Working Group outcomes

The following represents a summary of the collective responses from the working group to the questions posed during the skipjack presentations and in the workshop agenda:

Discussion of objectives

- The proposed TRP (50%) for SJ meets a broad range of objectives by maintaining the fishery at around current levels of catch and effort
- The proposed TRP meets the economic goals of PNA, noting some compromise among PNA members
- While some concern was expressed about potential impacts on artisanal/coastal fleets, it was sometimes difficult to estimate these (there is a need for better data on artisanal catches)
- Suggestion that any artisanal impacts in PICs may be more related to FAD bycatch

Trading off objectives

- There is currently no explicit consideration of other species/fisheries in the development of a SKJ harvest strategy; management arrangements for other species will be addressed through via other measures (e.g. bigeye via FAD measures).
- Need for clarity in the rationale and description of HCRs to promote understanding and support by industry

Frequency of catch/effort adjustment using HCR

- Should be related to the risk of a bad outcome and the stock status – closer to LRP = higher frequency of catch/effort adjustment
- While SKJ is a short-lived species (may indicate more frequent review), currently a large ‘buffer’ exists for this stock and catches/stock/CPUE have been stable for a long period
- General agreement that updating at 3 years intervals is appropriate, unless there are high/unforeseen circumstances in the fishery; there was also a need to allow for an appropriate level of flexibility – use of meta-rules can deal with such issues.
- Limits on changes to catch/effort between management periods
- General agreement that limits would be useful; in the case of SKJ, primarily for economic reasons noting potentially undesirable effects of significant change
- Limits on changes to catch/effort between management periods
- Agreement that the use of offset catch/effort adjustment will be useful i.e. lower limit for increase than decrease
- MSE should offer an invaluable tool to test all elements of a candidate HCR, including limits on changes
- Key objective of HCR is to avoid major fluctuations and maintain the stock around the TRP on average rather than overfishing and then implementing rebuilding requiring dramatic change

Limits on changes to effort between management periods

- General support for limits, but need to be moderated to avoid undue volatility, noting issue with mobility of capital and current over-capitalisation
- Need to test range of values for change limits 20% (approx current for SBT/ICES, BFT in ICCAT) too high
- Possibility that changes can be implemented over a number of years
- Limits on changes to effort between management periods
- Consider trade-offs:
 - Tight limits = more frequent adjustments and harder to keep in target range
 - Wide limits = less frequent but large changes may be required

Frequency of HCR re-evaluation

- Will depend on time to determine effectiveness of, and stock response to, HCR
- 3 years generally considered to be reasonable?
- Provided adequate MSE testing, less frequent re-evaluation might be reasonable

HCRs and management objectives

- TRP generally meets objectives expressed at MOW
- Alternative HCRs to achieve a given TRP are possible and should be tested via MSE
- (fishing less during good times will tend to result in less revenue over time but give greater stability of returns – another trade off)
- Establishment of ‘trigger points’ for action important

Potential HCR indicators for SC consideration

- Stock status – SC to advise on best choice of biological indicators
- Changes in CPUE (noting effort creep/hyperstability considerations)
- Economic indicators
- Spatial indicators
- Effort/capacity
- Other species
- Other issues
- Compatibility

While biological targets and indicators are more commonly used, HCRs can be based on economic indicators.

There were no comments in plenary on the outcomes of the Skipjack Working Group.

7. Developing a south Pacific albacore harvest strategy

Revised bio-economic TRPs for south Pacific albacore

Graham Pilling (SPC) presented an update on revised TRPs based on an updated 2015 stock assessment, which featured new spatial structure and new input parameters, and the associated bio-economic analysis. The conditions of the fishery arising out of the alternative TRP levels were highlighted. It was noted that the results are an 'average' (some fleets will be better off, some will be worse) and that a TRP is a desirable point where fisheries management objectives are, on average, met; the time period to get to that point will have consequences for the fishery and is a separate question.

Target levels examined included MSY and a range of financial targets (MEY, 'Breakeven' (sufficient profit to remain in the fishery) and 10% revenue over economic costs (additional profits to allow e.g. licence payments). The following conclusions were drawn and questions posed to the workshop:

- Continuing to fish at recent levels leads to further stock and fishery CPUE declines, and a 20% chance of the stock falling below the LRP. Is this acceptable?
- Is it enough to ensure a low risk of breaching the LRP? This 'minimum' TRP (~37% $SB_{F=0}$ at 5%) means a decline in CPUE from recent levels, a stock size 4% lower than recent levels – its lowest level ever - and zero profit.
- If fleet profitability is desired, what profit levels are preferred?
- Do the corresponding changes in fishing effort/catch to achieve those levels affect decisions?

Proposed CMM for south Pacific albacore

Wez Norris provided the proposed TRP CMM for SPA, explaining FFA members' consideration of the data and the decision-making process leading to the 45% $SB_{F=0}$ proposal.

MOW 1-2 looked at a range of objectives and Most CCMs agreed on objectives of biological sustainability and while most also had economic objectives, these varied. Some CCMS at the time advocated MEY, while others simply wanted some degree of economic improvement. It was noted that circumstances change over time and with better science it is necessary to move away from abstract concepts to concrete proposals.

FFA members strongly believe, and the SC advice supports the view, that the performance of the fishery needs to be improved. It is apparent catch rates are low and falling and many fleets are experience zero or low profits.

From a **biological** perspective the assessment indicates that SB_{MSY} actually lower than the agreed LIMIT Reference Point eliminating SB_{MSY} a target. Doing nothing is insufficient, since the assessment indicates that the status quo in respect of catch/effort will result in an unacceptably high risk of breaching the LRP (20%). To achieve an acceptable (to FFA) risk level of 5%, the stock could be allowed to fall marginally to 37% $SB_{F=0}$. Consequently, the minimum standard under any circumstance is 37% $SB_{F=0}$. This level represents a worse case than current, where fleets are unprofitable and are tying up.

Consequently an **economic** perspective is required. Modelling suggests that MEY would be something like 59% $SB_{F=0}$, which would result in substantially higher catch rates and vessel profitability but would require an unrealistic and unacceptable 59% cut in catch. The projections will need some review. The Pacific Industry Association took a simplistic view that returning the fishery to when it was performing reasonably well with respect to profitability was a sound strategy. This was some time around 2008, at 45% $SB_{F=0}$.

The TRP at 45% $SB_{F=0}$ results in CPUE being 17% higher than now, and “Average vessel” profit of 20% profit (@ costs of \$1.10 per hook). This increased viability will support the development of domestic fisheries and enhance partnerships between coastal States and foreign partners. The cost is a 41% catch reduction, noting that on biological considerations alone, avoiding the LRP requires 33% catch reduction anyway.

To place the required reduction in an acceptable form requires separation of i) the TRP, which is interim and subject to change as the stock assessment improves, from ii) the speed at which reductions are required and the allocation of that burden amongst members (e.g. under a HCR). Finally it was noted that the proposed TRP meets most of the objectives suggested at MOW1-2.

Harvest Control Rules – south Pacific albacore

Graham Pilling (SPC) provided a preliminary proof-of-concept that HCRs can be based upon catch or effort, based on 2015 south Pacific albacore assessment. The outcomes of this preliminary work provide a basis for future discussions of albacore HCRs for the catch-based control of fishing/harvest.

An example of robustness testing based on alternative assumptions of natural mortality i.e. lower (less productive) and higher (more productive) rates of mortality were considered. Some considerations for the future were highlighted

- Alternative levels of natural mortality had acceptable outcomes in terms of risk, but very different implications for catch;
- There is a need to discuss different forms of the HCR, particularly to improve acceptance of proposed reduction in catch
- Candidate TRPs will require consideration of alternative periods to allow the stock to rebuild to the TRP, the timescale of which will have economic implications that can be examined via NPV analysis.

Albacore Working Group outcomes

The following represents the a summary of the collective responses to the questions posed in the workshop agenda and associated discussions held in the skipjack tuna working group:

Does the proposed CMM (WCPFC-2016-DP03) address your objectives for the fishery?

It was noted that the proposed south pacific albacore CMM:

- Formalizes LRP to 20% $SB_{F=0}$
- Sets interim TRP to 0.45 $SB_{F=0}$
- Sets max. risk of breaching LRP at 5%

Main group discussion points

- General agreement that setting a TRP and a LRP risk level is a good idea. Not necessarily agreement on exact levels.
- The proposed DP03 TRP implies a 41% reduction in catch. Uncertainty about how this will be achieved (time frame, allocation) makes it difficult for some CCMs to agree to this TRP

Other discussion points

- Many participants (especially SIDs) worry that catch rates and profits have progressively worsened in recent years (though 2015 appears to be better for American Samoa). This worry is independent of what the stock assessment indicates.
- Many factors may influence profitability. Not everyone agrees that CPUE is a good proxy for profits
- There is general concern that fishing capacity continues to increase.
- Given current trends – increasing capacity and effort, the longer it takes to agree a management response, the harder it will get over time. Adoption of a TRP and HS work should not be used as an excuse to delay needed action.
- Generally agreed that a key management objective is stability in the fishery. But “stability” can be confused with status quo.
 - Some fleets would like to maintain current catch levels (status quo). But the assessment shows this cannot be sustained.
 - Proponents of draft CMM would like to transition from the current state to a stable CPUE state that would be more profitable.

Thoughts on a way forward

- Agreement on a TRP seems attainable but more clarity about future actions (how catch will be reduced) is needed
- SBT (reverse) analogy: The CCSBT HCR has allowed for the gradual increase in catches in a stock that is severely overfished. In our case, could a HCR facilitate a gradual decrease in catches in a healthy stock?
- DP09 (HS Workplan) proposes HCR (MSE) work to be conducted in 2016-2018. Could DP03 be amended to make it clear that alternative future actions will be analyzed in the HS workplan?
- In other words: Agree on an **interim** TRP that will enable HS work to go on, and not necessarily agree to a specific catch reduction today. Possibly look at alternative candidate TRPs and risk levels?

Ideas on HCR development

- Timeline for change in state of resource 20 years
- General support for HCR that combines empirical (CPUE) and model-based (assessment) indicators to track progress
- Need to think about monitoring (e.g. observer coverage)
- Capacity controls
- Consider other factors that add to uncertainty, such as catches in the east etc.

Discussion

Fishing mortality may be managed in the short term but to achieve a new state in the fishery takes longer. SPA takes 5-8 years to recruit to the fishery and so any actions to guide the fishery towards a 45% TRP will take time. Changing fishing mortality can be achieved in one year – but to take the stock to a new state with a range of variable cohorts is a longer-term proposition hence 20-30 year projections

were used. For SBT a 20% target with a 2035 deadline was considered reasonable compromise for a stock-rebuilding trajectory.

An important advantage in selecting a 'workable' TRPs rather than a wide selection is that it simplifies the analysis and the management decision-making process. If multiple TRPs are analysed the number of options becomes unmanageable. It is important to recognize that agreeing a TRP is not an action in itself, and it doesn't affect any other actions that may be taken to safeguard the fishery.

In developing harvest strategies and HCRs the unique circumstances of the region, and in particular the reliance of Pacific Island Coastal States on tuna fisheries, must be a primary consideration. Some 'bottom up' approaches to HCRs have been developed and these must not be undermined by current efforts for the more comprehensive harvest strategy approach currently being developed. Coastal states will make a range of decisions on harvest strategies within their own waters.

The choice of 45% $SBF_{=0}$ as a TRP is considered by FFA to be a reasonable interim target and provides a focus on a target that is likely to work in terms of sustainability and the economics of the fishery. FFA is keen to have the 45% $SBF_{=0}$ adopted and happy to work with anyone concerned regarding the details of implementation such that fisheries are not unduly impacted, including by recognising the need to continually review the interim TRP as HCRs are developed and considered.

8. Work plan for developing harvest strategies for key tuna species

The Commission shall agree a workplan and indicative timeframes to adopt or refine harvest strategies for skipjack, bigeye, yellowfin, South Pacific albacore, Pacific bluefin and northern albacore tuna by no later than the twelfth meeting of the Commission in 2015. This workplan will be subject to review in 2017. The Commission may agree timeframes to adopt harvest strategies for other fisheries or stocks.

The draft workplan proposed by the FFA covers skipjack, bigeye, yellowfin and South Pacific albacore. It is anticipated that the Northern Committee will be responsible for Pacific bluefin and NP albacore. The plan, which is to be considered by WCPFC 12, was presented to the workshop.

The workplan has been designed to take account of some of the issues raised by CCMs in 2014 when CMM 2014-06 was adopted. In particular the workplan allows for harvest strategies to be developed for specific stocks, or for fisheries based on multiple species or specific gear types.

The workplan is designed to provide a practical sequence of work towards the development of harvest strategies that takes into account the workload of the Commission and the role of the subsidiary bodies in providing advice to the Commission in the development of the various elements. However it was acknowledged that progress towards harvest strategies would be an iterative process.

It was noted that work on the elements described in CMM2014-06 had already taken place, with the Commission already agreeing limit reference points for skipjack, yellowfin, bigeye and south pacific albacore at WCPFC9.

It is anticipated that the workplan will be reviewed on a regular basis.

Discussion

It was suggested that the draft harvest strategy workplan has a rigid schedule, and there needed to be greater flexibility, for example to accommodate the two TRP proposals put before the commission.

In response the presenter agreed that there would be a need for flexibility in the workplan and some of its elements, explaining that the workplan should be considered a living document to be reviewed

annually by the Commission as a permanent agenda item. Where there is a need for revision and if the advice indicates that the process timeline needs adjustment then this can be done. Any suggestions for improving flexibility in the current proposal would be welcome.

There was an observation that the workplan presented did not include the two northern stocks, Pacific bluefin and North Pacific albacore. It was suggested that these processes should be in parallel, with a timeline for rebuilding the Pacific bluefin tuna stock. It was indicated that the Northern Committee report to the Commission would include this item.

In response to a suggestion to consider other species including sharks and billfish during the 2017 review of the harvest strategy work plan., e.g. sharks and billfishes. It was indicated that this was a decision for the Commission, but the workplan's structure should be able to accommodate additional stocks or fisheries.

One participant queried whether the HCRs for a stock would take into account the TRPs for other stocks as they were agreed. Yellowfin will need to have an agreed TRP at some time, and it was thought that there should be a line item in the workplan for 2018. The presenter indicated that it was expected that the development of HCRs could consider the implication of actions on other species as required. The explanatory notes clarify this and other issues but suggestions for ways to provide additional clarity on this issue were welcome.

Role of MSE

Gorka Merino provided an overview of the MSE process as being used in ICCAT for North Atlantic albacore. The use of a Pareto frontier approach was described, in which is a set of choices in which it is developed where it is impossible to improve the performance of one variable without worsening the other. Positions within the frontier are feasible and those outside, non-feasible. The use of MSE testing to determine if HCRs achieve management objectives was described.

Robert Scott described the MSE framework in the context of the operating model (OM) and the management procedure. Some considerations regarding how these frameworks could be applied to the skipjack and albacore fisheries were outlined.

The essential components of an effective MSE include:

- Limit and Target Reference points
- Defined Objectives
 - What do you want to achieve?
 - When do you want to achieve it?
- Agreed performance criteria
- Discussion and agreement on key sources of uncertainty
- Candidate harvest control rules
- Agreement on presentation of results and method for selecting the preferred management procedure
- Schedule for re-evaluation or formal review
- Provisions for exceptional circumstances – when is it OK (necessary) to take emergency action

MSE is a consultative process and requires input and feedback from managers and stakeholders throughout. To achieve this a realistic timeframe for implementation is required. An indicative time frame for MSC testing, which aligns with the workplan was presented.

9. Links between harvest strategies and CMMs

Bubba Cook (WWF) provided an over view examining options for how best for the Commission to give effect to the elements of the harvest strategies, including TRPs and HCRs and integrate and simplify Commission instruments and measures into an operational fisheries management framework.

The role of CMMs as binding resolutions of the Commission and Resolutions, decisions, and other non-binding instruments that are “highly persuasive” were compared, along with the role of TCC to review and provide recommendations on decisions of the Commission.

The application of CMMs and other instruments in various waters within the Commission area were described, noting that unless a CMM specifically excludes certain types of waters, it should be interpreted as including all waters within the Convention Area. The issue of compatibility (of measures under national jurisdiction, and the requirement to take into account previous measures adopted national and sub-regional organisations) was briefly covered.

The approach of using an overarching CMM consolidating CMMs containing elements of harvest strategies was discussed and presented as having several advantages including less repetition of preamble text and improved consolidation of CMMs. These were offset by the issue of opening a single element, which would open the entire CMM and run the risk of exposing the CMM to protracted negotiation contrary to HS Approach. A similar comparison for individual CMMs was presented.

A recommendation for a combination approach was floated whereby the elements common to all harvest strategies in the main body of a single CMM, with elements of the HS unique to specific stocks or fisheries would be provided in individual annexes. The advantages of such an approach were listed as: less repetition of preamble text; allows independent assessment and adoption on a fishery/stock basis; all HSs consolidated in a single document; and all aspects of the HS are binding. No disadvantages were identified in the presentation.

Discussion

The presentation appeared to go straight to the assumption that components of harvest strategies should be packaged in the form of a CMM or multiple CMMs. There is a rationale for other approaches and these should be considered.

While discussions of and presentations on harvest strategies have been helpful it is important to remember that compatibility was not defined in the presentation and remains ambiguous.

The Commission has not been consistent in the way management decisions have been packaged, some are CMMs, and others are annexes to meeting reports and so forth. The south Pacific tuna treaty, which has individual annexes which can be updated independently of the main document, was mooted as a possible model for the commission to adopt. Another suggestion was that it might be worth reviewing the way other RFMOs, including non-tuna RFMOs, record decisions.

PNA noted the importance of approaching the Harvest strategy work as a way of improving the decision-making framework for conservation and management measures, by implementing pre-agreed rules

responding to stock status changes, and by implementing improved techniques for dealing with risk and uncertainty. However, it appears that the harvest strategy approach is being used by some CCMs as a means to undermine existing arrangements in the waters of SIDS. PNA will not support Harvest strategy outcomes that undermine the way in which fisheries are managed in PNA waters, and are concerned that this approach by some other CCMs will put at risk the potential benefits from improved decision-making in the Commission offered by agreed harvest strategies.

10. Where to from here

The WCPFC Chair provided a presentation focusing on advancing the harvest strategy approach. The requirement for the Commission to agree a workplan and indicative timeframes to adopt or refine harvest strategies for skipjack, bigeye, yellowfin, South Pacific albacore, Pacific bluefin and northern albacore at the twelfth meeting of the Commission in 2015 and associated provisions for funding were described.

The Chair then asked the workshop to consider options for progressing HS work. These were:

- Restructure/task existing WCPFC bodies (TCC/SC)
- Continue Harvest Strategy Workshop
- Establish an independent panel of experts to progress HS work (intersessional work, electronic)
- Extend the Commission meeting
- Shorten the Commission's agenda
- Consider options for progressing HS work including restructuring/tasking existing WCPFC bodies (TCC/SC).

The workshop was then invited to consider these and any other options.

Discussion

Different views were expressed on how best to move this process forward, with most agreeing that the options presented were not mutually exclusive and various combinations of options were proposed by the floor. Cost and the burden on SIDS is recognised as an important consideration and an appropriate budget would have to be reviewed at the FAC. The workshop was advised that CCSBT didn't make much progress until they appointed an independent panel of experts. If SPC is to take up much of that role, they would need adequate resources or a restructuring of their current tasks. The financial aspects of any reorganisation of work would have to be addressed in the FAC.

FAO ABNJ to facilitate advancement of this work could provide resources to assist the members however they decide to move forward.

Some felt that the MOW and HSW series of workshops had run their course and that the work should pass to the Scientific Committee. In general the TCC was not seen as an appropriate platform for this work. Other members saw that this type of forum was an important part of progressing the work of the Commission, especially in relation to the harvest strategy work.

Others recognised the hard work done by the Scientific Committee, and expressed concern about the appropriateness of that body to discuss management, noting that the Commission should avoid blurring the boundaries between science and management. The HSW workshop was seen to be an interface between science and management, conveniently scheduled immediately before the regular session of the Commission.

One CCM suggested as a compromise that there could be a one-day workshop following the Scientific Committee meeting.

Capacity building

The issue of capacity building, given the complexity and extent of the work required, particularly for SIDs was highlighted.

Capacity building activities should not be restricted to large, occasional regional workshops. This work should be mainstreamed through the year. If CCMs, and in particular SIDs are to be engaged, there is a high priority need for in-country capacity building of national fisheries administrations. FFA and PNA members have already invested heavily in capacity building and technical work along these lines, as evidenced by the more advanced state of consideration of albacore and skipjack respectively. Other CCMs were encouraged to invest in expediting the development of harvest strategies.

Closing comments

The facilitator handed over to the WCPFC Chair for closure. The Chair thanked presenters, participants and the facilitator, noting that the two days had been very productive.