WCPFC
MANAGEMENT OBJECTIVES WORKSHOP

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EVALUATING OPTIONS:

RULES TO GUIDE HARVEST MANAGEMENT DECISIONS

MOW1-WP/07
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SPC-OFP

Agenda 4.3 - Evaluating options: rules to guide harvest management decisions

This paper describes a process for evaluating alternative management strategies (e.g., managing allowable catch levels to ensure selected targets are reached and maintained) and describes progress towards the development of harvest control rules (HCRs) for Western and Central Pacific Ocean (WCPO) fisheries.

This process requires input from managers and stakeholders to identify management objectives, candidate target reference points, options for harvest control rules, and the criteria against which their performance should be evaluated. The Scientific Committee has identified potential appropriate biological limits to exploitation (limit reference points), and scientific evaluations can compare and contrast the potential consequences of alternative harvest management strategies to allow stakeholders to select the strategy that best meets agreed objectives.

Current approach: projections to evaluate fixed management options

The Scientific Committee has evaluated the implications of future management options using population 'projections'. In these analyses, the fish stock as output from the stock assessment is sent forward through time based on a range of assumptions and under a range of fixed (constant) future levels for each of the fisheries exploiting that stock. These may be, for example, 'status quo' conditions, where current catch and effort levels are maintained into the future and the resulting consequences for the stocks evaluated. Where feasible, uncertainty is taken into account by running those projections on each of the stock sizes output from each of the 'uncertainty grid' runs. This forms the basis of the analyses presented in SC8-MI-WP-01 and SC8-MI-WP-06.

Kobe II strategy matrix

A further element of the current approach is the use of a strategy matrix that was recommended at the second global summit of Tuna RFMOs (Spain 2009) as a standard tool to convey management advice. The Kobe II strategy matrix details specific management measures that would achieve the intended management targets with a certain probability, by a certain time. For example, under a given future management strategy what is the probability that in 10 years time, the stock size will increase to reach target levels if it is currently around the limit reference point?

The probabilities and timeframes to be evaluated would be determined by WCPFC. Its use should promote the application of the precautionary approach by explicitly laying out probabilities of meeting specified targets. A set of clearly specified management objectives (e.g., probabilities, targets, time frames) is the first requirement to implement the strategy matrix. Results from projection analyses that evaluate alternative harvest management strategies can then be directly integrated into the strategy matrix for setting management measures.

Next step: projections to evaluate dynamic management options (MSE)

The ‘current’ projection approach described above assumes that the fishery remains constant over the period of the projection (e.g. for the next 10 years). In reality, management attempts to adjust fisheries

more frequently, on the basis of stock assessment results relative to reference points. Therefore, more 'adaptive' (dynamic) projection analyses are required to assess the expected performance of alternative management options. In these projection analyses, regular assessments of stock status are made over the projection period (e.g. every 2 years) and then management action is applied in reaction to those results. Key uncertainties are also incorporated into the analyses, recognizing that there is imperfect knowledge of the status of stocks and their biology, uncertainty due to potential biases in the data sampled from the fishery, and uncertainty in the implementation of management decisions (see paper for Agenda item 4). In this way, decision makers can compare and contrast the performance of management strategies relative to performance indicators that relate to the set of pre-specified management objectives, prior to implementing them. These type of analyses are commonly performed through the use of 'management strategy evaluation' (MSE) simulations (Figure 1), which enables one to evaluate whether the proposed management system is robust to the uncertainties inherent within it. To do this, however, the management decisions for a given stock status relative to agreed reference points must be predictable, through a set of Harvest Control Rules.

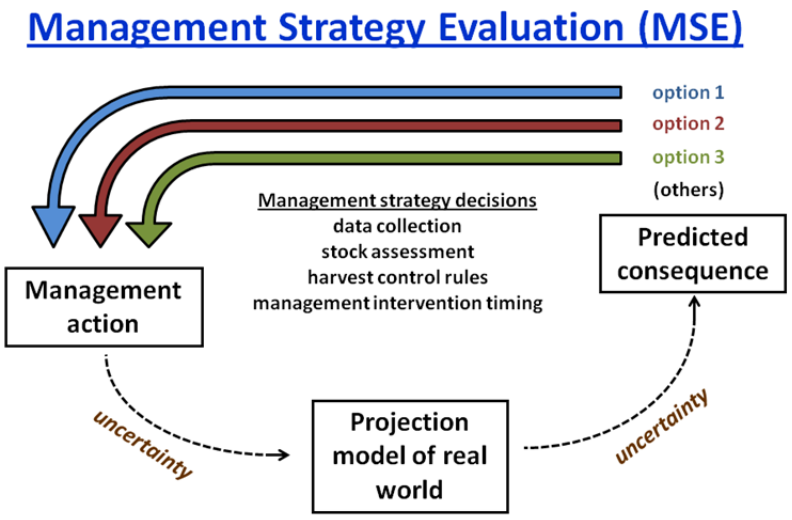

Figure 1. The general process involved with evaluating alternative management strategy options, including the choice of rules (HCRs) to guide harvest management.

Harvest Control Rules

Management strategy evaluation analyses help to find the best way to set total allowable harvest levels to ensure that we don't exceed our limit reference point often and generally stay around our target reference point level and hence achieve objectives. Often, to achieve our targets and avoid our limits we find that the best way to set the harvest level is to allow it to 'respond' to the state of the stock. For example, when the population is declining close to the limit reference point you decrease harvest, but if it is increasing above the target reference point then you may want to increase harvest. The way in which the total allowable harvest is adjusted to changes in population status (e.g., spawning stock biomass) is called a *Harvest Control Rule* (HCR). In essence, harvest control rules identify a pre-agreed course of management action as a function of identified stock status and other economic or environmental conditions, relative to agreed reference points (see SC8-MI-WP-03 for more details). A generalized example is provided in Figure 2; in this example, the total effort allowed in the fishery is reduced if the stock biomass falls below the target level, and the fishery is closed if the limit reference

point is reached. When determining the best harvest control rule, we can also examine other important issues such as catch rates, variability in catches, potential climatic impacts, and tradeoffs among these.

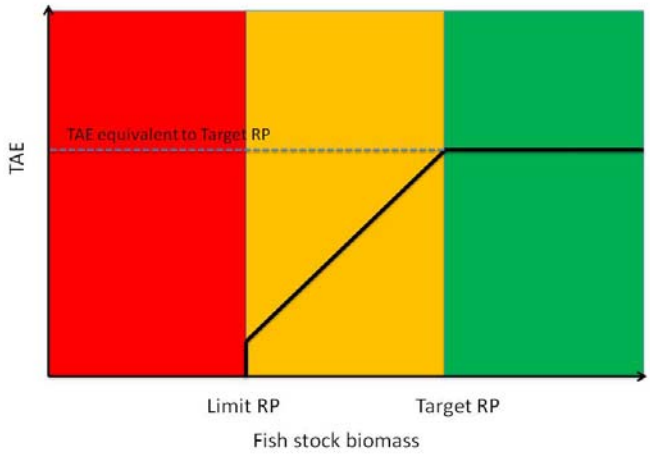

Figure 2. A generalized example set of harvest control rules (black line) that adjust the allowable harvest level (in this case total allowable effort; TAE) according to population status (e.g., stock biomass) in relation to specified target and limit reference points.

Harvest control rules (including their component biological reference points) should be developed in the management planning stage with the involvement of all stakeholders. Candidate HCRs can then be evaluated for robustness to uncertainties in, for example, our estimates of stock status, due to environmental conditions, in harvester behavior, and in managers' ability to change harvest levels. If harvest control rules are based on large amounts of uncertainty, then the formulation of the control rule should be more precautionary. If, on the other hand, inputs to harvest control rules are based on little uncertainty and/or if resulting controls are more stringent, then a less precautionary formulation of the control rule should be successful. Periodic reviews of the HCR are typically conducted to ensure that management objectives are being met. This allows adaptive changes to be made to the policy as social, economic, biological, or ecosystem conditions change.

A key part of the harvest control rule is that it is pre-agreed. The status of the stock defines the management action (in Figure 2, the level of the TAE) to be taken in subsequent years. This is particularly important in the case of a declining stock, where agreeing management action, particularly reducing the level of fishing, can become significantly harder. This also allows the harvest control rule to be tested within the fishery prior to implementation using MSE.

Evaluating harvest control rules

MSE involves testing different control rules (and their reference points), incorporating uncertainty, to see whether they achieve the desired management objectives.

Inevitably, tradeoffs arise when there are multiple management objectives (e.g. see paper for Agenda item 4.1). What might be a good harvest policy for one management objective may be less than desirable for another. To resolve conflicts, tradeoffs among competing objectives are clearly presented through MSE. Some common tradeoffs assessed when evaluating alternative harvest rules include (from SC4-ME-WP-10):

- average long-term catch versus average long-term catch rate;
- average long-term catch versus probability of the stock being below the LRP;

- average long-term catch versus probability of the stock being above/below the TRP;
- average long-term catch rate versus inter-annual variation in catch; and
- average long-term effort versus stock rebuilding time to a target level.

Evaluating performance metrics (particularly tradeoffs) between alternative sets of harvest rules is a good way to contrast between them, and ultimately provide support for the selection of a harvest strategy that best balances all objectives, including multi-species objectives. For example, will the fishing level associated with a target reference point for skipjack, combined with current CMMs (e.g., CMM 2008-01) enable the bigeye stock to stay above the limit reference point? Will it reach its target level and maintain that level on average? In this way, MSE provides stakeholders with the information on which to base a rational decision on the management strategy to be used, given their management objectives, preferences and attitudes to risk. In turn, the approach is consultative, with all key stakeholders having input into the management strategies to be tested. It also highlights the need to have clear management objectives and performance indicators against which to do the evaluations.

Progress towards developing rules to guide harvest management

The modeling framework to allow the evaluation of different HCRs and strategies is currently being developed and tested. Example management strategy comparisons for skipjack and south Pacific albacore were recently presented to SC8 (SC8-MI-WP-03). However, several critical steps are necessary before HCR evaluations can meaningfully be conducted. For each management system (e.g., WCPO tuna stock) there is a need to:

- establish a clear set of management objectives, of which contain specifics (quantities, probabilities, time frames, etc.);
- define management target and limit reference points consistent with those objectives;
- establish a set of performance metrics corresponding to each management objective;
- define key system uncertainties that should be taken into account during analyses;
- identify alternative management options; and
- using the above, formulate candidate HCRs to be evaluated through simulation analyses.

In the meantime, the exploration of harvest rules that take into consideration recommendations from SC8 is continuing.

Further reading

Anonymous. 2009. CANADA – proposal for the establishment of a pilot project for using the Kobe II strategy matrix. WCPFC6-2009/DP31.

Deroba, J.J., Bence, J.R. 2008. A review of harvest policies: understanding relative performance of control rules. Fish. Res. 94, 210-223. (click here for pdf)

Sainsbury, K. J., Punt, A. E., and Smith, A. D. M. 2000. Design of operational management strategies for achieving fishery ecosystem objectives. ICES J. Mar. Sci. 57, 731-741 (click here for pdf).