WCPFC
MANAGEMENT OBJECTIVES WORKSHOP

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WHAT ARE STOCK ASSESSMENTS?

AND THEIR ROLE IN FISHERIES MANAGEMENT

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Agenda 3 - What are stock assessments? And their role in fisheries management

What is a stock assessment

The basic purpose of a stock assessment is to determine the 'health/state' of a population of fish. Typically we conduct a stock assessment because we are harvesting from the population and want to know if the level of harvest is safe.

In the WCPFC we undertake our stock assessments using what is known as a population dynamics model. In this approach we take our knowledge about the biology of the species and combine this with the data provided by members (e.g. catches, effort, sizes of fish taken). Then we use some relatively simple mathematics (e.g. we have some fish at the start of the year – some new ones are born – some die naturally – and others are caught) to estimate the total size of the population, how it has changed over time, and what are the levels of catches which are sustainable (Figure 1).

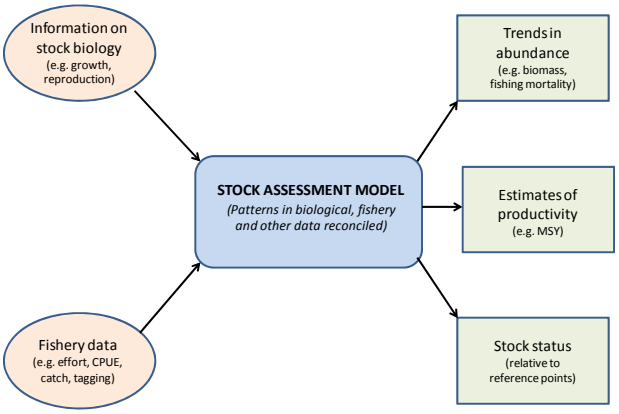

Figure 1: Schematic of the basic concept behind a stock assessment.

There are many different sorts of population dynamics models used (even within tuna). Some models consider the population as a single group and don't distinguish the different fishing gears. The stock assessments undertaken by the Oceanic Fisheries Programme use a stock assessment model called MULTIFAN-CL. This software was specifically designed to use the key data sets we have for tuna including size data (e.g. market samples) and tagging information. It allows us to divide up the Western and Central Pacific Ocean into sub-regions where different fisheries exist and allow the fish to move between areas seasonally.

Stock assessments produce a range of outputs that can be of use for fisheries management such as trends in the size of the population and estimates of the status of the fish population relative to some key levels (or reference points, e.g. Figure 2).

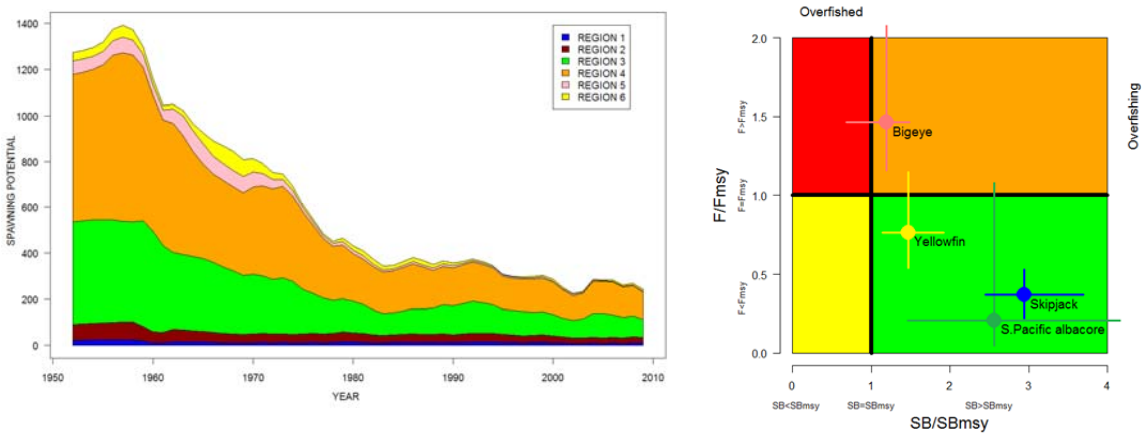

Figure 2: Examples of the important types of outputs that come from a stock assessment. Time trends in spawning biomass in different regions for bigeye tuna (left) and estimates of stock status in relation to MSY-based reference points (right).

Using stock assessment models to evaluate management options

One increasingly important use of stock assessment models is to evaluate the potential impacts of alternative future management options. The more complex the management arrangements, the more complex the model needs to be to allow that evaluation. For example, analyses for the WCPFC often involve catch limits for some fleets, effort limits for others, and time and area restrictions.

When we undertake projections to evaluate management options we input the proposed catch/effort limits and model then predicts future stock status and trends in abundance (Figure 3). Importantly, the model can make predictions about what might happen to catch rates and the sizes of fish taken – both of these have significant economic implications for fisheries managers to evaluate.

One of the most important factors to consider is that we don't know exactly what will happen to oceanographic conditions – even in the short term. Given the impact that oceanography has on tuna stocks, the projection results can only be seen as what might happen 'on average' under the conditions specified.

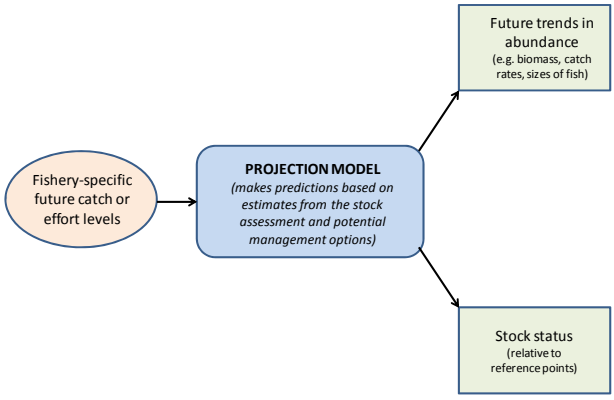

Figure 3: Schematic of the basic concept behind using a stock assessment to evaluate management options.

Capturing uncertainty

Many fishery managers want to know 'the answer' from a stock assessment and expect just a single number with an obvious management response. However, one of the most important aspects of fisheries management is 'dealing with uncertainty'. It is therefore important to adequately describe the uncertainty within our scientific assessment of the status of a fish stock.

The truth is that stock assessment for tuna are difficult when compared to other fish species -- we do not have independent surveys of these populations nor data on the ages of fish taken. Also, the area covered by the stocks are huge and the fishery data is often missing or poor for many important fleets.

To honestly reflect the scientific knowledge of the status of a fish stock, it is important and take into account those things that we are not certain about – to see if they change our impression of the status of a fish stock.

This type of approach is presented in Figure 3 below, in the context of the stock assessment for silky shark. While it would be nice to have a single model to describe the stock status (left panel), it is more fair to indicate that there are some things that we are not certain about (middle panel). When you consider, in combination, the different sources of uncertainty (e.g., what have catches been? What series of catch per unit effort truly reflects abundance? What is the productivity of the species?) you end up with a very different picture on what the status of the stock might be (right panel). Each point represents the result of individual stock assessments that use different input data and settings to examine the impacts of uncertainties such as those listed above. For example, we run different assessments with alternative catch data sets to examine their influence on the results. The array of assessments run to capture that uncertainty is called the 'uncertainty grid'.

How can managers respond to the uncertainty present within the stock assessment results?

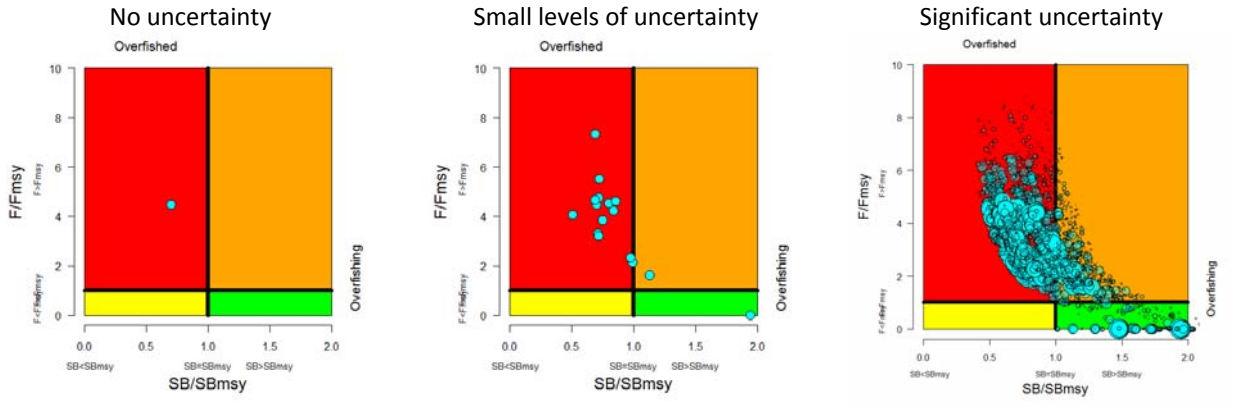

Figure 3. The impact of different levels of uncertainty on advice to managers.

Current approach for summarizing stock assessment outputs

The current approach used within the WCPFC is based upon the Kobe plot (Figure 4). This plot relates stock assessment results for the tuna species to B_{MSY} or SB_{MSY}, and F_{MSY}. Uncertainty in the relative status of the stock is shown in Figure 4 through the lines radiating out from the central point, which display the range of F/F_{MSY} and SB/SB_{MSY} ratio values estimated across the 'uncertainty grid'.

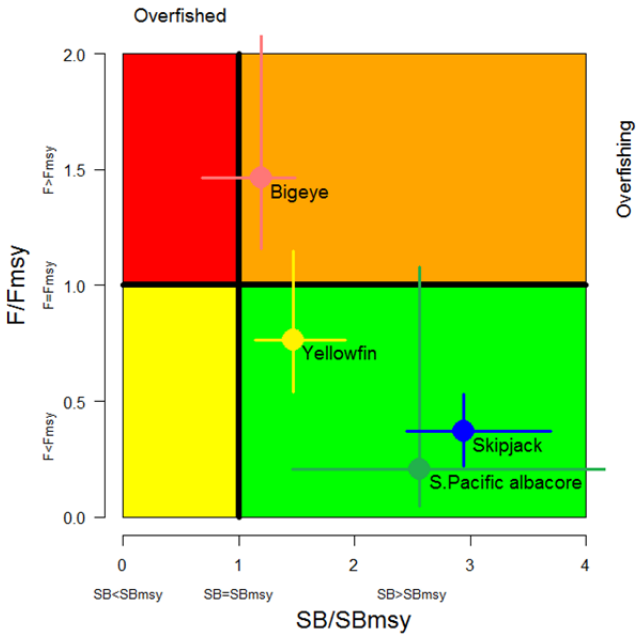

Figure 4. Kobe plot of the latest stock assessment results of four key WCPFC tuna stocks.

The WCPFC Scientific Committee selects the stock assessment results from the uncertainty grid that is felt to best represent the status of the stock. This may be a single run from the grid (e.g. the 2011 skipjack stock assessment) or an average across the grid (e.g. the median of the grid as taken for the 2012 south Pacific albacore stock assessment). This value, along with the range of individual parameters, is then presented for consideration by managers.

Further reading

Davies, N., Fournier, D., Hampton, J., Kleiber, P., Hoyle, S., Bouyé, F., Harley, S. (2011). Recent developments in the MULTIFAN-CL stock assessment software. WCPFC-SC8-2012/SA-IP-01.

Fournier, D.A., Hampton, J. and Sibert, J.R. (1998). Multifan-CL: a length-based, age-structured model for fisheries stock assessment, with application to South Pacific albacore, Thunnus alalunga. Can. J. Fish. Aquat. Sci. 55, 2105-2116.