



**WCPFC
MANAGEMENT OBJECTIVES WORKSHOP**

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**GUIDING PRINCIPLES:
DEVELOPMENT OF REFERENCE POINTS FOR WCPO FISHERIES**

**MOW1-WP/06
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Agenda 4.2 - Guiding principles: development of reference points for WCPO fisheries

This paper describes the utility of setting reference points to guide rational fisheries management and notes the current state of development for the Western and Central Pacific Ocean (WCPO) fisheries.

What are reference points

Reference points are a key component of modern fisheries management and relate to the health of the fish population being fished and the performance of the fishery in response to both fishing and environmental effects. (see Annex II of UNFSA, Article 6 of the WCPFC Convention and Sainsbury 2008, for further details). Reference points can be defined as a pre-determined level of a given indicator that corresponds to a particular state of the stock or fishery (e.g., adult stock size or catch rate/CPUE) that management either seeks to achieve (target) or avoid (limit). Hence, there are two types of reference points are typically set:

- limit (or conservation) reference points which describe undesirable places where we don't want our fish stocks or fisheries to go to; and
- target (or management) reference points which describe places where we would like to see our stocks or fisheries maintained.

The key benefit for defining reference points is that they provide managers a set of criteria to evaluate how suitable proposed management actions will be in achieving specified management objectives. Target and limit reference points work together to guide rational management decisions (Figure 1).

Limit reference points and risk

The central goal of limit reference points is to keep the fish population within "*safe biological limits*" and to ultimately protect the resource and fishing industry against long-term damage. It is suggested that when we choose a management strategy for a fishery, we should choose one that "*shall ensure that the risk of exceeding limit reference points is very low*" (UN Fish Stocks Agreement, Annex 2).

The two most commonly used limit reference points relate to a) fish stock size (e.g., biomass) and b) the level of fishing mortality (how hard we are fishing the stock). There are numerous examples of fisheries that use just one of these and some that use both. For some fisheries, additional limit reference points relevant to the economic performance of the fishery may apply (e.g. CPUE in longline fisheries).

Biomass limits are more commonly used, as it is the size of the stock which typically defines the critical level below which issues arise, such as dangerously low numbers of mature fish leading to low future recruitment. For this reason, spawning or mature biomass is typically used instead of total biomass.

Limits can also be placed on fishing mortality - which is the proportion of the population that fishing is removing each year. Limit reference points on fishing mortality are typically designed to stop us reducing the size of the stock too quickly. This is important because if we are fishing the stock down too fast it is possible to quickly 'overshoot' a target reference point. Further, high levels of fishing mortality

can be associated with overcapacity (too many boats), and it can be very difficult to implement effective fishery management measures when there are already too many boats in the fishery.

Harvest management strategies should ensure that the risk of exceeding the limit reference point under a given management strategy is "very low". This risk takes into account the possibility of the stock size falling to a low level just through chance occurrences and defines how often that is considered allowable. It also needs to account for the fact that stock assessment is not an exact science, and there will always be some uncertainty in estimates of stock status in relation to the chosen limit. Defining an acceptable risk of falling below a limit reference point has implications for setting the target reference point and thus is critical for the design of an acceptable management strategy (Figure 2). In many cases, specified management objectives (e.g., maintaining high catch rates) may define a target sufficiently far from the limit that the risk is unlikely to be exceeded given the level of uncertainty. The acceptable risk is not a biological (scientific) issue, but is defined by managers and other stakeholders, and reflects the level of risk they are willing to take when managing the fish stock. In many fisheries where this approach is applied, a 10% risk of exceeding the limit reference point is used to represent the 'very low' risk.

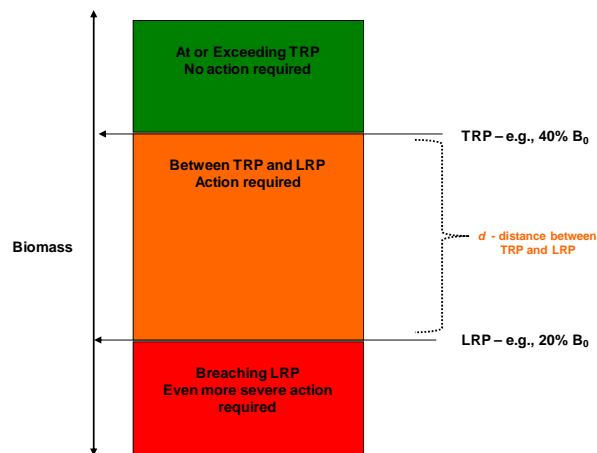


Figure 1. Generalization of how target and limit reference points guide rational management decisions (i.e., “operationalize” management action). Specific management actions are dictated by harvest control rules (see paper for Agenda item 4.3).

ACCEPTABLE RISK	low	<p>d: intermediate to small</p> <p><i>Moderately aggressive harvest management rules acceptable</i></p>	<p>d: large</p> <p><i>Precautionary harvest management rules required</i></p>
	high	<p>d: small</p> <p><i>Aggressive harvest management rules tolerable</i></p>	<p>d: intermediate to large</p> <p><i>Precautionary harvest management rules suggested</i></p>
		low	high
		UNCERTAINTY	

Figure 2. Minimum distance (d ; see Figure 1) allowed between target and the limit reference points under low and high levels of acceptable risk (falling below the limit reference point) and uncertainty (imperfect knowledge in the fishery/management system).

Target reference points to meet management objectives

The central goal of target reference points is to identify a population size/structure and fishery state that achieves specified management objectives. Harvest management strategies should ensure that target reference points are "achieved on average".

Target reference points therefore attempt to make desired biological (ecosystem) and socio-economic objectives of management operational, in a measurable way. They are generally translated into the states of fish stocks and fisheries (biomass, fishing mortality) required to achieve them, allowing them to be related to the results of scientific stock assessment. It is the role of fishery managers and relevant stakeholders to identify the desirable fishery and stock conditions that define target reference points as well as the tradeoffs and risks associated with them.

The definition of targets requires a consideration of the trade-offs between management objectives (e.g. stock sustainability, maximising economic benefits, ensuring social benefits) and multispecies-multifleet fisheries. For example, maximising economic benefits from a target species may allow fishing at levels that reduce bycatch species populations to low levels. In this example, the status of bycatch species has been traded off in favour of optimising benefits from the target species. To allow testing of the performance of potential reference points and harvest control rules, quantifying the acceptable trade-offs between different goals is important.

Thus, a target reference point is selected at a level that aims to balance the various, and often times competing, management objectives for the fishery. In many cases, these include biological and socio-economic performance indicators that are informed by stock assessment model outputs or directly measurable quantities. Some examples are shown in Table 1 (see [SC8-MI-WP-02](#) for further details).

Table 1. Characteristics of some example target reference points (TRPs) used in fisheries management.

Measure	Indicator	Derived From	Example TRP
Biological	$B_{MSY}; SB_{MSY}; F_{MSY}$ ¹	Stock assessment	$F/F_{MSY} < 1$
	$B/B_{F=0}; SB/SB_{F=0}$	Stock assessment	$X\% SB/SB_{F=0}$
	Size composition of catch	Empirical measurement	Average size of X in the catch
Socio-economic	$B_{MEY}; SB_{MEY}; F_{MEY}$ ²	Bioeconomic assessment	B_{MEY}
	Catch rates	Empirical measurement	Desired CPUE
	Employment	Empirical measurement	X number of employees

¹ MSY = Maximum Sustainable Yield; ² MEY = Maximum Economic Yield

Development of reference points for WCPO fisheries

The definition and application of reference points for WCPO fisheries management has already received much attention (e.g., [SC4-ME-WP-10](#); [SC5-ME-WP-01](#); [SC8-MI-WP-01](#); [SC8-MI-WP-02](#); [SC8-MI-WP-03](#)). The following recommendations regarding limit reference points came out of SC8 in Busan, Republic of Korea:

- Biomass-based limit reference points for bigeye, yellowfin, and south Pacific albacore to be set at $20\%SB_{recent,F=0}$, with deferral of a recommendation on the value of $X\%$ for a fishing mortality-based limit reference point of $Fx\%SPR$ for these species to SC9.

- $SB_{\text{recent},F=0}$ refers to the estimated average spawning biomass over a recent period in the absence of fishing.
- SPR refers to the spawning-potential-per-recruit.
- Biomass-based limit reference point for skipjack was recommended to be set at $20\%SB_{\text{recent},F=0}$.
- A majority of CCMs recommended a 10% level of acceptable risk be used but that a lower more precautionary value could be considered in some cases.
- The Management Objectives Workshop review appropriate values for specifying the level of risk for individual species.
- Further work be conducted to define the appropriate period for estimating the average recruitment for each species to define the $20\%SB_{\text{recent},F=0}$ limit reference point.

No recommendations were made for target reference points at this point as they will be influenced by the outcomes of this Management Objectives Workshop.

As noted, once limit and candidate target reference points have been selected, there is a need to examine how well they perform, relative to each other and to acceptable risk levels. Harvest control rules provide the implementation framework to operationalize limit and target reference points whilst accounting for risk and uncertainty, and their development and evaluation represents the next step in WCPO fisheries management (see paper for Agenda Item 4.3).

Further reading

Caddy, J.F. 1995. Reference points for fisheries management. FAO Fisheries Technical Paper No. 347, Rome, FAO. (<http://www.fao.org/docrep/003/V8400E/V8400E00.HTM>)

Sainsbury, K.J. 2008. Best Practice Reference Points for Australian Fisheries. Australian Fisheries Management Authority, Canberra, Australia, 156 pp.

UN Fish Stocks Agreement. 2002. http://www.un.org/Depts/los/convention_agreements/convention_overview_fish_stocks.htm.