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SECOND MANAGEMENT OBJECTIVES WORKSHOP

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TRADE-OFFS IN MULTI-SPECIES, MULTI-GEAR FISHERIES

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WP 4: Trade-offs in multi-species, multi-gear fisheries

Introduction and Context

WCPO fisheries are probably the most complex of multi-species, multi-gear fisheries. With the possible exception of pole and line, every gear type takes several key species and a range of bycatch. Equally, every key species is taken by a range of gear types, in some cases at different stages in their life history, across several EEZs and the high seas.

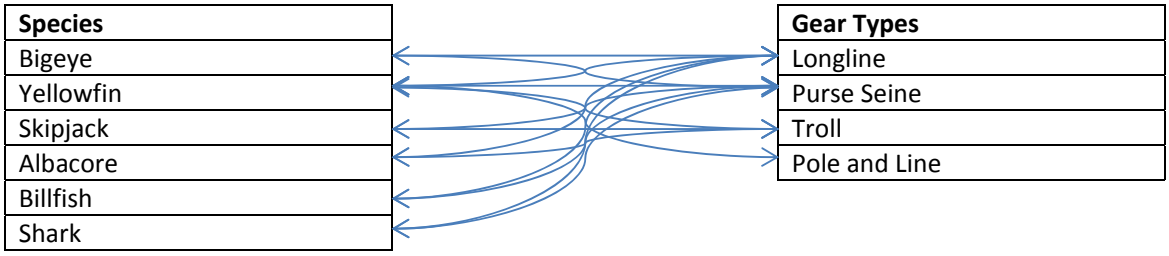

Figure 1 – Indicative gear-species interaction

While each species undoubtedly has a "dominant" gear type and vice versa, these relationships generally mean that it is impossible to manage any one part of the fishery in isolation. Efforts to remove overfishing of bigeye over the past few years have brought this issue to the forefront, but it would be a mistake to assume that this is the only case where the Commission will encounter such difficulties. For example, yellowfin plays a far more important role in the purse seine fishery than bigeye, is also a fundamental component of the long line fishery and contributes to both troll and pole and line catch.

Purpose

The MOW process has been effective so far at encouraging common understanding of key concepts of management objectives, reference points and harvest control rules. The Objectives identified in the "strawman" document provide an excellent step towards actioning some of these concepts. However, what is also required is an ability to test management measures that would achieve one objective to see how they impact on the achievement of others, including those in other fishery sectors, or related to other species.

This paper examines how the existing modelling work produced by SPC could be developed to achieve this level of examination. In doing so, it would allow the Commission to adequately recognise the trade-offs that exist between fishery sectors/species, and to make better informed decisions.

This is a theoretical exercise and it cannot be overstated that the data and modelling currently available are not sufficient to rely upon solely as the basis for decision making against the mix of objectives identified at MOW1 and since then.

In particular, some of the assumptions and practices currently used are appropriate for answering macro questions about conservation effectiveness ("How much bigeye overfishing will be removed?") but have not been developed specifically to answer more detailed flow on questions ("What will that mean for the profitability of longline fleets in different areas"). It does, however clearly illustrate the types of trade-offs that will need to be considered to achieve a given conservation and management outcome (reduction of bigeye mortality).

This paper examines differences in predicted catch, value of catch and CPUE under various combinations of associated (FAD) effort and longline bigeye catch reductions that remove bigeye overfishing. The associated effort/bigeye catch reduction combinations used follow the analysis presented in"*SC9-MI-WP-01 [Measures_eval_final] REV2"*. The aim of the analysis is to provide MOW2 with an indication of how such modelling could be used in the future to inform management decision making. This paper deals at the macro level and should not be viewed in the context of the Tropical Tuna agenda item for WCPFC 10, even though they are conceptually related.

Equally, this paper does not comment on specific management arrangements (such as whether a FAD closure is more appropriate than a FAD set measure, or how, when and by whom LL catch reductions would be implemented). Similarly, the dollar values in Table 1 are a gross over-simplification of the economic and other implications of management decisions and ignore important trade-offs and nuances, such as the distribution of value losses amongst members.

Approach

This paper uses two approaches to predict future catch, catch values and CPUE:

1. First, the predicted 2018 skipjack, yellowfin and bigeye catch and vulnerable biomasses for purse seine (FAD and free) and longline fishery generated by SPC modelling under a range of specified scenarios that are expected to remove bigeye overfishing are used (the scenarios as those detailed in *SC9-MI-WP-01 [Measures_eval_final] REV2*).

2. The SPC projections are based on 2009 and 2010 FAD closure data, which the Commission has noted is not representative of the FAD closure responses in 2011 and 2012. In addition the observed effect of changes to the effort mix on CPUE during FAD closures have indicated a greater impact on CPUE then that predicted in the SPC projection modelling. An alternative approach has therefore been developed in which free-school CPUE (and, hence, catch) is assumed to be lower. The observed relative decline in free-school CPUE observed since the introduction of the FAD closure, that is 6%[1], has been applied to the duration of the extended closure under each scenario.

Under each approach the predicted outcomes for three fishery sectors (LL, PS FAD and PS Free) are used to demonstrate the relationship between gear types and the trade-offs that the Commission must work within.

[1] Over 2004-08 3rd Quarter free-school CPUE was 24.8mt/day and over 2009-12 23.8mt/day. Over the rest of the year free-school CPUE was 25.1mt/day over 2004-08 and 25.7mt/day over 2009-12. If the same increase in CPUE was observed during the 3rd Quarter as that seen for the rest of the year free-school CPUE over 2009-12 would have been 25.3mt/day or 6.0% higher than that observed.

Indicative fishery responses to a range of scenarios

Table 1 indicates, at a macro level, the potential outcomes of 20 scenarios that have been estimated to remove 100% of bigeye overfishing under the SPC and alternative projections. A "status quo" scenario is also shown, which is *broadly* representative of 2011 conditions.

The first clear message from this table is the diversity of management actions that can achieve the same conservation outcome. At the extreme ends, a 53% FAD reduction (akin to an 8 month FAD closure) could be accompanied by a significant (19%) increase in LL catch and still achieve the same bigeye status as a 14% FAD cut (just over 4 months FAD closure) and a 80% reduction in LL catch. This highlights the importance of economic and social objectives in fisheries management because ultimately it is these factors that should guide decision making as to how conservation objectives are achieved.

Secondly, the value of catch in the longline fishery is seen to vary very dramatically according to the scenario, while in the purse seine fishery while the relative changes are not large the absolute changes are significant. For example, under the alternative approach imposing a 45% reduction in FAD effort reduced the value of the purse seine catch by just over 4% which translates into a reduction of around $134 million (under the SPC projections the amounts are 3% and $91 million dollars). There are clear distinctions in the mix of interests that each CCM has in the fishery and this has driven debate and decision making over the last few years (WCPFC-SC8-2012/ MI-WP-05). The overall value of the catch in each sector is however only one indicator that is important for CCMs to consider.

Table 1: Potential outcomes under the SPC projections and alternative model

Run	% change		Purse Seine (SPC projections)				Purse Seine (Alternative model)				Longline (BET+YFT)	
	FADs	LL Catch	FAD catch *(mt)*	Free Catch *(mt)*	Total Catch *(mt)*	Value *($mill)*	FAD catch *(mt)*	Free Catch *(mt)*	Total Catch *(mt)*	Value *($mill)*	Catch *(mt)*	Value *($mill)*
1	-53%	19%	427,043	1,226,512	1,653,555	2,999	427,043	1,197,260	1,624,303	2,946	139,602	1,355
2	-51%	14%	444,585	1,210,621	1,655,207	3,002	444,585	1,182,837	1,627,422	2,952	134,095	1,302
3	-49%	9%	462,089	1,194,715	1,656,805	3,004	462,089	1,168,372	1,630,461	2,956	128,556	1,248
4	-47%	4%	479,558	1,178,791	1,658,349	3,007	479,558	1,153,860	1,633,418	2,962	122,986	1,194
5	-45%	-1%	496,992	1,162,849	1,659,841	3,009	496,992	1,139,301	1,636,293	2,966	117,384	1,140
6	-44%	-4%	505,712	1,154,960	1,660,672	3,010	505,712	1,132,092	1,637,804	2,969	114,008	1,107
7	-42%	-9%	523,099	1,138,983	1,662,082	3,013	523,099	1,117,456	1,640,555	2,974	108,356	1,053
8	-40%	-14%	540,453	1,122,981	1,663,434	3,015	540,453	1,102,767	1,643,220	2,978	102,673	998
9	-38%	-19%	557,780	1,106,954	1,664,734	3,017	557,780	1,088,025	1,645,805	2,983	96,959	942
10	-36%	-24%	575,079	1,090,899	1,665,978	3,019	575,079	1,073,226	1,648,305	2,987	91,213	887
11	-33%	-32%	600,998	1,066,847	1,667,845	3,022	600,998	1,051,004	1,652,002	2,993	81,956	797
12	-31%	-37%	618,235	1,050,716	1,668,951	3,023	618,235	1,036,059	1,654,294	2,996	76,131	740
13	-29%	-42%	635,450	1,034,550	1,670,000	3,025	635,450	1,021,049	1,656,499	3,001	70,274	684
14	-27%	-47%	652,645	1,018,348	1,670,993	3,026	652,645	1,005,975	1,658,620	3,004	64,387	626
15	-25%	-52%	669,820	1,002,108	1,671,928	3,028	669,820	990,834	1,660,654	3,008	58,468	569
16	-22%	-60%	695,572	977,756	1,673,328	3,030	695,572	968,076	1,663,648	3,012	48,931	476
17	-20%	-65%	712,706	961,412	1,674,117	3,031	712,706	952,759	1,665,465	3,015	42,930	418
18	-18%	-70%	729,827	945,027	1,674,854	3,032	729,827	937,372	1,667,199	3,018	36,897	359
19	-16%	-75%	746,936	928,593	1,675,529	3,033	746,936	921,907	1,668,843	3,021	30,830	300
20	-14%	-80%	764,034	912,112	1,676,146	3,033	764,034	906,366	1,670,400	3,023	24,732	241
SQ	0%	0%	845,804	872,299	1,718,103	3,100	845,804	872,299	1,718,103	3,100	117,851	1,143

Evaluation of indicators

To further highlight the potential trade-offs, 4 scenarios have been selected for further assessment:

- Status quo – for comparison purposes;
- Scenario 1 because it represents the extreme of achieving both bigeye conservation and longline increases through purse seine management;
- Scenario 5 because it is indicative of a management regime with no additional longline cuts;
- Scenario 11 because it is broadly representative of the 6 month FAD closure that is being discussed and because it represents equal % reductions for FAD sets and LL catch; and
- Scenario 20 because it represents a management regime where purse seine contribution is minimised.

These 4 scenarios are examined below using fishery value, change in fishery value from status quo, and change in catch rates as indicators. Again, these results should be viewed as indicative of a theoretical *long term* outcome. Nominally, they represent a possible 2018 outcome, but in reality they are reflective of what the stock assessment model views as an *equilibrium outcome*. Given the biological characteristics of bigeye (longevity, fecundity and recruitment to the longline fishery) and skipjack (inter-annual recruitment variability) it would definitely require more than seven years for an equilibrium state to be achieved; and these outcomes would probably be more appropriately viewed in a 10-year time window. Understanding of fleet reactionary behaviour in response to changes in management is very limited at this stage. Understanding this and incorporating it in the modelling is a key action necessary going forward.

Table 2 – Additional indicators for 4 selected scenarios

	% Change in		**Absolute value** ($ mill)			**Value change (from SQ)** ($ mill)			**% CPUE change (from SQ)**		
	FAD effort	**LL Catch**	**PS**		**LL**	**PS**		**LL**	**PS**		**LL (Bigeye)**
			SPC	**Alt**		**SPC**	**Alt**		**SPC**	**Alt**	
SQ	0%	0%	3,100	3,100	1,143	0	0	0	0		0.0
1	-53%	19%	2,999	2,946	1,355	-101	-154	+214	+7.8	+5.9	+46.5
5	-45%	-1%	3,009	2,966	1,140	-91	-134	-3	+8.2	+6.6	+41.6
11	-33%	-32%	3,022	2,993	797	-78	-107	-346	+8.7	+7.7	+35.3
20	-14%	-80%	3,033	3,023	241	-67	-77	-902	+9.2	+8.8	+27.1

Each indicator is discussed below.

Fishery Value

Gross value of the fish taken is a relatively uninformative indicator by itself as:

- The value of the LL fishery is "locked" by management in that the tool used to decrease its impact is catch reductions so the value reductions shown are directly proportional to the % reductions in catch that management would be prescribing.
- The value of the purse seine fishery is so high that relatively substantial changes appear insignificant in the figure.

Nevertheless, certain macro trends are visible; primarily in terms of the substantial LL value decline as the magnitude of cuts increases. This does not take into account variations in market price as supply is restricted. For example, scenario 20 removes approximately 30,000 tonnes of premium tuna from the market place. This drop in supply would be expected to result in an increase in prices, albeit one that is unlikely to mitigate the value decline. In addition yellowfin longline catch is assumed to fall in direct proportion to bigeye under a catch reduction measure, and this is debatable.

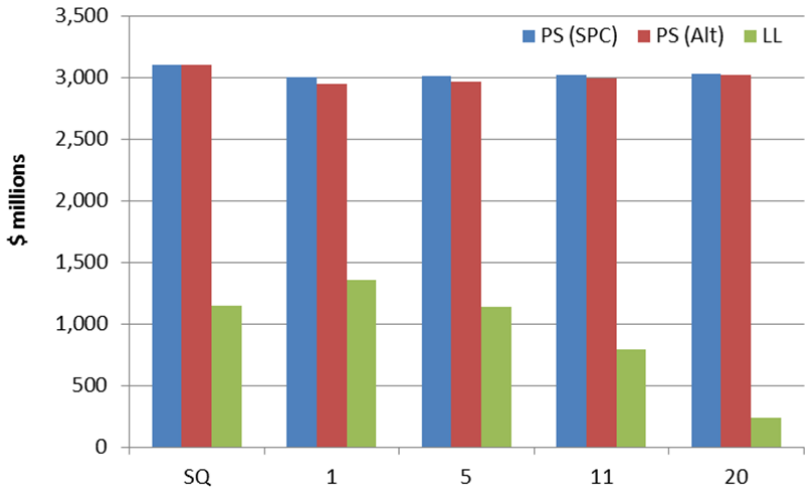

Figure 2 – Value of PS and LL fisheries under the 4 scenarios

Change in Value

Figure 3 provides a more informative view of the trade-offs in value of the different sectors. It demonstrates quite clearly the concept that there will be "winners" and "losers" from each decision and provides some basis for determining what the magnitude of those gains and losses might be.

At a general level, this type of modelling would allow the Commission to factor relativities better into decision making. For example, using the agreed objectives for a fishery, the Commission could be in a position in the future to determine what is an acceptable cost to one fishery in order to deliver a conservation outcome to another. It would then be possible to use this type of approach to identify scenarios that do not exceed this acceptable cost. Alternatively, the Commission may wish to equalise losses and gains between sectors.

Similarly, this type of information highlights the need for examining both short term and long term objectives, and whether there is a need for temporary trade-offs under certain circumstances.

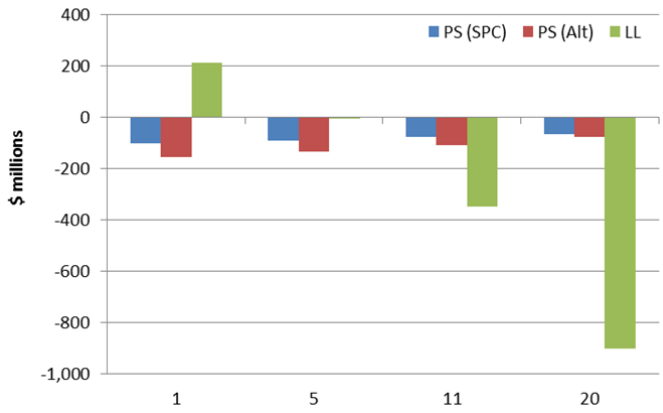

Figure 3 – Changes to the value of PS and LL fisheries under the 4 scenarios compared to the status quo

Change in CPUE

Examination of the CPUE under different scenarios is important in deciding on management regimes. This is because many of the candidate objectives already identified relate to concepts such as economic returns, profitability, efficiency and optimum utilisation. Cath rates (measured in the context of bigeye vulnerable biomass for the LL sector) are an important indicator of fishery performance and often the first available signal of the success or otherwise of a management intervention.

The projected increases in CPUE for the PS fishery result from the reduction in total effort levels (the status quo is modelled under 2011 effort levels which were around 12% higher than 2010 levels under which the various other scenarios where modelled). As can be seen, according to the modelling, effort reductions have a greater impact on PS CPUE then changes to the PS effort mix.

This type of indicator provides a useful contrast to earlier indicators such as overall value in that while under some scenarios the catch and therefore value of LL is diminished; it is accompanied by very strong efficiency increases (minimum 27%). This is important as it reduces the magnitude of financial impact.

In the wider context it is also important because under a formal harvest strategy (or even ad hoc decision making) if such a trend were observed it would be reasonable to expect the Commission to agree to increases in catch limits.

Again, these significant positive signals in the longline fishery should be viewed with caution as possible long term outcomes. It is implausible to expect this type of signal to be evident for several years, during which time the loss of value through catch cuts would be combined with continuation of current fishing conditions.

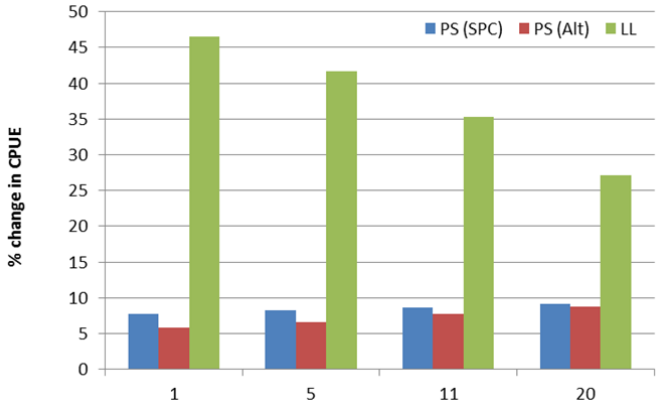

Figure 4 – Changes to the CPUE of PS and LL fisheries under the 4 scenarios compared to the status quo

Other indicators that could be used

There are numerous additional indicators that can be used to assess the relative implications of a given management scenario. These would depend on the type of fishery interactions that are to be dealt with and the specific objectives agreed upon. As examples:

- If fishery stability is an objective, stochastic projections could be used to determine the average relative variation (in catch, value, CPUE etc). The relative stability of each fishery can then be compared.
- If avoidance of impacts on other fisheries is an agreed objective then the estimated bycatch of other species under different scenarios may be used.
- The relative performance and outcome of fisheries could be assessed by EEZ or by flag to assess the Commission's progress on issues such as "islandisation", support for SIDS domestic development and avoiding disproportionate burden.

As with the selection of reference points, the indicator used to assess fishery performance and potential management outcomes must be suited to its application.

Discussion Points

This paper does not recommend adoption of a specific method, nor seek agreement on conclusions that could be drawn from the data presented. It is intended solely to commence a general discussion on the broad issue of fishery trade-offs.

Items that MOW participants may wish to discuss include:

- How current modelling approaches could be enhanced to provide more meaningful assessments of fishery trade-offs;
- The types of data and indicators that would be needed to allow better inform the Commission's decision making;
- The importance of including economic or financial assessments in the evaluation of proposals and options;
- Mechanisms for the Commission to consider trade-off evaluations to determine whether they are acceptable and if not how they can be rearranged (fisheries management forum).