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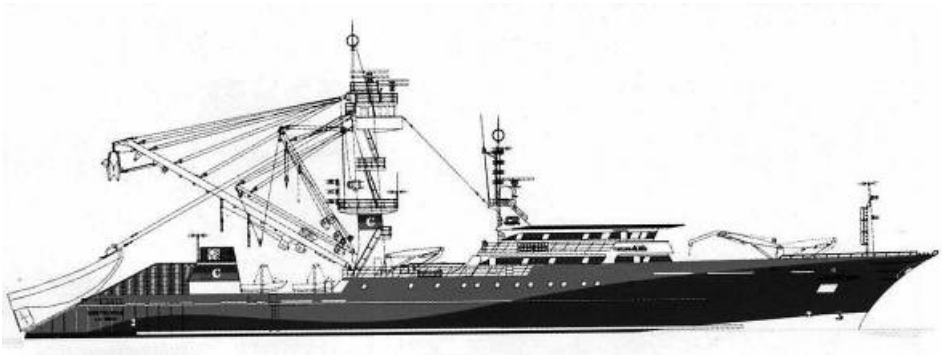
A summarization and discussion of technical options to mitigate the take of juvenile bigeye and yellowfin tuna and associated bycatch species found in association with floating objects



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1. Introduction

Considerable effort has been channeled toward the examination of management options to assure the sustainable use of fishery resources within the Commission Area. In respect to the need for management of bigeye and yellowfin tuna as suggested by recent stock assessments, efforts have concentrated on these two species and on bigeye tuna in particular. WCPFC/PrepCon/WP 24 (*Management Options for Bigeye and Yellowfin Tuna in the Western and Central Pacific Ocean*), first presented to PrepCon VI provides a comprehensive review document on management options with reference to what has been done or proposed by other regional fishery management organizations (RFMO)s, e.g. ICCAT, IATTC, IOTC and CCSBT. The document also provides comments on their feasibility with the pros and cons of various approaches.

In response to directives from PrepCon VII, the Scientific Coordinating Group (SCG), specifically SCG3 devoted a great deal of effort toward evaluating the management options outlined in WCPFC/PrepCon/WP 24.

2. Purpose

WP 24 lists several critical factors related to the implementation of management options for bigeye and yellowfin, such as: "*ease of implementation; the need for, and basis of allocation; management costs; monitoring; observer coverage; compliance; data and research needs; impact on behaviour of fishers; and impact on the economics of fishing operations*". The paper states that it does not attempt to weigh each of the management options against these factors. Instead, the paper identifies the main positive and negative characteristics of the various options to serve as a vehicle for discussion.

The work of SCG3 took a step back and examined the issue within a science-based environment, following the Convention's mandate to adopt measures to ensure long-term sustainability based on the best scientific advice available[1]. Therefore, SCG3 worked to identify the data requirements, status of data availability and the types of analyses necessary and possible given current data sources. The Report of SCG3 specifically states that. "*Implementation issues related to each management option were not considered by the SCG (these will need to be considered by the Commission*)".

It is the intention of this paper to review the proposed management options as outlined in WCPFC/PrepCon/WP 24 with additional discussion on listed options, emphasizing purse seine gear and fleets. Specifically, matters of implementation, practicality, and "likelihood of success" will be discussed in relation to realistic levels of monitoring, compliance and scientific data that may be available to the Commission in the short to medium term. Aspects of the biology and behaviour of yellowfin and bigeye tuna will also be discussed in relation to certain management options, e.g. time area closures and technical options.

[1] Convention, Part II, Article 5a, b.

3. Review of Management Options

3.1 No Controls

Considering the results of recent WCPO stock assessments for bigeye and yellowfin and the more pessimistic EPO stock assessment for bigeye tuna, the option for no controls on fishing mortality of these principal species is unsupportable within the Convention framework. However, as WCPFC/PrepCon/WP 24 suggests, the analysis for No Controls is feasible in the immediate term and should be conducted as a benchmark against the analysis of more restrictive management measures. In fact it could be argued that such analyses have already been conducted in the form of current stock assessments considering that fishing mortality of both species has increased steadily to date despite nominal efforts to limit effort and capacity in both longline and surface fisheries.

3.2 Output Controls

Output controls attempt to control effort by establishing a maximum level of catch, generally through the establishment of a total allowable catch (TAC). Typically a TAC is implemented with some form of competitive or allocated quota system.

Ideally, the setting of some form of TAC could be a simple fix to a complex problem. However, in practical terms, management by output controls has severe shortcomings for a mixed-species pelagic resource with multi-gear and multi-national characteristics as exists within the WCPFC region. The limitations and practical considerations that argue against management of WCPO tuna fisheries in the short and medium term can be summarized as:

- the need to establish and update appropriate TAC levels in a timely manner that achieve goals of sustainability and healthy stock condition;

- the need for near real-time and accurate species-specific monitoring of catch requiring close to 100% observer and port sampling coverage;

- the added incentive for fleets to high-grade and discard at sea to reserve quota for optimal size target catch;

- the added incentive for fleets to under-report or fail to report catches;

- for competitive quotas, the likelihood that a “race to fish” scenario may develop, encouraging –
  - the adoption of greater fishing power/strategies to harvest fish quickly,
  - safety considerations for vessels fishing when they should not, and
  - uneven temporal catch characteristics with negative economic impacts on the fishery and markets due to stockpiling of frozen product;

- for allocated quotas, the initial setting of reasonable and equitable quotas for each segment of the fishery is extremely difficult, time consuming and subject to the same problems of periodic adjustment and monitoring.

A fundamental constraint to the use of TACs as a management tool for the WCPO has to do with the setting and timely adjustment of appropriate TAC levels that reflect rapid adjustments by the fisheries in response to inter-annual variability in stock abundance or vulnerability. Specifically, the daunting task of establishing a TAC level carries a high degree of risk due to uncertainties that remain in the robust prediction of recruitment processes and movement.

3.3 Input Controls

Management of input controls attempts to maintain or reduce fishing effort by controlling some aspect of the fishery that contributes to total fishing effort, e.g. number/type/power of vessels, gear limitations, gear specific restrictions on fishing time/area, etc. Controls on fishing capacity is another form on input control subject to the wide variety of ways in which fishing power or capacity may be measured. Unlike Output Controls, input controls will not directly cap fishing mortality but attempts to control the rate of fishing mortality through some standardization of some aspect of effective fishing effort, and can be applied in broad or very specific terms.

WCPFC/PrepCon/WP 24 notes that input controls can fail if fishermen make unanticipated or unregulated adjustments to their vessels or fishing mode to compensate for the regulated input control. For example, fleets can move or prospect and locate other productive areas if excluded from one region, or will improve the efficiency of their vessels and operations in response to a limit on fishing days. In this respect, the efficacy of input controls need constant monitoring and adjustment to determine if management goals are being addressed.

However, Input Controls have significant advantages over Output Controls because:

- they avoid the difficulty and risk inherent in setting and allocating specific quotas;
- they are generally less costly to monitor and enforce (not always so depending on type of control); and
- they do not by nature encourage discards, high-grading or under-reporting of catches.

Input Controls can be applied broadly or to highly specific segments of a fishery. Limitations on capacity can result in creating more efficient fleets, which may work against restrictive management goals, but generally improve the overall economic health and marketing situation. The problem to utilizing Capacity as an Input Control is related to the difficulty in arriving at a suitable definition for “capacity” or even agreeing upon what is being discussed, e.g. fishing power, carrying capacity, aggregate fishing capacity, total allowable effort (TAE), effective fishing effort, etc. Also, some Input Controls can significantly impair the economic viability of some fleets, particularly for developing situations.

3.4 Technical Measures

Management of technical measures attempts to maintain or reduce effective fishing effort through more specific limitations on fishing methods, strategies and/or gear. These measures may be tailored to target a particular management issue or concern. WCPFC/PrepCon/WP 24 discussed a list of applicable technical measures which are further discussed below.

3.4.1 Gear restrictions
a) gear type, design, selectivity
i) Net size

In regard to purse seine, some discussion has centered on restricting the size or design of the purse seine net. The average length of US purse seine nets were reported to have stabilized at around 1800 m by the late 1990s (Itano 1998) while Japanese purse seiners were using slightly larger nets of around 2200 m (corkline length). The length of purse seines have likely increased to some degree, but not a great deal. However, all fleets underwent a deepening of

their nets during the establishment phase of their development. Net length is related to how large a circumference is required to efficiently circle and capture surface and floating object associated tuna schools in the WCPO.

Discussion of regulatory controls on net size have focused on net depth, due to the tendency of bigeye to frequent deeper water generally below the skipjack and yellowfin schools. However, restricting net depth has significant drawbacks in implementation and may not fully address the objective, e.g. reduction in fishing mortality of juvenile bigeye tuna. For example:

- Restrictions on net depth would require in port inspections combined with 100% observer coverage.

- Bigeye tuna undergo regular diurnal shifts in depth, particularly when in association with drifting and anchored objects (Schaefer and Fuller 2002; 2005; Josse and Bertrand 2000) making them vulnerable to shallow nets, particularly at night.

- Restrictions on time of set on drifting objects may significantly reduce catches of skipjack and yellowfin (e.g. delaying set till after sunrise) [SPC, OFP unpublished analysis).

- Reductions in net depth would likely result in significant reductions in fishing efficiency on free schools of large tuna, particularly large yellowfin.

Opnai (2002) concluded that limiting net depth was not a practical means to limit bigeye catch in the WCPO.

ii) Net design

Sorting grids have been used successfully to reduce levels of bycatch and undersize fish in some net fisheries, such as trawl and temperate water seine. The IATTC conducted trials and a development project on the use of sorting grids to reduce bigeye and undersize tuna take in the EPO purse seine fishery (Nelson 2003; 2004). Initial trials were made on captive tuna at the IATTC tuna research facility at Achotines, Panama followed with field trials on a working purse seiner. Generally, the tuna tended to avoid the sorting grids and the project has not been funded for further development. Due to the clarity of the waters in the WCPO and the relative large size of juvenile bigeye in relation to the target catch of skipjack, it is not likely that sorting grids will be a viable solution.

b) Controls on vessel efficiency

A suite of controls can be put on fishing vessel power or efficiency, such as limiting main engine size, power block size, hydraulic power, etc. Other options may be used to reduce the effective searching power of a vessel, such as eliminating helicopters, electronics or support vessels. These types of controls significantly inhibit the efficiency of vessels and come at a high economic cost that may not be supportable by the industry. While some of these restrictions may seen relatively easy to monitor through port inspections, the reality is that it would take a tremendous effort to continually monitor the thousands of port calls made and fishermen could easily find ways around the regulations. However, restrictions on the use of tender/supply vessels to assist searching and for FAD support would be easily enforced and have already been applied in some areas.

Total vessel efficiency is related to how many fishing trips can be carried out during a fishing season, which in this case is all year for WCPO tuna fisheries. The prohibition of at-sea transshipment has been quite successful in reducing vessel efficiency without undue economic cost and promotes better reporting and monitoring of fleets. Mandating a minimum

tie up period between trips is another way to reduce total fishing effort and has also been applied by regulation or voluntarily to improve market conditions.

c) FAD restrictions

WCPO purse seine fleets take almost all of their catch on free/unassociated schools or from schools found in association with floating objects (drifting natural objects, drifting FADs or anchored FADs). Restrictions on the use of floating objects for fishing operations can come in a variety of ways, e.g. banning all floating object sets, restricting FAD sets, restricting numbers of FADs deployed, etc.). These measures can be applied across all fleets or parsed within the fishery or within specific time/area strata. The design or manner in which FADs are used can also be regulated (e.g. depth of attractors, use of chum/oil, use of artificial light) but would be difficult to enforce.

The primary advantage of adopting some form of regulation on floating object sets would be a direct decrease in fishing mortality on juvenile yellowfin and bigeye as well as a significant reduction in mortality on undersize skipjack, oceanic sharks, billfish, associated fish bycatch and marine turtles. The take of these categories of target and non-target species are significantly higher on floating object sets compared to unassociated sets (Hampton and Bailey 1993).

Time/area closures could be monitored by VMS but most FAD related restrictions would require 100% observer coverage to be effective.

Limitations on the number of FADs carried or set by a purse seine vessel are problematic due to the plastic nature of FAD use. Anchored and drifting FADs are often lost or abandoned and it is nearly impossible to determine how many FADs are currently on station or active. Drifting FADs are monitored by expensive electronic equipment that can malfunction or be lost to other vessels (see Itano 2003). It is a regular occurrence in all tuna purse seine fisheries that vessels regularly utilize the FADs belonging to other vessels and cooperating vessels often leave drifting FADs out for parner vessels to use. Arrizabalaga (2001) reported that Spanish FAD tender vessels spent the majority of their time at sea either searching for the FADs/rafts of other vessels or protecting their own productive FADs from being set upon by other vessels.

d) Minimum size restrictions and mandatory retention

The removal of undersize fish from a completed set was discussed in section (a.ii) in regard to sorting grids and is not seen as a viable solution at this time. Simply not setting on undersize fish has been a regular feature of the WCPO fishery from the beginning but is dependent on the experience and also the marketing structure of the fleet in question. Some fleets can utilize very small tuna for their canneries while others have economic dis-incentives to take small fish.

It is believed that with experience, purse seine captains have been relatively successful at discriminating size of fish and even species using a combination of visual, sampling (jigging) and electronic means. However, these assumptions have not been well investigated or documented.

Scientific investigations are also underway to develop electronic means to determine size and species of fish using high definition echo sounders and sonar through a combination of vertical behavior and target strength measurements. From a practical standpoint, it is believed that experienced purse seine fishermen are already able to discriminate size and species by electronic means in combination with repeated verification from their landed catch.

e) Time/Area restrictions

The use of time/area restrictions on fishing activity holds promise as an effective means to reduce juvenile yellowfin and bigeye take, either for all fishing or specifically for floating object sets. Langley (2004) examined the main factors that influence bigeye take by purse seine drifting FAD sets in the WCPO while Molony (2004) took a broader look at catch and effort statistics of purse seiners with an emphasis on the use of FADs and a similar analysis for longline fleets (Molony 2004). However, more research is clearly needed.

Time/area restrictions can also be used to protect fish during critical life stages. Generally speaking, Pacific bigeye tuna are believed to spawn throughout the year in tropical regions, primarily within 10E - 12E of the Equator. However, the age, growth and reproductive parameters of western Pacific bigeye stocks are still not well defined and need further investigation. It appears, particularly for reproduction and maturity, regional studies will be necessary due to the unique characteristics of sea surface temperature and thermal structure existing in the western Pacific (WPRFMC 2005).

4. Problem statement

Since 2003, the Standing Committee on Tuna and Billfish has recommended that there be no further increases in fishing mortality on bigeye and yellowfin tuna in the WCPO. These recommendations were based on annual stock assessments with added precautionary emphasis made due to uncertainties in estimates of recruitment and incomplete catch and effort data from the critical Philippines/Indonesia region. Current levels of fishing mortality have even been considered to carry a high risk of overfishing of bigeye stocks.

The call for a capping or reduction in fishing mortality is for both juvenile tuna taken primarily by floating object purse seine sets and also for the adult spawning stock targeted by longline fleets.

It would appear that the most direct way to address the take of juvenile yellowfin and bigeye would be to implement some form of restriction on purse seine fishing on floating objects, both FADs and natural objects.

However, there is a current need to manage both purse seine and longline gears. Technical solutions to the management of longline fleets is highly problematic with all the difficulties already discussed (monitoring, enforcement, determination of TAC, allocation, etc.). The most direct solution to reducing effective effort may be restrictive capacity measures across both gear types.

5. Summary points

Previous papers have discussed the available options and scientific data necessary to make rational choices on appropriate management measures to reduce fishing mortality on yellowfin, bigeye and surface bycatch. This paper attempts to examine the same options identified in WCPFC/PrepCon/WP 24, adding a biological, technical and practical perspective. Current stock assessments suggest that there is an immediate need to prioritize these options with all these criteria, combined with some notion of their likelihood of success in achieving the desired result and their successful implementation.

The issues are now relevant to both purse seine and longline fleets in the Commission Area, but with a current priority on the equatorial regions corresponding to MULTIFAN Areas 2 and 3. These areas not only represent the bulk of the fisheries and landings but also represent the core of the active spawning stock for both yellowfin and bigeye tuna in the WCPO.

Time/area closures may represent one of the more viable solutions in relation to achieving the desired result with reasonable expectation of enforceability using vessel monitoring systems. However, allocation of areas is contentious. However, large blocks of high seas exist in the core of the region that should be examined as possible starting points.

WCPFC/PrepCon/WP 24 states *"…the IOTC's Scientific Committee identified time/area closures of fishing grounds to fishing on floating objects as the best option to reduce catches of small bigeye tuna by purse seine vessel"* (ref IOTC 1999). The paper continues to note that the IATTC was not able to identify discrete areas and times for which it was possible to predict unusually high catches of small tuna, and has therefore moved toward time/area closures for all purse seine activity that is more easily enforced.

The root of the problem likely lies in issues of total capacity or overcapacity in both the longline and purse seine segments of the fishery (see GN IP-7: FT IP-5 from this meeting). Some measure of capacity or fishing power needs to be established upon which capacity issues can be based. The IATTC has adopted cubic meters of hold space as their standard measure of capacity, noting that it is a measurable quantity that in combination with refrigeration method will define the length of fishing trips and total amount of fish harvested over time. Gillett and Lewis (2004) in an examination of fishing capacity in WCPO purse seine fleets that fish hold capacity was the only proxy for fishing capacity currently available but its utility was significantly impacted by incomplete or old data.

Dealing with the problem retro-actively will be a difficult and painful process but needs to be confronted in the short and medium term. However, reductions in effort need to be balanced against the needs and desires of developing states toward nationalization of their own harvesting and processing sectors.

6. Recommendations

Unless regularly monitored and adjusted for increasing effective fishing effort, simple input controls such as a blanket limitation on numbers of fishing vessels are not an effective management strategy. For example, the Palau Arrangement allowing a maximum of 205 large purse seine vessels to operate in the region has been a reasonable means to allocate the fishery and adjust for new entrants but has not been an effective means to control fishing mortality. Some reasonable combination of Input Controls and Technical Measures focused on FADs (to include all floating object sets) may provide the best solution given current levels of scientific knowledge, data availability, monitoring and enforcement.

In order to facilitate the management of yellowfin and bigeye within the Commission Area, there is a strong need for:

- a standardized measure of capacity for large fishing vessels and means to collect/verify it;
- the collection of appropriate operational details from purse seine (i.e. FAD designs, fishing modes, vessel and gear attributes that contribute to higher targeting/bycatch) and longline fleets (i.e. information to better define horizontal and vertical targeting);
- greatly strengthening monitoring and enforcement capacities;
- integrated habitat-based modeling to better position management options;
- improved knowledge of size and species specific behavior and discrimination of FAD associated target and bycatch species; and
- the identification of appropriate levels of effort for the region and a long-term plan to rationalize current capacity levels accordingly.

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