Scientific Report on Effort Reduction Measures in the Western and Central Pacific Ocean Tuna Fishery

GREENPEACE AUSTRALIA PACIFIC

Executive Summary

As a result of growing concerns about the sustainability of fishing activities directed at Western and Central Pacific Ocean (WCPO) tuna stocks, Greenpeace has commissioned an analysis of the commercially exploited species in the region managed under the aegis of the Western and Central Pacific Fisheries Commission (WCPFC). Based on the latest information, it appears that while Skipjack tuna is being fished at a moderate level, both Bigeye and Yellowfin tuna are now being overfished. Catch levels of these two species are, therefore, not sustainable. These conclusions are based on the use of what are essentially conventional fisheries models that use the concept of Maximum Sustainable Yield (MSY) to define management targets.

Even under the current management paradigm, it is clear that reductions in fishing efforts to bring fishing mortality to a level consistent with MSY, are necessary. To prevent a further decline in Yellowfin and Bigeye tuna in the WCPO, effort reductions of the order of at least 20% would be required. Long-term average catch levels consistent with F_{MSY} would be less than 70% of present levels (2001-2003 average) for both species. Substantial uncertainties,

however, exist in the stock estimates and in estimates of the species' biological parameters. In addition, substantial uncertainties are attached to the monitoring of landed catch and to the accuracy of the reported figures. Illegal, Unreported and Unregulated (IUU) fishing activities also compromise the quality of data relevant to the management of the tuna fisheries in the WCPO.

Accordingly, in order that these fisheries are managed on a precautionary basis, and with due regard to the overall ecosystem, Greenpeace takes the view that effort reductions of 50% would be desirable. This would imply the use of F_{MSY} as a limit to be scrupulously avoided rather than one to be routinely exceeded in these fisheries. In addition, Greenpeace is proposing that a network of marine reserves should be established in the region which would significantly strengthen management of WCPO tuna stocks and facilitate wider environmental management in the region.

Hence, Greenpeace proposes:

(1) The immediate establishment of a marine reserve in an enclosed high seas area bound by Palau, FSM, PNG and Indonesia, and a commitment to establishing a second fully-protected marine reserve to the east in the future.

(2) Establishment of management objectives of the WCPO fishery, based initially on Annex 2 of the UN Fish Stocks Agreement.

(3) An immediate moratorium on the construction of new large Purse Seine (Super Seiner & Super Super Seiner) and large Longline vessels intended to fish in the WCPO, and controls on the relocation/deployment of such vessels from other areas.

(4) The WCPFC undertakes a study of the capacity of large Purse Seine and Longline vessels active in the WCPO, leading in the short term to the introduction of overall limits on vessel numbers. Also, development of a suitable measure of capacity (Purse Seine and Longline) to facilitate the orderly management of fleet capacity in the WCPO, including clear definition of vessel categories e.g. "large scale". From a conventional fisheries perspective, this study is critical to determining the level of capacity available in the region and more importantly what "capacity" the region's fish stocks can sustain. From Greenpeace's perspective, however, we take the view that Super Super Seiners should not be allowed to operate in the region given their huge capacity.

(5) Large uncertainties are inherent in the models used to produce assessments and forecasts for tuna fisheries in the WCPO. These relate to input data quality together with substantial indeterminacies in data relating to effort, catch and IUU fishing, as well as to factors such as recruitment and the influence of climate change. Greenpeace believes that basing management upon MSY target reference points is not sufficiently precautionary. Accordingly, Greenpeace regards the 20% effort reduction

figure suggested from modeling as an absolute bare minimum requirement. To assure future sustainability of fisheries in the region this figure should be set at 50%.

(6) The WCPFC should apply a Longline Total Allowable Catch (TAC) for Bigeye, based on lower catch levels from an earlier time period, with allocations/quotas for countries or entities taking a large amount of catch (e.g. more than 3,000t). The restriction of catches by other nations to catches at that earlier time should also be enforced. This measure should be introduced in conjunction with a trade certification/verification system for Bigeye, as used by other Regional Fisheries Management Organisations (RFMOs).

(7) Immediate prohibition of at-sea transhipment, with such transhipment to occur only at designated ports, as provided for in the Convention and to be implemented by the Commission.

(8) Implementation of the following series of measures to reduce IUU fishing in the WCPO, as proposed by Greenpeace: ratify and implement the Compliance and Fish Stocks Agreements; exert control over port access and marketing of tuna products (trade verification); strengthen the WCPFC capacity to take action (regional and global vessel registries, IUU vessel blacklist, reduce size of vessels covered by Monitoring, Control and Surveillance (MCS) regulation, boarding and inspection regulations, prohibition of at-sea transhipment);practice good governance at national level (comprehensive

management plans, appropriate legislation enforced); inspect and arrest IUU stateless vessels (national-level action).

(9) That the Commission commence work on the development of criteria for the allocation of TAC and Total Allowable Effort (TAE), as provided for by the Convention.

(10) Additional research must be carried out to reduce uncertainty and indeterminacy attached to key parameters/assumptions and model structure of the present MULTIFAN-CL models.

1. Introduction

The WCPO extends east from the coasts of Asia. It is home to over 20 island nations and coastal states supporting the world's largest tuna fishery. Around 50% of the global production of the main market species of tuna comes from this region, and it has often been referred to as the last great under-exploited oceanic fishery. This may have been the case until the end of the last decade with annual catches of around 1.6 million tonnes. There are increasingly clear signs, however, that this can no longer be assumed. The estimated total catch[1,2] has increased by nearly 50% since 1990, and the estimated 2004 catch of 2.022 million tonnes was the highest ever recorded. Stocks of Skipjack tuna, (the mainstay of the fishery comprising 65% of the overall

catch tonnage), are considered to be in good condition. There are increasing concerns, however, about stocks of Yellowfin and Bigeye tuna, which account for 24% and 5% of the total catch respectively, but represent nearly half the landed value of the total catch. Connected with these concerns are the concerns attached to suspected increases in IUU fishing throughout the fishery sector in question.

The Standing Committee on Tuna and Billfish, which provides consensus scientific information on the status of tuna stocks in the region, has been advising for some years that stocks of Bigeye tuna were being heavily fished. Since 2003, the advice has been that this species was probably being overfished, but, due to some fortuitous recent high recruitment into the population, was not yet in an overfished state. Similarly, Yellowfin tuna stocks have been regarded as close to fully exploited for some time, and since 2003 the consensus has been that this species is possibly being overfished.

Despite these concerns, the WCPO fishery, has in effect, been left unregulated. Until 2004 no RFMO existed. With the entry into force of the WCPF Convention on June 19th 2004, and the first meeting of the WCPF Commission held in December 2004, there now exists a framework for the conservation and management of the stocks (tuna and other species) which are exploited in the region. There is now an urgent need to consolidate this framework and recognize the urgent need to formulate and adopt appropriate conservation and management measures.

The sustainability of WCPO fish stocks, which can be regarded as “at risk”, must be assured through an appropriate, precautionary and ecosystem based approach to their management.

This report evaluates measures for the conservation and management of the WCPO tuna fisheries, addressing issues raised in a recent Greenpeace position paper submitted for consideration by the WCPFC[3]. These measures primarily involve recommendations for effort reduction, which are the management instruments which have, historically, been most often applied to the management of tuna fisheries in other regions. The impacts of IUU fishing on the stocks and the possible application of marine reserves to the WCPO tuna fishery are also considered as part of the suite of measures which could be considered. There is, however, no discussion of non-target, associated or dependent (NTAD) species, nor of ecosystem-based management. However, any reduction in efforts might be expected to lead directly to reduced impact of fishing on the ecosystem overall, both on the target and the NTAD species. Benefits could be expected to accrue to the WCPO epipelagic ecosystem as a whole and the emplaced measures could be used as the basis on which to ultimately define and formulate an ecosystem based management approach.

2. Fishery Overview

2.1 The WCPO tuna fishery[1]

The WCPO tuna fishery operates over a vast area stretching from the coasts of Asia to 150^0W, and from 50^0N to around 40^0S. Within the Convention area (WCP-CA – see Figure 1), EEZs of coastal states occupy much of the equatorial area (10^0N to 10^0S), whereas high seas predominate in subtropical areas, especially north of the Equator. It is a very diverse fishery. On the one hand, it involves large international fleets plying the high seas and the EEZs of numerous coastal states. On the other hand, artisanal and small-scale commercial fisheries supply the large populations of Indonesia, the Philippines, and the less populous Pacific Islands. The majority of the catch[2] (considered by weight) is taken in tropical areas, with a high proportion of the Purse Seine catch taken in the waters of the Parties to the Nauru Agreement (PNA)[3] group.

---

[1] Most of the information in this review is taken from papers[1][2] presented at the recent Scientific Committee meeting in Noumea, August 2005

[2] All catch estimates given refer to the WCP Convention Area and thus will differ from previous estimates which referred to the WCPO, mostly with respect to Longline catches.

[3] Members of the PNA group are PNG, Solomon Islands, Palau, FSM, Kiribati, RMI, Nauru and Tuvalu.

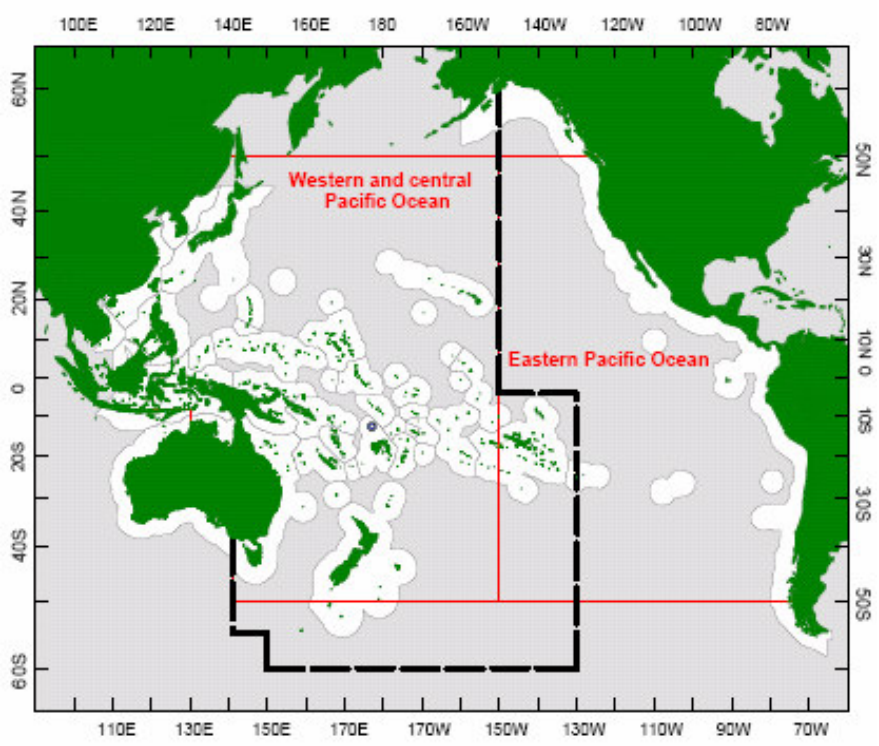


Figure 1
The Western and Central Pacific Ocean (WCPO), with the Eastern Pacific Ocean (EPO) and the WCPFC Convention Area (WCP-CA) in dashed lines

The provisional total catch[4] in 2004 was 2,021,773 tonnes (t), a record catch, but nonetheless likely to be an underestimate (see later). This represents 51% of the global catch of the main market species of tuna, and 78% of the Pacific Ocean tuna catch. The total catch rose steadily from the early 1980s onwards, with the advent of large-scale Purse Seine fishing. Catches reached a relatively stable plateau in 1998. Since then catches have been around 2 million tonnes per annum. A record (albeit provisional) catch of 1,376,670t of Skipjack was taken in 2004. This represented 68% of the provisional total tuna catch in this year with Yellowfin 20% (413,201 t), Bigeye

[4] This total includes only the primary market tuna species (Skipjack, yellowfin, bigeye, and Albacore) and not other scombrids (eg frigate and bullet tunas), billfish and a range of by-catch species, including sharks, which are taken in tuna fisheries

6% (125,940t) and Albacore 5% (105,962t) making up the balance of the total (Appendix 1-3).

Although a multi-gear fishery, the majority of the catch is taken by Purse Seine (62%, and 1,263,161t in 2004), with pole-and-line taking 15% (297,515t) and Longline 11% (225,786t). The remainder (11%) was taken by a variety of artisanal gear, mostly in eastern Indonesia and Philippines, and through a small troll catch (Appendix 1-3).

The *Purse Seine* fishery operates primarily in equatorial waters, between 10^0N and 10^0S. There is a seasonal fishery in the home waters of Japan. Over 200 large vessels exploit this fishery. The fleet is made up of vessels from Distant Water Fishing Nations (DWFN) namely Japan, Korea, Taiwan and the USA. Together with Pacific Islands-based and Philippines vessels, these take the majority of the catch in PNA waters. In addition, small (< 250 GT) and large Purse Seine vessels are responsible for incompletely reported catches in Indonesian, Philippine and high seas.

The industry targets free (unassociated) schools of fish and fish schools associated with floating logs, and with artificial Fish Aggregation Devices (FADs). These deployed devices are either anchored or allowed to drift. The spatial distribution of the target fish, and hence of effort and catch, is influenced by large-scale oceanographic (ENSO) events. Catches are made further east in the equatorial WCPO in El Niño years.

Skipjack tuna dominate the Purse Seine catch, typically making up 70-75% of the catch, with Yellowfin 20-25%, and Bigeye < 5%. It is generally considered uneconomic for large Purse Seine vessels operating in the Convention Area to fish exclusively in the limited area of high seas in the equatorial zone, and DWFN fleets rely on agreements with Pacific Island states to allow access to tuna within EEZs.

The *Longline* fishery involves a variety of vessels. Large distant water freezer vessels operate widely throughout the region. Smaller offshore vessels operate in tropical waters and in the waters of sub-tropical Pacific Islands and are often domestically-based. They may land fresh or chilled fish. These vessels and the small handline vessels working around Indonesia, the Philippines and Vietnam, all take large adult fish. The overall Longline catch in 2004 consisted of similar proportions of Bigeye (37%), Yellowfin (31%) and Albacore (30%). Bigeye and Yellowfin were taken mostly in tropical areas, and Albacore in more temperate waters. The number of Longline vessels operating in the WCPO is uncertain, but probably exceeds 5,000 distant water and offshore vessels, plus 2,500 or more handliners in the Philippines. An unknown number of handliners operates in Indonesian waters, together with an unspecified number of both small and large Longline/handline vessels in Vietnam. Unlike the large-vessel Purse Seine fleet, a number of these vessels operate primarily on the high seas, especially in southern waters. Here, they target Albacore, and to the north and east of the region, Bigeye tuna are targeted.

The *pole-and-line fishery* involves large domestic/offshore fleets in Indonesia and Japan together with a distant water Japanese fleet. Smaller fleets exist in Pacific Island countries. Skipjack comprises over 80% of the catch (> 90% of the catch in tropical waters), Albacore accounts for around 12%, (mostly taken in waters east of Japan), with Yellowfin comprising around 4%. A small quantity of Bigeye is taken by the pole-and-line fleets.

2.2 WCPO Yellowfin

Yellowfin tuna of the WCPO are assumed to be a single stock for management purposes but are regarded as distinct from the Eastern Pacific Ocean (EPO) stock. Growing to over 200kg, Yellowfin school at the surface, together with Skipjack and Bigeye, as juveniles. They then spend progressively more time in midwater as they grow towards adult size and progressively develop a swim bladder. They remain fish of the upper mixed layer of the ocean (epipelagic). ENSO events are known to influence their vertical distribution and accordingly, their vulnerability to Purse Seine gear. They reach maturity at around 20kg, and Yellowfin are taken by both surface gear (Purse Seine) and by longlining as adult fish. The majority of the Yellowfin catch (413,201t in 2004) is taken in western equatorial areas, with Purse Seine catches accounting for 43% of the total (in both associated and unassociated sets). Longlining accounts for 17% of the catch, and pole-and-line around 3%. The remainder (a very large 37%) is

accounted for by assorted gear such as ring net, handline and gillnet in the domestic fisheries of the Philippines and Indonesia. The total catch in the WCPO has been relatively stable since 1997 at between 410,000t and 470,000t, although the Purse Seine catch has been declining in recent years.

The size distribution of the catch by the various gear, based on regional port sampling programs, is shown in Appendix Figure 1. The Philippines and Indonesian fisheries account for the majority of the juvenile catch (< 60cm LCF[5], or 5kg). These take adult (> 100 cm LCF or > 20kg) fish in the handline fisheries. Purse Seine sets on schools associated with floating logs and deployed FADs (anchored or drifting) and account for a significant juvenile catch, as well as some adult fish. The Longline catch consists almost entirely of adult fish, taken in tropical areas. There are difficulties in separating the quantities of juvenile Yellowfin and Bigeye taken by Purse Seine gear. This leads to some uncertainties in catch estimates for both species.

There is some evidence of ENSO influences on Yellowfin recruitment which is subsequently reflected in surface and Longline catch levels. There is evidence of decadal-scale variation in the productivity of the stock.

[5] fork length (length to the caudal fork)

2.3 WCPO Bigeye

Bigeye tuna can reach over 200kg size. They school with Skipjack and Yellowfin tuna in equatorial waters as juveniles. As adults this association is less marked and their distribution is governed by physical factors: they become more closely associated with the thermocline and cooler water. It is uncertain whether Pacific Bigeye tuna can be regarded as a single basin-wide stock for management purposes[6], or whether they should be managed as separate western and eastern stocks, as is done for Yellowfin and Skipjack. Bigeye attain maturity at around 25kg (110cm), and as adults, are caught primarily by Longline gear. The catch is taken mostly in an equatorial band across the Pacific Ocean, that dips southwards in the EPO. The WCPO Bigeye catch in 2004 (125,940t) was the second highest on record, with 65% of this taken by Longline, 21% by Purse Seine (nearly all in associated sets, particularly on drifting FADs). Relatively little is taken by pole-and-line and other gear. The total catch of Bigeye in the WCPO has been relatively stable since 1997, but the balance attributable to specific gear has changed. Purse Seine catches have declined and Longline catches have increased. In the EPO, catches have been declining since 2000 (total catch 106,679t in 2004), with Longline catches showing the greatest decline (39,729t, from an historical high of 104,000t in 1991) (Appendix 1-3).

[6] genetic studies show little evidence of differentiation, and there some examples of almost basin-wide tagged fish movements over long periods; both basin-wide and separate WCPO/EPO stock assessments are usually undertaken, given this uncertainty .

The size distribution of the catch by various gear is shown in Appendix Figure 2. Once again the Philippines and Indonesian fisheries account for most of the small (<50cm) fish taken. Associated Purse Seine sets account for the greater proportion of catches of sub-adult (50-100cm) Bigeye. Longliners account for most of the catch of adult fish. There is considerable uncertainty about the catch of juvenile Bigeye. This figure can only be estimated on the basis of sampling carried out on the catches of several fleets using different gear.

2.4 WCPO Skipjack

The Skipjack tuna resource in the Pacific, in common with Yellowfin, is assumed to consist of two Pacific stocks, in the WCPO and EPO respectively. Skipjack, which do not usually exceed10kg, are schooling species of the upper mixed layer at all sizes. They are susceptible to ENSO influences on their distribution in equatorial areas. The 2004 provisional catch was the highest ever, at 1,376,670t, with surface gear - Purse Seine (78%) and pole-and-line (18%) - accounting for virtually all of the catch. Most of the catch is taken in equatorial areas across the WCPO, except for those taken in a seasonal fishery in Japanese waters (Appendix 1-3). As with the other species, much of the juvenile catch (< 45 cm) is taken in the Indonesian and Philippine fisheries. Skipjack are taken equally in associated and unassociated Purse Seine sets. As with the other two species of tuna, there is

evidence of ENSO impacts on recruitment. Recent levels of recruitment into the fishery have been high.

2.5 WCPO Albacore

Albacore are managed as two stocks, those north and south of the equator, respectively. The greater part of the overall catch (80-90%) is taken in the WCPO in both hemispheres. The balance is taken in the EPO. Recent South Pacific Albacore catches (~ 62,000t) has been the highest on record, largely as a result of the continued development of Pacific Island domestic Longline fisheries. The reported 2004 catch was slightly down on 2002-2003 levels. Longlining accounts for the great majority of the South Pacific catch (72%), and this is mostly taken in sub-tropical and temperate areas beyond Latitude 10^0S. A recent Resolution from the RFMO responsible for the northern Albacore stock the Inter American Tropical Tuna Commission (IATTC), R[7] calls for the need to avoid any increase in fishing mortality on this fully exploited stock. The resolution recognizes that management cooperation with the WCPFC will be necessary. The southern Albacore stock is regarded as only moderately exploited, although there are signs that the biomass available to Longline fishing has declined in some areas to the point where economic overfishing may be occurring.

[7] IATTC Resolution on Northern Albacore Tuna (C-05-02)

Albacore will not be further considered in this report as they are generally beyond the terms of reference of the present study.
The table below (Table 1) summarizes the main features of the fishery for each species.

Table 1. Summary of tuna fishery characteristics, by species

Abbreviations: WEP Western Equatorial Pacific, CEP Central Equatorial Pacific, STSP Sub-Tropical South Pacific, STNP Sub-Tropical North Pacific; U = Unassociated set, A = Associated set, T = Troll gear

	Total catch 2004 (est)	**Main area fished**	**Purse Seine % of catch, set type**	**Longline % of catch**	**Pole & line % of catch**	**Other gear % of catch**
Yellowfin	407,509	WEP	**44 -**U, A	17	3	**36**
Bigeye	116,259	WEP/CEP	21 - A	**65**	1.5	12.5
Skipjack	1,369,818	WEP/CEP	**78 -**U, A	<1	18	4
SP Albacore	56,740	STSP	~ 0	92	~ 0	8 –T
NP Albacore	90,348	STNP	~ 0	28	39	29 - T

2.6 Other species in the WCPO tuna fishery

A range of non-target (by-catch or incidental species) is taken in tuna fisheries, and their estimated catch levels have been recently reviewed for the Commission.[4] By-catch levels are generally highest in the Longline fishery, low to moderate in associated sets by the Purse Seine fishery, and lowest in the pole-and-line fishery and unassociated sets by the Purse Seine fishery.

Further consideration of these non-target species is beyond the scope of this study, but their management has been the subject of resolutions by other RFMOs. Assessment of the impact of fishing on the stocks of non-target, associated or dependent species is, *inter alia*, one of the conservation and management principles of the Convention (Art. 5(d)). Hopefully, early steps will be taken at the Commission to introduce resolutions dealing with sensitive by-catch and other species, including turtles, seabirds and sharks.

3. Stock assessments - analyses over the last 5 years

The current basis of tuna fisheries management in the WCPO is an integrated length-based age-structured model, MULTIFAN-CL, has been developed and used by the Oceanic Fisheries Program of the Secretariat of the Pacific Community (OFP-SPC) since the early 1990s.

Initially, applied to South Pacific Albacore, it was subsequently applied to Yellowfin tuna in 1999, to Skipjack tuna in 2000 and to Bigeye tuna in 2000. Although production models, tag-based attrition models and other approaches have been applied in the past, this data-intensive model is considered robust and is now routinely applied to WCPO stock assessments. The model has an integrated spatial structure (based largely on results of earlier tagging experiments), is able to test various assumptions (e.g. measures of abundance, Longline effort weighting, etc) and can be used to calculate a range of the reference points commonly used in tuna management.

Results of MF-CL assessments are normally updated annually to incorporate additional data and accommodate any adjustments to the model structure. The results have been presented to the Standing Committee on Tuna and Billfish (SCTB) since 1992. The results were communicated to the Scientific Coordinating Group of the Preparatory Conference until Prep Con 7 in December 2004. In August 2005 the results were presented at the first meeting of the WCPFC Scientific Committee. These assessments constitute the primary basis of scientific advice on tuna stocks to the Commission. The results from the assessments for Yellowfin and Bigeye tuna over the last five years are tabulated below. The recommendations for the management of these species derived from assessments of the past five years are summarized.

3.1 Yellowfin tuna

According to assessments presented in the years 2001 to 2004 inclusive, the Yellowfin stock was believed to be neither overfished (as described by $F_{current} < F_{MSY,}$ in the range 0.6 –1.1) nor in an overfished state (as described by $B_{current} > B_{MSY}$, in the range 1.5-2-5). Nonetheless, it was recognized that the stock was nearing full exploitation. Indeed, equatorial areas were regarded as fully exploited. Biomass declines of around 50% in these areas (cf. 35% overall for the WCPO) were attributable to fishing. (Appendix 1-3). It was considered that any increases in fishing mortality would be unlikely to result in any long-term increase in yield and could move the stock to an overfished state. Given indications, moreover, of a shift to a lower productivity regime in the WCPO serious concerns arose that current catches (at near record levels) might not be sustainable. Successive SCTBs, therefore, recommended that there be no further increases in fishing mortality, especially on juvenile Yellowfin.

Year	Status	Other indicators	Recommendations
2001 (14th SCTB, 2000 data)	At least moderately exploited; not over-fished or in overfished state	Impact of fishing has led to 35% reduction in biomass (greater in equatorial Pacific)	No further increases in F (particularly on juveniles); closely monitor stock condition
2002 (15th SCTB 2001 data)	Likely to be nearing full exploitation; not over-fished or in overfished state; catches may not be sustainable if shift to lower productivity regime	Impact of fishing has led to 35% reduction in biomass (greater in tropical areas)	Reiterate no further increases in F (particularly on juveniles);closely monitor stock condition
2003 (16th SCTB2002 data)	Not over-fished nor in an overfished state; catches may not be sustainable if shift to lower productivity regime		Reiterate no further increases in F (particularly on juveniles)
2004 (17th SCTB 2003 data)	Not being over-fished nor in an overfished state; nearing full exploitation	Biomass reduction of 20-35% (but around 50% in tropical regions)	Reiterate no further increases in F (particularly on juveniles;
2005 (1st SC, 2004 data)	**Overfished** but not in overfished state	Equatorial regions heavily impacted by fishing; urgent management action may be required	$F_{current}$ must be reduced for sustainable stock levels

Source: 14th, 15th, 16th and 17th SCTB summary statements; 1st Scientific Committee (SC) record

The 2005 assessment incorporated several adjustments to the model. These included changed weighting factors for Longline Catch per unit of effort (CPUEs), and redefinition of the model regions to give six areas. It was considerably less optimistic then previous assessments. It strongly indicated that overfishing was now likely to be occurring (as described by $F_{current} > F_{MSY,}$ 1.0-1.89, base case 1.22). Although the stock appeared at this stage not to be in an overfished state, (as defined by $B_{current} > B_{MSY}$, 0.93-1.55, base case 1.32) the assessment made it clear that the current total catches were unlikely to be sustainable in the medium to long term (10 years). In short, catches at these levels will continue to reduce the total biomass of the stock. Hence, long-term maximum sustainable yields from the fishery are estimated to be around 270,000t. This is very much lower than the recent reported catches in excess of 400,000t. The assessment suggested that the Longline fishery had a relatively low impact on the stock. The greatest impacts were attributable to surface fisheries, especially those in equatorial areas of the Indonesian and the Philippine fisheries. As noted earlier, juvenile and sub-adult Yellowfin are taken in both associated and unassociated sets in these fisheries.

3.2 Bigeye tuna

The picture that emerged from early assessments of Bigeye were characterized by a high degree of uncertainty, considered both Pacific-wide and in the more restricted WCPO region. Even so, by 2004 the assessments were clearly indicating a high risk of overfishing (described by $F_{current} \sim F_{MSY}$, 0.89-1.02), although the stock was not considered at that stage to be in an overfished state (as described by $B_{current} > B_{MSY}$, 1.75-2.28). In addition recent recruitment of this species in the WCPO had been high. The assessment noted that if there was a return this was to return to long term average or lower levels of recruitment, current catches could not be maintained.

By contrast, the EPO situation for Bigeye was somewhat more severe. The stock was considered to be both overfished and in an overfished state. Accordingly, management measures were implemented for the Longline fishery by IATTC in 2004, and even earlier for catches of juvenile Bigeye by Purse Seine operations.

Assessment	Stock Status	Other issues	Recommendations
2001 (14th SCTB 2000 data)	Uncertain; moderate impact on stock.	Declining biomass, recent low recruitment	Develop reliable assessments; no further increases in F on surface fisheries until uncertainty resolved
2002 (15th SCTB 2001 data)	Uncertain but nearing full exploitation; not being overfished or in an overfished state		No further increases in F on juveniles
2003 (16th SCTB 2002 data)	Uncertain; overfishing occurring, but not in an overfished state		No further increases in F on Bigeye tuna (all sizes)
2004 (17th SCTB 2003 data)	Close to overfished, but not in an overfished state	Recent recruitment above average	No further increases in F on Bigeye tuna (all sizes); decrease in total catch may be needed
2005 (2004 data, 1st SC)	Overfishing occurring but not in an overfished state	Equatorial regions heavily impacted by fishing; urgent management action may be required	$F_{current}$ to be reduced; if recruitment returns to long term average levels, a further reduction in catch and effort is likely to be required to maintain the stock at sustainable levels

Source: 14th, 15th, 16th and 17th SCTB summary statements; 1st Scientific Committee (SC) record

Following redefinition of areas used in the modeling assessments, changes in Longline abundance indices and effort standardization, the 2005 assessment took the view that overfishing of Bigeye was in fact occurring. ($F_{current} > F_{MSY}$, 0.90-1.45, base case 1.23). The stock was not thought to be in an overfished state ($B_{current} > B_{MSY}$, 1.06-1.48, base case 1.25). Both reference points showed some decline relative to the 2004 values. The assessment made it clear that if current F levels are maintained, however, this will move the stock to an overfished state. This would become even more likely if current high recruitment levels return long-term average levels or below. MSY values based on recent and long-term average recruitment are of the order of 90–100,000t and 65,000t respectively, considerably lower than the present catch level of around 115,000t.

3.3 Skipjack tuna

Skipjack assessments continue to conclude that Skipjack is currently exploited at a moderate level relative to its biological potential. The stock is neither being over-fished nor in an over-fished state. Biomass levels in this short-lived, high natural mortality species are largely driven by recruitment, and assessments suggest that environmentally driven variation in recruitment will be the main influence on stock size and fishery performance. Recruitment levels appear to be very high, as has been the case for Yellowfin and Bigeye tuna.

While the biological status of the fishery may be relatively healthy, initial bioeconomic modeling indicates that reductions in effort, while reducing catch, would result in economic gains and increased profitability. This would result largely from increased catch rates for Purse Seiners. In addition, other benefits would be likely to accrue in the form of potentially increased recruitment of Yellowfin and Bigeye to the Longline fishery. Conversely, it should be noted that, as the Purse Seine fishery is a multi-species one, any increase in the Purse Seine Skipjack catch would result in increases in Yellowfin (and to a lesser extent, Bigeye) catch, as there is currently no fishing technique to enable fully effective Skipjack targeting, to the exclusion of the other species.

3.4 Overview

The assessments of the status of Yellowfin and Bigeye tuna in the WCPO have grown increasingly more pessimistic over the period 2001 to 2005. It is now thought that both Yellowfin and Bigeye tuna are being overfished according to output from the MF-CL model used. Some important points emerge from these assessments. Firstly, the identification of over-fishing of the stocks has resulted from refinement of the models used rather than from any obvious changes identified in fishing operations. Secondly, the fisheries of all species appear to be sustained by recent high levels of recruitment into the populations. Hence, it would be prudent to assume that resolution of further uncertainties and indeterminacies in the data used to inform the models may bring further

unwelcome findings and suggestions. Under such conditions, management under a precautionary paradigm should be implemented urgently. Thirdly, the ecological drivers and constraints on the target populations need to be taken fully into account. This should include recognition that to a certain extent the fisheries overlap by gear type and region and are essentially mixed species fisheries. This implies that these fisheries need to be subject to an ecosystem-based management regime in order to achieve true sustainability. Currently, however, the management options that have been proposed fall well short of what is necessary to assure true long-term sustainability in these fisheries. The following sections of the report outline some of the suggestions that have been made to date and articulate the views of Greenpeace on what will constitute an effective approach.

4. Conventional Management Options for Yellowfin and Bigeye Tuna

At the request of the 5th Preparatory Conference, an information paper[5] was prepared by the Interim Secretariat on *"management options …on how the Commission could respond to sustainability concerns in respect of Yellowfin and Bigeye*". This report was submitted to the 6th Preparatory Conference in Bali in April 2004, and provides an overview of a range of management options that have been applied to tuna fishery management in other regions. Some of these measures could conceivably be applied in the WCPO.

In general, restrictions on total fishing effort and hence rate of fishing mortality (input controls) have historically been preferred over direct controls on catch (output controls). Notwithstanding this, the use of combined effort and catch controls in contemporary management strategies has increased. This tendency is based pragmatically on the realization that either type of measure used in isolation may prove inadequate.

The various schemata are summarized in Table 2 below and the possible application of these in the WCPO area is discussed in the following sections of this report.

Table 2. Summary of management options applied to Bigeye and Yellowfin in other ocean areas by RFMOs

Source: RFMO websites, references 5, 20.

Management measure applied	Eastern Pacific Ocean (IATTC)	Indian Ocean (IOTC)	Atlantic Ocean (ICCAT)
OUTPUT CONTROLS			
Competitive quota (TAC)	Yellowfin TAC 1966-1979; Juvenile Bigeye catch limits 1988-99; Yellowfin catch limits 1998–2001	Quota for Bigeye catch on floating objects considered, but not adopted	(Competitive TAC for southern Albacore, for countries targeting the species)
Allocated quota (TAC)	Longline Bigeye catch limited to 2001 levels (2004). Longline catch limits (2004-2006) for four countries; limited to 2001 levels for others	Bigeye Longline catch limits for one nation; limits under development for others	Bigeye Longline TAC of 90,000t (2005-2008) Longline catch and vessel limits by country, based on average 1991-92 catch; adjustment provisions
INPUT CONTROLS			
Capacity limits	Limits on total Purse Seine carrying capacity (m^3 of well space); limits in entry of new vessels and expansion of capacity	Restricting number of Longline vessels > 24m LOA, and GRT, to number registered in 2003	Restricting number of vessels > 24m LOA to average number fishing in 2001-02
Gear limits	Net depth, escape grids		

	considered		
FAD restrictions	Catch limits on juvenile Bigeye, to trigger ban on FAD fishing (1999-2001); now time/area closures on all purse seining	Consideration of time/area closures for FAD fishing	Closed area/season for FAD use in 1999; renewed in 2004, to be reviewed this year; all surface fishing, not only FADs
Restrict at-sea transshipment	High seas transshipment by Purse Seine vessels prohibited		
Area-time restrictions, including Marine Reserves	Time/area closures considered; preference for total bans for two periods (2003 and 2004); choice of two six-week periods (2005)	Considered but not adopted (large Skipjack catch foregone)	Area closure to surface fishing for November (years 2005-2008), review effect in 2005
Minimum size restriction		Considered, but not implemented	Since 1982 (3.2kg); recently rescinded
Compulsory retention of all tuna species of all sizes	In place (needs 100% observer coverage); continuing to Jan 07.		

Pursuant to this 2004 review, and the updated stock assessments from SCG 3, the first meeting of the WCPF Commission (December 2004), directed that advice be provided to the second meeting of the Commission (December 2005), on the following points:

- "estimates of both sustainable catch and effort levels for Bigeye, Yellowfin and South Pacific Albacore"

- "five and ten-year projections of total and spawning stock biomass under 2003 catch levels, and possible scenarios of changes in catch and effort in the WCP-CA for the Purse Seine, Longline and other surface fisheries which have a major impact on Bigeye and Yellowfin tuna, including the effects on the stocks of possible time/area closures by fishing methods for Bigeye and Yellowfin tuna"

- "the effects on the stocks of measures to mitigate the catch of juvenile Bigeye and Yellowfin, including controls on setting of floating objects"

In response to this directive, a comprehensive analysis[6] was prepared by the OFP and other collaborators. The findings were presented to the 1st Scientific Committee (SC) meeting in August 2005 and are summarized below:

    - In relation to the questions concerning sustainable and effort levels, the OFP concluded that for Bigeye and Yellowfin tuna, effort reductions for

both species to around 80% of the current F, which would reduce overfishing to F_{MSY} levels.

- In relation to sustainable catch levels, the OFP concluded that for Yellowfin and Bigeye tuna the long-term average catch levels consistent with F_{MSY} would be less than 70% of present levels (2001-2003 average) for both species. With recent high levels of recruitment, especially for Bigeye, catches of 0.95 and 0.77 of current levels for Bigeye and Yellowfin respectively would be consistent with F_{MSY}.

To fulfill the five and 10-year projections requested by the Commission, projections on a 10-year time horizon were made. It is noted that the baseline fishery conditions in 2003 used were in some ways atypical. For example, high Purse Seine catches, especially of Yellowfin, took place that year. Twelve scenarios, with subsets, were tested, with outcomes graphically represented in Figure 1 of the report of Agenda Item 5. Stock projections are somewhat simplistic, however, and should be taken as indicative only, given uncertainties in the simulations. A number of insights were gained through these projections of possible fishery performance under various conditions and of responses to restrictions applied over the fishing sectors and gear types.

a) Current general situation

The projections broadly confirmed the general situation outlined in Section 3. Both Bigeye and Yellowfin are currently overfished.

Current catches of Bigeye tuna are not sustainable under long-term average recruitment. Under the unusually high recent recruitment levels, overall catches may be sustainable in some regions but not in others. In the Western Equatorial Pacific (WEP) projected abundance declines towards zero even with significant catch reductions. The modeled projections suggested that 2003 effort levels were generally sustainable insofar as they would stabilize biomass at levels consistent with MSY.

For Yellowfin tuna, the high 2003 catches are not sustainable, and would lead to rapid depletion of stocks, especially in the WEP, where abundance declines towards zero even with significant catch reductions. 2003 effort levels were considered to be sustainable, with most forms of effort reduction generally effective in keeping biomass above levels consistent with MSY.

The projections suggested that biomass levels above those consistent with MSY could be achieved for both species by effort reductions of between 15% and 30% in all fisheries. Together with catch reduction of 30% in all fisheries for Bigeye, strong increases in modeled biomass levels were achieved for Yellowfin and Bigeye.

b) Projected Effects of Specific Measures

i) Bigeye tuna

The greatest positive impact on adult biomass for Bigeye tuna was achieved through projections in which reductions in Longline catch and effort were reduced. In relation to Purse Seine gear, the most effective measure was the switching from associated to unassociated sets. Modeled reductions in catch/effort in Indonesia and the Philippine fisheries had little positive impact. Closure options on the Purse Seine fisheries were explored and quarterly time-area closures were found to be effective. Specifically, closure of log/FAD sets together with a localized redirection of associated sets to unassociated sets was found to be beneficial. Quarterly Longline closure options were modeled and these simulations suggested that the best results were achieved from closures in the Eastern Equatorial Area.

ii) Yellowfin tuna

Of the options modeled for Yellowfin tuna, reductions in Purse Seine effort and of effort in the Indonesian and Philippine fisheries gave better results than reduction in Longline effort. A switch from associated sets to unassociated sets gave less clear benefits for Yellowfin than for Bigeye tuna. This is probably due to the fact that Yellowfin are taken by both set types. Little impact was achieved through quarterly closures with effort transfers,

but minor benefits were observed in the simulations by shifting Longline effort from west to east.

c) Projected effects of reduced catch of juvenile Bigeye and Yellowfin tuna

Projections were made involving the impact upon biomass of reduced catch of juvenile Bigeye and Yellowfin tuna. The best outcomes in the form of increased biomass and catch gains were achieved through transfer of effort from associated to unassociated sets. These included benefits to the Longline fishery. Effort reductions in Purse Seine fisheries and in the Indonesian and Philippine sectors demonstrated potential benefits for Yellowfin, as did many of the time/area closures also simulated for the Purse Seine sector.

d) Summary

A number of broad conclusions can be drawn from the results of the simulated management scenarios and the assessments described above.

Firstly, the simulations suggest that current catches of both species are not sustainable. This is particularly true of the WEP extending from the Philippines to Kiribati. In this area drastic declines in tuna stocks are predicted by the models used, even if catch levels are substantially reduced. Accordingly, this points to the need to emplace a robust, enforceable management regime for tuna over the WCPO as a whole.

Secondly, in the model simulations carried out to explore the impact of possible management intervention, it was established that there are positive benefits that flow from reducing effort across all fishery types for both Yellowfin and Bigeye tuna. Reducing catch levels across all fishery types would be of benefit to Bigeye tuna populations.

Thirdly, the simulations suggest that effort reduction involving Purse Seine gear were generally most beneficial for the Yellowfin stock, while effort reduction in the Longline sector was beneficial to the Bigeye tuna stock.

Finally, the simulations predict that some time/area closure options and options involving transfer of fishing from associated/FAD sets to unassociated sets were beneficial to both species.

While these predictions are useful for illustrative purposes, there are considerable uncertainties in the data used to form the model and in other aspects of the information available, to form policy. In addition, the scientific advice generated from the assessments appears to be predicated on the use of MSY as a target limit value. Hence, Greenpeace is of the view that the effort and catch reduction suggested by these simulations represent a bare minimum level of management which should be applied to tuna fisheries in the WCPO. The basis for this assertion is examined in the context of the following sections of the report which outline current management instruments in use in the WCPO fisheries. The report then

examines specific difficulties in applying management schemata in the WCPO.

5. Current management approaches in the WCPO

Various management systems have been applied to various tuna fisheries around the world under the auspices of the relevant RFMOs. These have been summarized in Table 2 above. In general, input controls have more commonly been applied (capacity limits, FAD restrictions, area-time closures) but output controls are also commonly applied, in particular to Longline fisheries. In relation to the WCPO, however, there are currently no management measures that apply throughout the Convention Area or throughout the range of any of the stocks.

At national level, measures may be embedded in national tuna management plans to limit *inter alia* numbers of operating vessels or catch levels. Exercising of sovereign rights in the context of bilateral access arrangements may also be used to achieve both in-zone conservation and management of the resource. At the sub-regional level, the US Multilateral Treaty administered on behalf of the Pacific nations by the Forum Fisheries Agency (FFA) controls access to EEZs and adjoining waters of Pacific nations. This limits the number of US Purse Seine vessels which may fish in the region. Since 1995, the Palau Arrangement has limited the number of Purse Seine vessels that may fish in waters of the Parties to the Nauru

Agreement (PNA). This arrangement limits the number of Purse Seiners that can operate in what is effectively the PNA region to 205 vessels.

This is potentially a very powerful influence on tuna fishing operations, (and their impact) in the region. Vessels operating under the Palau Arrangement are thought to take around 70%[8] of the WCPO Purse Seine catch. Hence, this arrangement has the potential to exert a significant amount of control on the Purse Seine effort impacting WCPO stocks. At both national and regional level therefore, some form of capacity limits are in place, at least for the Purse Seine fishery. Nothing is, however, in place in the WCPO for the regulation of the Longline fishery or for other gear.

Even so, the adequacy of the restrictions on Purse Seine vessels is open to considerable question. In particular a number of weaknesses have been identified in the Palau Arrangement that has led the Parties to formulate an alternative approach. The Vessel Days Scheme (VDS) is described more fully below.

[8] As a significant number of Purse Seine vessels operating in the western equatorial Pacific are probably not included in current effort estimates, this is an overestimate.

a) Vessel Days Scheme – Purse Seine effort

In December 2000, the Palau Arrangement Parties signaled their intent to move to a new scheme. This was intended to replace the limits on "vessel numbers by fleet" in the Arrangement, using a scheme based upon limits on "vessel days by zone (EEZ)". The VDS was intended to

"enhance the economic and biological sustainability of the Western and Central Pacific Purse Seine fishery by controlling the level of fishing effort by Purse Seine vessels within limits consistent with resource sustainability; and also increasing economic benefits to resource-owning states and economic returns to participating vessel owners"[7].

The broad thrust behind the scheme was the establishment of a TAE based initially on an average effort for the period 1999-2001, then subsequently for 2000-2002. Overall, this was designed to limit fishing effort to a lower level than currently occurring, consistent with a precautionary approach. In addition, it took account of SCG recommendations to cap fishing mortality on Bigeye and Yellowfin tuna.

In operational terms, this involved the calculation of the total number of vessel days available for allocation to the Parties (PNA TAE), minus days in international waters and EEZs of other states. After further subtracting obligations associated with the United States Multilateral Treaty (USMLT) and the Federated States of Micronesia

(FSM) Arrangement, individual allocations (Party Allowable Effort, PAE) would be made according to a formula giving equal weight to biomass estimates within the EEZs (Skipjack and Yellowfin) and the average vessel days fished in the EEZs for the period 1996-2002.

It was intended that PAEs would be transferable according to an established set of rules, the definition of a fishing day would be pro-rated to vessel size (3 categories of Length Overall) (LOA), and Parties would be free to allocate their days (PAE) as they wished, presumably according to a set of established priorities. Crucial to the success of the scheme would be the fully operational status of the vessel monitoring system, the Forum Fisheries Agency (FFA) Vessel Monitoring System (VMS) and the associated in-country hubs. In addition, the effectiveness of the scheme would also be determined by other factors. The capacity of individual countries to manage their PAEs to good effect, on a real time basis, was likely to be important. The effectiveness of trading of effort days amongst Parties to take account of ENSO-driven variation in biomass distribution would also be a critical parameter in determining the effectiveness of the proposed scheme.

Unfortunately, the effectiveness of the VDS as a management tool in the WCPO remains untested and indeed it is yet to be implemented in any form. It is possible that the scheme may be implemented in mid-2007, subject to endorsement by the PNA at ministerial level. This involves a transitional period of between 4

months and 18 months from existing arrangements. The scheme has faced considerable criticism from Purse Seine operators. The 2005 World Tuna Purse Seine Organization Meeting (WTPO)[9] appeared to be losing patience with the VDS process. They considered that huge difficulties existed in its application and even in it gaining wide acceptance among PNA members. They recommended that its implementation be postponed.

In any case, the original ambitions of large scale effort control under the VDS scheme appear to have been comprehensively undermined by the reported likelihood that it will be the 2004 effort level that will be used as a baseline. This is more than 20% higher than the averaged 1999-2001 effort level originally proposed. The assumption of this as a baseline means that the scheme can no longer be regarded as being consistent with a precautionary approach. It is possible that the VDS could serve as a framework through which future effort reductions could be made, but this is far from certain. However, the success of the VDS as a pivotal management framework through which timely management of the WCPO Purse Seine fishery can be achieved looks extremely doubtful.

The above concerns translate from the Purse Seine fishery which accounts for the bulk of tuna caught in the WCPO to the Longline fisheries.

[9] WTPO Declaration, 5th Annual Assembly, Manila, Philippines, 20-21 September, 2005.

b) Longline Effort

As yet there has been no attempt to limit Longline effort in the WCPO, in contrast with other ocean areas administered by other RFMOs. Early consideration of options for managing effort (and catch) in the South Pacific Albacore fishery did not result in any substantive measures. Proportionally, much less longlining effort is directed in areas of the EEZs of coastal states than is the case for Purse Seine fisheries. Nonetheless there is a wide range of vessel size and a very large number of Longliners fish within the PNA area and in the WCPO as a whole. The estimates are subject to large uncertainty, but number at least 5000. This figure does not include thousands more small vessels (handliners etc.) fishing in Indonesia and the Philippines but which take adult fish of similar size to those taken by Longliners.

Though data is scarce, Longline effort in the WCPO appears to be increasing. It has been claimed that at least one entity has increased the number of Longline vessels on the FFA national register by 148 since the 1999 Multilateral High Level Conference (MHLC) Resolution was made to limit capacity increases. This is offset to some degree by plans of the same entity to dismantle 120 older Longliners over the next two years. The Longline fishery in Vietnam is also expanding, as is the Chinese DW Longline fleet. Moreover, Longline fishing has also provided many of the examples of known IUU fishing in the region.

As described above, the output of modeled simulations to investigate the impact of effort reduction has singled out limits on longlining in the region as the single most effective measure to increase and stabilize biomass of Bigeye tuna. It is recognized, however, that such regulation is extremely difficult.

As a result, catch limitation has probably been the most widely used regulatory tool for Longline fleets.

Recently, for example, the IATTC introduced a self-enforced Bigeye TAC for Longline vessels of four countries (China, Japan, Korea and Chinese Taipei) over the period 2004, 2005 and 2006. This requires other contracting parties to ensure Longline catches of Bigeye do not exceed their 2001 levels. This has already had ramifications for the WCPO. There has been some transfer of effort -during 2004 - after EPO quotas were reached, and some "laundering" of Bigeye caught in the EPO and described as WCPO fish, has also been documented[10].

[10] Report on the Fishing Capacity of Chinese Taipei. Informal Consultation towards WCPFC 2, Tokyo, 8-9 September 2005

c) Economic and Regulatory considerations

Any management framework proposed must take into account the important role that tuna fisheries play in the economies of the region.

Longline fishing is less capital intensive than Purse Seine operations. It has less requirement for input of capital, technology and expertise. Accordingly, it has been a primary focus of domestic fishing industry development for many Pacific Island States, in particular those in sub-tropical areas. By contrast, Papua New Guinea (and to a lesser extent the Solomon Islands) have pursued a preferred development pathway of gearing a domestic Purse Seine capacity to onshore processing of the catch. The economies of other island states (notably atoll states such as Kiribati) in the tropical region are significantly dependent upon access fees for Purse Seine vessels.

Hence, in considering potential management options, most Island states will heavily weigh economic factors in their evaluation. There is wide perception that the current state of the stocks is due to the large-scale expansion of the fisheries by the DWFN in past years. Unsurprisingly, most states are unwilling to curtail current and future development aspirations as a result of historical over-expansion. This has led to a great overcapacity in the sector as a whole and in turn has led to departure of the fisheries from sustainability. This unsustainable state is

characterized by complete lack of equity in the distribution and availability of the natural capital these fisheries represent. In turn, this implies that balancing development ambitions with the need to restore the fisheries to sustainability and to manage them subsequently will be a major challenge. Essentially, negotiation of timely and substantive fisheries management measures in the Convention area may well be held hostage to economic development, that in and of itself departs significantly from sustainability.

6. Problems identified for effective management of WCPO tuna stocks

A range of management options has been considered for tuna fisheries in other tropical ocean areas (as summarized in Table 2 above) where RFMOs have been in place for some time, but where similar problems with Yellowfin and Bigeye stocks are nonetheless evident. There are, however, a number of potential difficulties which are likely to complicate attempts by the Commission to apply any or all of the potential management options that have been recognized in studies of the options [5].

(1) The WCPO fishery is much larger (in terms of catch – 50% of the global catch), more complex and spread over a much wider area than any of the other ocean areas where RFMOs manage tuna fisheries. These areas (and the relevant RFMOs) are: The Eastern Pacific Ocean

(IATTC), Indian Ocean (IOTC), Atlantic Ocean (ICCAT) and the Southern Ocean (CCSBT).

(2) A second raft of complexities arises as a result of some of the coastal state fisheries being large and highly complex. The Philippines and Indonesia are good examples of this. In these countries, multi-species tuna fisheries operate using multiple gear and involves very large numbers of vessels of varying sizes. These land their catch at hundreds, if not thousands of landing points.

(3) There is a much greater sea area under the jurisdiction of coastal states (cf. high seas) than is the case in any other ocean area. Much of this sea area is located in the productive equatorial zone. On one hand, in management terms, this confers potential advantages to coastal states, particularly with management of the Purse Seine fishery. On the other, these coastal nations vary considerably in size and economic circumstances. Hence, they vary in terms of the way they choose to exercise their rights to manage their natural resources. The resultant geo-political environment complicates many aspects of regional management, not least being resource allocation issues.

(4) The relative importance of Skipjack in the total catch (68%) and Purse Seine catch (78%), is higher than in any other fishery[11, [2]], whereas management concerns are with species that form a relatively minor proportion of the catch

[11] This has been the subject of some uncertainty recently[9], with discrepancies between observer data and logsheet/port sampling data with respect to the relative proportion of Skipjack and "yellowfin plus bigeye" in the catch

e.g. Yellowfin (20%) and Bigeye (2.2%). Issues of effort and catch reduction, therefore, require careful economic consideration. Management measures applied to the Bigeye and Yellowfin stocks will result in a forgone catch of the majority species (Skipjack).

(5) The WCPFC is the most recent of the RFMOs to be established. Accordingly, the range and scope of the monitoring and surveillance it conducts are limited. It is likely to be some time before it is well established and fully functional as a significant regulatory force. As things stand, its limited capacity will compromise support of identified management and conservation measures and the co-ordination of regional management efforts.

The points 1-5 immediately above represent a broad spectrum of general organizational capacity issues and economic issues. These act as constraints on the delivery of effective management and advice for the WCPO tuna fisheries. There are a number of more specific issues which act to constrain effective management. These relate to the availability and provision of data to inform the advisory process necessary in defining management needs and objectives. These aspects are explored in more detail in the following sections.

a) Data provision and availability

The relatively recent creation of the WCPFC means that currently there are substantial gaps and inadequacies in the data covering the WCPO tuna fisheries. These contribute to a substantial level of uncertainty and indeterminacy, which translates into a substantially reduced confidence in the output from fisheries models and the management measures put in place. In some cases, data is absent from nations that are not members of the Commission and, therefore, do not contribute data on their fisheries, despite these being of great relevance to management in the WCPO. A good example is Vietnam. Indonesia and the Philippines, on the other hand, have acknowledged inadequacies in existing statistical coverage due to the complexity of the fisheries as noted above. These types of data deficiencies are critical given that between 35% and 40% of the total Yellowfin catch is estimated to come from this area. The Commission members are supporting a project [12] to remedy this situation in the medium term.

An illustration of the likely scale of the problem is provided by the statistics for logsheet coverage in the WCPO. This is somewhat less than the 50% overall and falls to 25% or below for Longline and 15% for pole-and-line. This lack of data introduces substantial uncertainty into certain operational analyses. In addition, the relative proportions of juvenile Yellowfin and Bigeye in the Purse Seine catch, is not well characterized. This is possibly because they

are of similar appearance and value. The situation where species composition is estimated from sampling of a subset of the fleets and then extrapolated to others needs to be resolved if data precision is to be improved.

b) Fleet capacities

The considerable uncertainties attached to catch and biological data are paralleled by inadequacies in the data describing fleet capacity over the region. In short, the capacities (and indeed basic vessel characteristics) of fleets operating in the WCPO are not fully documented. The Commission, therefore, is poorly placed to consider the likely benefits of effort reduction options based on limiting capacity such as capacity limits for large scale vessels operating in the region. As an example, under the terms of Art. 24 (4,5) of the Convention, and the Decision of the Commission relating to the Record Fishing Vessels and Authorizations to Fish, the Commission was entitled to receive from members by July 1, 2005, a record of flag fishing vessels authorized to fish in the Convention Area beyond their jurisdiction together with similar data from co-operating non-members. It was intended that this information should form the basis of the WCPF Record of Fishing Vessels, in other words, those vessels authorized to fish in the Convention area beyond the national jurisdiction of the flag state. The degree of compliance with this process is unknown, but it is believed that few countries have complied with the requirement to provide information.

The general lack of information about fleet capacities is compounded by large scale failures to observe Resolutions from the 4th MHLC (1999), 5th MHLC (1999), the 3rd PrepCon (2002) and the 5th PrepCon (2003) to "exercise reasonable restraint" in "any further increase in fishing effort and capacity in the Convention Area and to apply the precautionary approach forthwith". Despite the Resolution on Conservation and Management from the first Commission meeting affirming that these resolutions continue to apply, fishing capacity has continued to increase in the Purse Seine and Longline fisheries in recent years. The current fishing capacity in the WCPO is sufficient to fish at levels well beyond MSY, an observation that appears to be true for Purse Seine fishing[9] and longlining fishing[10] on a global scale.

There have been several recent attempts to estimate Purse Seine vessel capacity in the WCPO[12][13][14]. Some of these studies [13] have excluded vessels active in the region on the grounds that they have a well capacity below 400m^3 or because they are active in only one EEZ. The overall effect of these essentially arbitrary exclusions has been to exclude from any management related calculations and modeling, a considerable proportion of the effective capacity for some fleets. For example, in the case of the Philippine Purse Seine fleet, half of the vessels over 250GRT were not included. This amounted to around 20 vessels. None of the smaller vessels of less that 250GRT were included. This is against a background of most newly constructed vessels (post 1999 Resolution on Capacity) being in excess of 2000GRT.

A full characterization of Purse Seine and longlining capacity on the WCPO is a vital prerequisite to the success of any management plan based on options restricting capacity[12]. If the capacity is not known with any certainty, the precise benefits of capacity reduction cannot be gauged. More fundamentally, if capacity is not accurately known, then it is likely to prove impossible to ensure that any mandated capacity reduction is translated into actual reductions in capacity in the real world.

c) Uncertainties in stock assessments

Notwithstanding the general flexibility and utility of the MF-CL model used to inform management in the WCPO region, there are important areas of uncertainty that require resolution in order to improve the stock assessments of the major target species. Examples include sensitivity of management reference points, to assumptions about the stock recruitment relationship (SSR), and about recruitment into the fishery together with the large gaps in Philippines/Indonesian data. Coupled with uncertainty attached to the capacity in the various fisheries sectors, these conspire to undermine confidence in stock assessments for the regions. These, and other areas, will require refinement and much further work. Under these circumstances, however, management should be predicated upon the most pessimistic assumptions in line with a precautionary approach.

d) Absence of management objectives

Even if efforts are successfully made to eliminate or accommodate sources of uncertainty affecting the output from fisheries models, meaningful advice on the direction of the fishery is not possible without management objectives actually being set. Annex 2 of the Agreement provides clear guidance in this regard, proposing that fishing mortality does not exceed F_{MSY} in stocks that are not overfished, and B_{MSY} as a rebuilding target for overfished stocks.

The Commission will need to frame a set of management objectives for the fishery, and presumably decide on the choice of reference points (target/management reference points and limit/conservation reference points) that will be used to evaluate fishery performance. In the view of Greenpeace, the use of F_{MSY} as a limit value does not constitute a sufficiently precautionary basis for the management of these fisheries. Accordingly, if MSY is to be used as a basis for management, it should be as a starting point, subsequently taking account of uncertainties and indeterminacies in the data.

e) IUU fishing

Allied to the problems concerning precise capacity levels within the industry, is the problem of IUU fishing. The scale of IUU fishing on the WCPO tuna stock is not known with any great certainty. It is, however, thought to be a substantial problem as discussed further in Section 7

below. Quite apart from the economic implications of such fishing activity, as an uncharacterized element in calculations involving effort, capacity and catch level, it clearly could impact upon the quality of assessments and the scientific advice drawn from them.

7. IUU fishing in the WCPO

IUU fishing in the WCPO tuna fishery is widely regarded as a serious economic and management issue in the region generally and for coastal states, in particular. This is in addition to the fact that it could act to seriously compromise effective management and conservation measures. Greenpeace [17] has estimated that IUU fishing represented a “conservative” 5% to 15% of the WCPO catch in 2002. This would likely be in addition to the total 2 million tonnes from landings and catches reported for the WCPO, or at least in part. Given the clandestine nature of much IUU fishing activity, there are few, if any, reliable data on the extent of IUU fishing in the WCPO [13]. This introduces further uncertainty into the assessment system, which is not currently acknowledged for the WCPO stock assessments. The following sections of the report examine IUU fishing and the management implications in more detail.

Illegal fishing

These activities are also generally unreported and often involve unlicensed fishing inside the national waters of Pacific Island[15] and other coastal states such as the Philippines[16]. It may consist of violations of conditions by vessels fishing under license. It may involve DWFN members or entities of the WCPFC, together with vessels of open register, or "flag of convenience" countries. It has been reported[15] that illegal fishing, as measured by the number of detected violations, has declined in the EEZs of FFA members since the mid-1990s, whereas this has not apparently been the case in south-east Asian coastal states. In these areas illegal fishing has probably increased. Incidents involving illegal at-sea transshipments, laundering of fish caught elsewhere during such transshipments and other violations continue in the WCPO, but the true scale and extent is simply unknown.

Unregulated fishing

High seas fishing has long been unregulated, and remains effectively unregulated for those countries that are not bound as signatories by the UN Fish Stocks Agreement. One of the first acts of a functioning WCPFC should be to enforce the requirement of flag states to issue authorization to fish on the high seas[12], as per the decision of WCPFC 1, and duly report to the Commission the details of such vessels on an annual basis. These

[12] Art 24(2) of the WCPF Convention

should be required to carry approved VMS equipment and be subject to effective observer coverage.

Unreported fishing

Such activities include two major categories of vessels. These comprise firstly, those vessels deliberately not reporting their activities and, secondly, vessels of member and non-members that fish in the convention area, but which are not obliged to report. The latter group includes some Vietnamese tuna vessels and some Philippine vessels fishing outside their EEZ. These boats are generally operating under access arrangements but are not required to supply catch data under the terms of these agreements, nor is such data routinely sought by the national authorities. As noted above, there are concerns attached to the quality of data that is reported. Indonesian and Philippine logsheet coverage remains incomplete, particularly in respect of the high seas activities of some fleets.

Overview

Between 5% and 15% of the overall WCPO tuna catch may be taken by IUU fishing activities as outlined in the recent Greenpeace Report on this topic. Of this, perhaps 150,000t may not be included in catch estimates due to passive non-reporting and an unknown amount of deliberate non- or under-reporting. This is potentially a significant proportion of the catch, and points to a pressing need for individual states in the WCPO to develop

National Plans of Action for IUU fishing and the WCPFC could reasonably be expected to develop an IUU POA. As a first step a list of IUU vessels and their illegal activities needs to be compiled in order to clearly identify known “bad actors”. This approach has been taken by other RFMOs, so is not without precedent [15].

8. Proposed effort reduction measures for WCPO and their impact

The data that exists on the tuna fisheries in the WCPO are characterized by considerable uncertainty and indeterminacy. The reliability of the models used in stock assessments is unknown within fairly wide parameters. Indeed, it was refinements to the models, rather than any substantial change in the body of data gathered to inform the model, that led to the 2005 conclusion that stocks of Bigeye and Yellowfin were being overfished at current levels of recruitment. The stocks of Bigeye and Yellowfin are not thought to be in an overfished state, however. Skipjack tuna currently appear to be exploited at moderate levels relative to current population estimates.

There are identified shortcomings too in respect of current effort and catch levels in the WCPO and in relation to levels of IUU fishing taking place in the region. Moreover, Purse Seine and longlining capacity is continuing to increase. Greenpeace considers that under such conditions a rigorous precautionary approach needs to be applied in the management of stocks and the fisheries require management on a whole ecosystem basis. The

goal of such management should be to reverse current overfishing and, thus, reverse continuing biomass trends towards an overfished state. This would accord with the spirit of the Resolution on Conservation and Management Measures made at the first session of the WCPFC.

As a starting point in this discussion, it is possible to use the projected scenarios produced for the WCPFC meeting in 2005. As noted above, these lead to the overall conclusion that using F_{MSY} as a limit reference point, fisheries for both Yellowfin and Bigeye would require a reduction in F to around 80% of current levels. As pointed out in the simulations[6], an "across the board" effort cut of this magnitude in most fisheries would eliminate overfishing of both species, given commonalities in fisheries for them. At the same time, however, effort reduction in the Purse Seine fishery would come at considerable cost in the amount of Skipjack tuna catch foregone. Sustainable catch levels are more difficult to estimate due to impacts of variable recruitment over time, but significant reductions in recent Yellowfin catch levels, given recent recruitment, would be necessary (23%). As noted above, Greenpeace does not consider MSY as a robust basis for establishing a precautionary management framework.

As a generality, however, effort reductions may well be the preferable suite of options in most cases, particularly in the short term, although inevitably "technology creep" and other slippage is clearly an issue in the long term effectiveness of such measures. Most of the output control

(catch-based) options would need to be backed up by comprehensive monitoring programs that are not likely to be in place in the near future.

One clear possibility exists to cap effort and establish a position from which further effort reductions could be achieved. Accordingly, Greenpeace proposes, as a first but substantive step in this direction, that a moratorium on the construction of large Purse Seine (Super Purse Seiner & Super Super Purse Seiner) and large Longline vessels[13] proposing to fish in the WCPO be imposed. This is in line with earlier Resolutions of the 4th MHLC, 5th MHLC, 3rd PrepCon and the 5th PrepCon. In addition, movement of vessels from other areas should be strictly controlled. At the same time, a WCPFC Record of Fishing Vessels should be established at the earliest opportunity and studies undertaken on the most appropriate measures of effort, and the most suitable option to limit capacity in WCPO Purse Seine and Longline fisheries. With these proposals in mind, the following sections consider possible more specific management options by gear type although it must be stressed that these are grounded in the current management paradigm, and may not, therefore, be sufficiently precautionary.

[13] "large" to be defined following careful consideration of the implications of the various specifications in place elsewhere eg 15m LOA/ 3 GT for municipal vessels, 24m LOA for Longline vessels

8.1 Purse Seine gear

Yellowfin

The projections indicate that reductions applying to Purse Seine effort, and Indonesian and Philippines effort in general were likely to be more effective for this species than reductions in Longline effort, in rebuilding biomass. This is due to the high proportion of the Yellowfin catch taken by Purse Seine in the WEP (Philippines/Indonesia).

Achieving a 20- 30% reduction in effort in all fisheries would be extremely difficult, with some form of fishery closure or capacity limit the most obvious options. The VDS, which will be predicated upon 2004 data as a baseline, appears unlikely to push back Purse Seine operations to the required levels. It would not cover all large Purse Seine operations in the WCPO. Limited previous experiences with industry initiatives to reduce effort have not been striking. These include the WTPO, with a voluntary scheme for vessels to spend a minimum specified time in port after unloading and calls, to limit fleet growth. The OPRT scheme to reduce the large DW Longline fleet by 20% is another example.

Nonetheless, some measures suggest themselves and could be implemented reasonably readily. For example, following the precedent set in the EPO, and as a short-term measure, the imposition of a six-week closure of the large Purse Seine fishery in the WCPO could be trialed. This closure could take place in January-February, 2007,

on an experimental basis**.** Considerable preparatory work would be necessary, but the trial would benefit from existing EPO experience.

Moreover, an indirect, but quantitatively large impact on fishing efficiency and, hence, on effort and catch in the fishery could be achieved if the Commission were to emplace a prohibition on transshipment on the high seas and allow this only to take place in designated ports. This is provided for in Art. 29 (1,3,5) and in the existing Minimum Terms and Conditions for Foreign Fishing Vessel Access as they apply to the EEZs of FFA members. It is probable that such a prohibition on transshipment would address IUU fishing activities to some degree by restricting opportunities for “laundering” illegal catch.

The inevitable economic impacts of these effective limits on effort could be minimized by planning to use the enforced closure period to carry out vessel and gear maintenance. Given that this is primarily designed to restrict effort, such closures could be applied in a staggered fashion across fleets to spread downstream impacts on the processing sector. Nonetheless, such a closure program should be regarded as a symptomatic response to the overall problem. It does not address the fundamental problem of too many boats chasing too many fish.

Even with restrictions in place on the larger Purse Seine vessels, the limitation of effort by smaller vessels operating in the WEP needs to be addressed. These vessels make a large contribution to the take of Yellowfin tuna and have thus played a significant part in drastic reductions in biomass of this species in the WEP. This has taken place against the backdrop of the WCPFC directive and increasing concerns about food security in the region. The issue of capacity in this sub-region may need to be dealt with at national level with the oversight of the WCPFC.

Finally, FAD/log sets are common in the WEP area and this is where fishery impacts are most severe. Simulations have suggested that transferring this effort to unassociated sets could considerably benefit both Bigeye and Yellowfin tuna.

Bigeye

The most effective modeled measure to conserve and regenerate Bigeye tuna stocks in the WCPO was found to be the transfer of FAD/associated set effort to unassociated sets. Relatively very few of these fish are taken in unassociated Purse Seine operations. Implementing and monitoring restrictions on associated sets, however, implies considerable resource intensive management oversight and enforcement. Limits on the number of FADs allowed might be a useful option administered at a national level, and indeed these

measures are included in some national tuna management plans (PNG and Philippines).

The benefits achieved by modeling various quarterly time/area closures for Bigeye were not clear. Measures which maintained a relatively high proportion of the Bigeye catch in a time or area limited scenario, resulted in the forfeit of a large amount of the Skipkjack catch. Moreover, the location of high catch areas is spatio-temporally variable. Overall limits on catch of juvenile catches by Purse Seine gear would only be likely to work if a system of 100% observer coverage was emplaced.

8.2 Longline

Yellowfin

Simulations have shown no options that specifically benefit Yellowfin other than overall limits on longlining capacity and on vessel numbers. Some benefits may be expected to accrue, however, from measures directed at conserving Bigeye tuna.

Bigeye

The modeled projections indicate that, to conserve and restore biomass of Bigeye reductions in Longline catch and effort were the most effective. Restrictions on fisheries targeting Bigeye have been applied by IATTC, IOTC and ICCA. These are based upon set TACs for

longlining based on historically lower catch levels as a baseline, together with allocations made by country and/or vessel flag. Such a scheme could be applied in the WCPO. This could be based on the 1999 catch levels which were some 20% lower than current catches coupled with national allocations. Hence, Japan, Korea, Chinese Taipei, China and possibly the USA, all of which take more than 3000t per annum, would agree to limit catches to the historical levels together with some other countries involved in the fishery. The major drawback to catch controls of this kind in the WCPO is that they would need to be self-enforced until trade verification measures could be formulated. Such controls already exist for trade in Bigeye tuna to Japan for other ocean areas and RFMOs. Japan is the major market destination for this species. In fact, design of such a scheme for the WCPO can be seen as almost an obligation in light of the existing similar scheme in place in the EPO. This has led to shifts of effort into the WCPO and highlights the limitations of measures imposed by single RFMOs.

8.3 Pole-and-line and other minor gear

The pole-and-line fishery catch is dominated by Skipjack tuna with low levels of Yellowfin and Bigeye. Effort in such fisheries is generally declining and generally restrictions on catch and effort have not been imposed by other RFMOs. In any case, restriction on mostly artisanal or small-scale commercial gear would be difficult to impose

and enforce. It is likely to be best regulated at individual coastal state level.

8.4 Impacts

Table 3 summarizes the options proposed for consideration on the basis of modeled projections and their possible impacts upon the fisheries.

8.5 Allocation

Under Article 10 of the Convention, the Commission, having determined "*the total allowable catch or total level of fishing effort within the Convention area*, is required to develop, "*without prejudice to the sovereign rights of coastal States for the purpose of exploring and exploiting, conserving and managing highly migratory fish stocks within areas under national jurisdiction"* criteria for the allocation of the TAC or total level of fishing effort. This must take into account a range of defined pertinent factors and any other factors that it might consider germane. Any decisions relating to the allocation of TAC or the total allowable level of fishing effort, given their importance, are required to be taken by consensus.
Greenpeace is of the view that, in practice, this is the most difficult and challenging issue facing the Commission. It will require resolution of a range of matters currently standing unresolved in the Convention on matters of detail e.g. compatibility of conservation and management measures. The Commission should begin to tackle the allocation question as soon as is possible.

Table 3. Suggested management options for the WCPO, with assessment of possible impacts of their introduction

Measure	**Rationale**	**Implementation**	**Fishery impacts**	**Economic impacts**
OUTPUT (Catch related)				
Overall TAC on Bigeye Longline catches in the WCPO, with individual country allocations for those catching more than 3,000t (see schedule); catches by others kept to (specify year) levels	Reductions in Longline catch/effort have large impact on adult biomass	Mandatory self-policing combined with trade certification. Monitoring of high grading etc	Catch of adult Bigeye reduced. Bring WCPO in line with similar measures in EPO, to avoid effort displacement (since possibly same stock); Little impact on coastal states and smaller non-target Longline fisheries	Economic impact largely restricted to target species and large Longliners
Overall TAC on Purse Seine Bigeye catches, aimed at juveniles	Trigger closure of fishery setting on floating objects when TAC reached	Peg nominal limit at 1999 (or other year) levels; very high observer coverage needed	May only impact in years following low recruitment, and if drifting FAD sets increase	Minor, but may be significant if triggered early in a given fishing year and TAC is low
INPUT (Effort related)				
Moratorium on construction of new vessels (large p/s and Longline) for the WCPO; restrict vessel	Halt any further increases in WCPO Purse	WCPFC decision and basic monitoring; need policy on transfers from other areas, and	Will cap total effort and catch initially until fishing power increases (effort	Help to secure aspirations of developing states

“Immigration”	Seine and Longline capacity	replacements	creep)	
Limit overall Purse Seine capacity (possibly by well volume); apply to vessels >250 GT	Overall effort limit and reduction of 20% needed for both Yellowfin and Bigeye; previous Resolutions	Gradual – will need capacity documentation; decisions on appropriate measure of capacity	Reduce effort, but will need constant monitoring	Considerable for some, assuming limit will be set lower than current capacity
National limits on Purse Seine effort (VDS system)	Limit effort in PNA area (standard days) to 1999-2001 levels, originally)	By PNA countries; fully operational VMS and national capability needed	Reduce effort to previous more acceptable levels, or provide basis to do so	Increase value of access Increase costs of fishing
Limit numbers and total capacity of Longliners > specified size eg > 24 m LOA	Halt increase in Longline capacity (and effort)	Vessel register and annual vessel registration In line with ICCAT and IOTC		
Limit FAD sets per vessel (250 per year) and number of FADs deployed per vessel	Reduce Purse Seine catch of juvenile Bigeye (and Yellowfin)	Difficult – national responsibility; needs further study	Reduce efficiency in some areas; reduce Bigeye catch	Increased fishing costs; greater impact in some EEZs than others

One month/six week closure of Purse Seine fishery (during 2006)	Reduction in effort needed in all fisheries	Verification of confinement to port		
Marine Reserve established on trial basis	Reduce effort in WEP; secure productive habitat; reduce high seas creep (20% of PNA catch)	100% VMS, IUU control Start with donut; monitor then possibly apply to area further east	Possible increase in state revenues	May not be great; effort redistributed and possibly greater catch in adjacent EEZs if no VDS

9. Proposed IUU management measures to complement effort reduction measures

Several international instruments and initiatives have attempted to tackle the issue of IUU fishing globally, namely the FAO Compliance Agreement (2002), the UN Fish Stocks Agreement (2001) and the International Plan of Action to Prevent, Deter and Eliminate IUU Fishing (2001). Unfortunately thus far too little progress has been made and IUU fishing reportedly continues to rise in some regions.

In the WCPO, PrepCon 3 (2002) adopted a Resolution[14] relating to IUU fishing and limits on fishing capacity, urging state and entities to prevent, deter and eliminate IUU fishing in the Convention area, and to promote cooperation in exchanging information on IUU fishing and other related activities. Little concrete action seems to have occurred on IUU fishing in the WCPO since that time.

Greenpeace[8] recommends five categories of action that should be undertaken "to protect and develop sustainable fisheries"

- ratify and implement the Compliance and Fish Stocks Agreements
- exert control over port access and marketing of tuna products (trade verification)

[14] Resolution of the Preparatory Conference relating to illegal, unreported and unregulated fishing, and limits on fishing capacity, November 2002, Manila.

- strengthen the WCPFC capacity to take action (regional and global vessel registries, IUU vessel blacklist, reduce size of vessels covered by MCS regulation, boarding and inspection regulations, prohibition of at-sea transhipment)
- practice good governance at national level (comprehensive management plans, appropriate legislation enforced
- inspect and arrest IUU stateless vessels (national-level action)

Most of these action categories would complement proposed effort reduction; others are already embedded in some of the management options under consideration e.g. prohibition of at-sea transhipment, enhanced MCS capability at national and WCPFC level (see later).

10. Outline and analysis of the Marine Reserves (MR) concept in the WCPO

The measures which suggest themselves as a result of the various model-based simulations outlined in the narrative above can be seen as a relatively complex mix. Ultimately, their effectiveness will be determined by the integrity of the model used and crucially by the quality of the data used to drive the models and the assumptions used to constrain them. These are problems common to all fisheries managed under a conventional management paradigm. Such management is generally not

precautionary and rarely departs from single species considerations to embrace ecosystems as a whole.

Recognition of the various shortcomings in conventional management has led to a growing appreciation of the potential positive role of marine reserves in this regard.

The establishment of globally-linked networks of marine reserves - areas where all extractive and destructive activities (including fishing) are prohibited - are coming to be seen as crucial to the conservation of marine species and habitats, and for preserving ecosystem functions in an undisturbed state. In addition to their primary conservation function, secondary benefits flow from this in the form of potential protection and enhancement of important exploited species.

The concept of marine reserves is also consistent with a precautionary approach to environmental protection. In general, the functioning and structure of marine ecosystems is very poorly understood. These systems are not readily amenable to investigation and analysis. Accordingly, preservation of significant proportions of these ecosystems, as a management strategy in its own right, represents adherence to a precautionary management and conservation paradigm. Marine reserves, then *de facto,* constitute an ecosystem-based approach consistent with principles and ethics of sustainability.

Nonetheless, designation of an area as a marine reserve does not preclude a need to define adequate management strategies applied to areas falling outside designated marine reserves. The goal is to achieve sustainable use of marine resources outside the marine reserves network. This implies that these activities must conform to principles of sustainability, causing no degradation of ecosystem structure and function, and also meet the needs of both current and future generations. Hence, marine reserves are a complement to such measures (applicable to fishing activities) as reduction in fishing effort and capacity, prevention of IUU fishing and development of non-destructive fishing methods.

Hence, marine reserves comprise one tier of a dual approach to ecosystem-based protection efforts and associated fisheries management. In this context marine reserves have two primary benefits to fisheries management which flow directly from their primary role in the holistic protection of marine ecosystems.

Firstly, marine reserves act as reference areas against which the impact of management initiatives executed outside the designated areas can be assessed. Secondly, they act as a form of insurance against management failure, resulting in degradation of the ecosystem in non-designated areas. A further benefit to fisheries which may flow from marine reserves is enhanced catches beyond their boundaries, although this will be most marked when the non-designated areas are subject to failing management and being overfished. This is due to the

export of eggs and larvae and the spillover of adult and juvenile fish.

While marine reserves cannot directly address the impact of climate change, they may help indirectly in as much as healthy marine ecosystems are likely to be more resilient. Marine reserves would also help protect tuna and other fisheries from unanticipated effects of climate change by providing a robust reference point.

The growing body of marine reserve research, reinforced by the findings of earlier work, formed the basis for a wide ranging consensus statement [21] published at a Symposium held at the 2001 annual meeting of the American Association for the Advancement of the Sciences. This statement identified a number of ecological effects both inside the reserve boundaries and external to them.

The beneficial effects can be restated as follows:

1) *Within reserve boundaries*

a) Long lasting and rapid increases in abundance, diversity and productivity of organisms attributable to decreases in mortality, habitat destruction and to indirect ecosystem effects
b) Reduced probability of extinction of marine species

It has been noted that, in general, increasing size confers increasing benefits, but even small reserves are effective.

To achieve a full range of benefits, full protection with stakeholder involvement and enforcement are required. Marine Protected Areas (MPAs) confer lesser benefits.

2) *Outside reserve boundaries*

a) The size and abundance of exploited species increase in areas adjacent to reserves, although this finding is based on relatively few studies.
b) Increasing evidence that reserves replenish populations regionally through larval export.

3) *Effects of reserve networks*

a) Increasing evidence shows that networks of reserves are more effective than a single reserve at buffering environmental variability and that they provide greater protection for marine communities.
b) Effective networks must span large geographic distances and encompass a substantial area to protect against catastrophic events and provide a stable ecological "platform" for long-term persistence of marine communities.

The statement goes on to make it clear that in order to be most effective in a joint role of conserving both fisheries and biodiversity, marine reserves must encompass the full diversity of marine habitats, and be operated in the context of complementary management tools and a monitoring program to define their effectiveness. It concludes that existing scientific information justifies the

immediate application of fully protected marine reserves as a central management tool for marine systems.

a) Greenpeace Proposal for a global network of marine reserves

Greenpeace[18] believes that if we are to ensure clean and healthy seas and oceans, 40% of each habitat in each large marine ecosystem, including the high seas, should be set aside as marine reserves. In parallel, the rest of the oceans and seas – the other 60% - needs to be managed in a sustainable and equitable way.

At the 2006 meeting of the Convention on Biological Diversity (CBD), Greenpeace released *Roadmap to Recovery: a global network of marine reserves*[15]. The report presents a proposal for a global network of high seas marine reserves developed by Professor Callum Roberts and his expert team based at York University in the UK, and sets out the principles used for designing the network.

b) Marine reserves and highly-migratory species

Almost all the marine reserves that have been established so far are small-scale and coastal. These have been shown to benefit biodiversity, leading to increases in density, biomass, size of individuals and diversity[22], and in many cases have been shown to benefit fisheries in the surrounding waters. Common sense, experience and

[15] http://oceans.greenpeace.org/en/our-oceans/marine-reserves/roadmap-to-recovery

scientific models suggest that marine reserves are likely to work best for fish species that are relatively sedentary as adults but produce offspring that disperse widely, the reserves acting as refugia.

Because of this, it has been widely assumed, in particular by fishery managers, that marine reserves will not protect migratory species of fish such as tuna. They consider that these species will not remain in marine reserves and are vulnerable when they move outside. The perception has grown that the more migratory a species is, the less relevant is the concept of marine reserves to their protection and management.

The underlying assumptions behind this perception have been examined[23]. A major problem exists with the models which are used to predict the impact of marine reserve designation. These models have as two key assumptions:

1: *that individuals are evenly distributed in a uniform sea*
2: that these individuals move randomly

A third key assumption involved is that

3: fishing activity is conducted at random.

These assumptions are demonstrably false. Migratory species are not evenly distributed and fishing effort is not randomly directed but is most intense where experience has revealed migration bottlenecks or habitat critical to a particular life stage.

Where exclusively marine migratory species are involved, the creation of marine reserves to protect known spawning grounds, nursery areas and migration bottlenecks, are all likely to confer highly protective benefits on the population overall, as well as the ecosystems of which they are part. When the somewhat crude predictive models are refined to incorporate a spatial variability in a species vulnerability to fishing mortality, particularly where this mortality is intense, then clear benefits emerge in the form of both an increased spawning stock and catch.[23]

Nonetheless, the precise changes that occur as a result of establishing a marine reserve are very difficult to predict. By establishing large-scale marine reserves there are likely to be increases in habitat and ecosystem complexity, increases in biomass and enhanced feeding opportunities for both prey and predators. Accordingly, highly migratory species when encountering such reserve areas may spend more time there compared to areas outside due to better feeding conditions and, consequently, benefit from the protection afforded in the reserves[23]. Most of the modeling of potential reserve effects has not considered such possible shifts in habitat use.

Hence, by taking into account information relating to the critical habitats and the behaviour of migratory species it should be possible to establish marine reserves that benefit these species as a component of pelagic

ecosystems, while simultaneously prosecuting a sustainable and profitable fishery based upon these species.

c) Implementing large-scale marine reserves in the WCPO

Although identifying marine reserves that would provide the greatest benefit to the tuna in the WCPO is challenging, there is information that could greatly aid the process, including considerable data relating to the spatial and temporal dynamics of the tuna fisheries. In addition, some data also exists concerning the biology and ecology of these species which could prove helpful in defining potentail marine reserves. For example, it might prove beneficial to site marine reserves over productive seamounts known to aggregate tunas[16]. Some work in this area is planned under a forthcoming Global Environment Facility (GEF) funded project in the WCPO.

In the case of Yellowfin tuna, although spawning is thought to take place over the whole Pacific Ocean, high densities of larvae and eggs have been reported in the Western Pacific. This includes the Coral Sea, and in the Indian Ocean adjoining the North West Shelf area of Australia. Catches of Yellowfin tuna increase towards the east in response to *El Nino* events, although the majority of catch is taken in equatorial regions. Tagging studies have shown that Yellowfin tuna may move 1000km or

[16] Not to be confused with seamounts bottom or midwater trawled in some parts of the Pacific

more over a twelve-month period, but no directed migration has been identified. [24]

In the case of Skipjack tuna, although they occur throughout the equatorial Pacific, catches are highest in the Western Pacific warm pool. This pool is displaced under the influence of ENSO variability [25], and this variability in location would need to be taken into account when designing a marine reserve network. This species [24] generally aggregates in the area of current convergence and boundaries between warm and cold water masses, upwelling areas and other areas where there are changes in hydrography. Larval distribution appears to be governed largely by water temperature which must be between 15^0C and 30^0C. The juvenile fish occupy the same waters as larvae, but move to cool waters as they mature.

Variation in the occurrence of Bigeye is also related to seasonal and climatic changes in surface temperature and thermocline and younger fish may aggregate with other tuna species at the surface and in the vicinity of floating objects. Juveniles have not been reported outside tropical waters. Adult fish tend to be solitary. As this species is more tolerant of lower water temperature and oxygen saturation, it is found generally in deeper waters, up to 250m depth [24]. In the case of Bigeye tuna, the greatest proportion of the catch appears to be taken by longlining in the eastern area of the equatorial WCPO. This information could be further refined by expanding the VMS currently used to underpin the regulation of the Purse Seine fishery to the longlining fleet.

By combining such fisheries data with biological information, such as information on migration patterns and known spawning areas, it should be possible to identify priority areas. One recent study that could help with this process suggests that species diversity for the Pacific was positively correlated with climatic variation. This variation was reflected in changes in Sea Surface Temperature (SST), adequate oxygen saturation coupled with oceanographic features such as fronts or eddies which gave rise to productive feeding areas [26].

While it should be possible to identify some key areas that could be set aside as large-scale marine reserves by combining different sets of existing information, further data and research directed at gathering these data is necessary.

d) Solving the problem of the "Donut holes"

One pragmatic first step to establishing a network of marine reserves in the WCPO, might be for the WCPFC to designate those areas of high seas which are completely enclosed by EEZs of coastal states, the so-called "donut holes", as marine reserves. There are two obvious examples - a smaller western area between Palau, FSM, PNG and Indonesia (approx.136^0E – 151^0E, lying east-west, just north of the Equator) and a larger area (157^0E to 176^0E, lying NW-SE between the equator and 15^0S) (see Figure 1).

Both areas are periodically highly productive and attract considerable effort and catch[17], although the smaller area seems not to be a high Bigeye catch area, based on earlier analyses[10]; both lie within the WEP, in the PNA area and their closure could have a positive effect in reducing overall effort and catch for both Longline and Purse Seine fisheries. Also, designation of these areas as marine reserves would be a tool in combating IUU fishing which is thought to be rife in these areas.

Comprehensive MCS arrangements would be required for the successful implementation of such MRs. In addition, it would be important to gather as much information as possible relating to the ecology of these areas and the history of the fisheries prosecuted within them, so that any changes occurring can be effectively monitored.

Initially agreeing to set one of these areas aside as a marine reserve for a few years on an experimental basis might be the best way of gaining support for the concept.

11. Assessment of MR models and an appropriate model for the WCPO

As noted, there seems to be few examples of extensive time/area closures as management options in tuna fisheries, let alone permanent no-take areas the equivalent of marine reserves. The IATTC, in the EPO,

[17] The estimated catch in international waters by the Purse Seine fleets fishing in the WCPO (excluding the Philippines domestic fleet) was around 19% for the period 1996-2003

closed an area[18] in December 2003 to all Purse Seine fishing for tuna. This was an area, mostly high seas, where catches of juvenile Bigeye had been higher than average, and where Yellowfin catches were also high. The RFMO closed the Purse Seine fishery for the entire EPO for six weeks in August-September in 2004. This Resolution was replaced in 2005[19] by a requirement that Purse Seine vessels of each party or entity cease fishing in the EPO for six weeks during one of two periods (August/September or November/December) in each of the years 2004, 2005 and 2006. The effects of those closures were to be analyzed and assessed in 2005 and 2006 by the IATTC Scientific Working Group. Apart from limited time area/closures associated with restrictions on fishing floating objects e.g. ICCAT, IATTC – see earlier, there appear to be no other examples of time/area closures in tuna fisheries which might be evaluated for their applicability to the WCPO situation.

Accordingly, Greenpeace suggests that much valuable data could be gathered through closing the Palau/FSM/PNG/Indonesia donut hole and the other defined area, provided the necessary monitoring and enforcement arrangements were in place at WCPFC. This is, therefore, suggested for trial at the earliest possible opportunity.

---

[18] IATTC Resolution on the conservation of tuna in the EPO (C-03-12)

[19] IATTC Resolution for a multi-year program on the conservation of tuna in the EPO for 2004, 2005 and 2006 (C-04-09)

12. Other options

No other options are considered at this point. The WCPFC will need, however, to work cooperatively with the IATTC on several issues:

- In order to manage north Pacific Albacore throughout the range of the stock, to implement the recent Resolution[20] calling for "measures to ensure that fishing effort on the stock in the WCPFC area does not increase, and as necessary, measures to reduce fishing effort to levels commensurate with the long-term sustainability of the stock".
- Compatibility between any management measures for Bigeye tuna introduced in the EPO and WCPO.
- Cooperation in data collection and management of particularly of that area in which there is overlap[21] in areas of competence of the two RFMOs.

Conservation and management options relating to non-target species will need to be considered in the near future, as requested by the Commission for the second session later this year e.g. cooperation in the conservation of sharks caught in association with tuna fisheries. These are likely to be shared stocks between the WCPO and EPO in many cases[22].

---

[20] IATTC Resolution on northern Albacore tuna (C-05-02)

[21] An area between 150^0W and 130^0W, and 4^0S and 60^0S.

[22] IATTC Resolution on the Conservation of sharks caught in association with fisheries in the EPO (C-05-03)

13. Recommendations to the Commission

The Commission is committed to adopting, at WCPFC 2[23], conservation and management measures necessary to address sustainability concerns, based on advice from the Scientific Committee, the Technical and Compliance Committee and any information provided by members at least 30 days in advance of the second annual session, in December 2005.

"*Such measures may include, inter alia:*

(a) catch and effort limits

(b) capacity limits for large–scale fishing vessels

(c) measures to address impacts of large-scale fishing vessels so as to ensure compatibility between measures applied outside areas of national jurisdiction and measures being applied by coastal states to manage such vessels within their zones

(d) time and area closures, and

(e) mitigation measures to address the mortality of non-target species, eg seabirds, turtles and sharks.

In accordance with Art.6 of the Convention, the precautionary approach will be applied and the absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures."

The current document focuses primarily on measures (a), (b) (c) and (d) at this time.

---

[23] Resolution on conservation and management measures. WCPFC/Comm.1/8, Annex II

Noting that overfishing is occurring on both Yellowfin and Bigeye tuna, Greenpeace believes that WCPO resources may be in overfished state, given the range of uncertainties that pertain to the present assessments, and the extent to which IUU fishing may be occurring. Measures to rebuild the stock are not yet under discussion, but should be anticipated. Such measures must accord with a precautionary approach, particularly since capacity and the catch of most species in the WCPO continue to grow. It should be noted that recent levels of recruitment have been relatively high for Skipjack, Yellowfin and Bigeye, and some projections predict much less optimistic views of the stocks at long term average levels of recruitment.

As noted, it will be some time before the WCPFC is fully operational and effective, in terms of tackling management and conservation issues. These include the development of allocation criteria leading to national allocations, and comprehensive MCS arrangements (including regional observer and VMS programs). Against this background, in the short term, it probably falls on coastal states, acting individually or in concert, to apply interim management measures at the national level, possibly within the framework of national tuna management plans.

Greenpeace calls for the following as major recommendations to the WCPFC at its second session, in terms of the adoption of conservation and management measures:

(1) The immediate establishment of a marine reserve in an enclosed high seas area bound by Palau, FSM, PNG and Indonesia, and a commitment to establishing a second fully-protected marine reserve to the east in the future.

(2) Establishment of management objectives of the WCPO fishery, based initially on Annex 2 of the UN Fish Stocks Agreement.

(3) An immediate moratorium on the construction of new large Purse Seine (Super Seiner & Super Super Seiner) and large Longline vessels intended to fish in the WCPO, and controls on the relocation/deployment of such vessels from other areas.

(4) The WCPFC undertakes a study of the capacity of large Purse Seine and Longline vessels active in the WCPO, leading in the short term to the introduction of overall limits on vessel numbers. Also, development of a suitable measure of capacity (Purse Seine and Longline) to facilitate the orderly management of fleet capacity in the WCPO, including clear definition of vessel categories e.g. “large scale”. From a conventional fisheries perspective, this study is critical to determining the level of capacity available in the region and more importantly what

“capacity” the region’s fish stocks can sustain. From Greenpeace’s perspective, however, we take the view that Super Super Seiners should not be allowed to operate in the region given their huge capacity.

(5) Large uncertainties are inherent in the models used to produce assessments and forecasts for tuna fisheries in the WCPO. These relate to input data quality together with substantial indeterminacies in data relating to effort, catch and IUU fishing, as well as to factors such as recruitment and the influence of climate change. Greenpeace believes that basing management upon MSY target reference points is not sufficiently precautionary. Accordingly, Greenpeace regards the 20% effort reduction figure suggested from modeling as an absolute bare minimum requirement. To assure future sustainability of fisheries in the region this figure should be set at 50%.

(6) The WCPFC should apply a Longline Total Allowable Catch (TAC) for Bigeye, based on lower catch levels from an earlier time period, with allocations/quotas for countries or entities taking a large amount of catch (e.g. more than 3,000t). The restriction of catches by other nations to catches at that earlier time should also be enforced. This measure should be introduced in conjunction with a trade certification/verification system for Bigeye, as used by other Regional Fisheries Management Organisations (RFMOs).

(7) Immediate prohibition of at-sea transhipment, with such transhipment to occur only at designated ports, as

provided for in the Convention and to be implemented by the Commission.

(8) Implementation of the following series of measures to reduce IUU fishing in the WCPO, as proposed by Greenpeace: ratify and implement the Compliance and Fish Stocks Agreements; exert control over port access and marketing of tuna products (trade verification); strengthen the WCPFC capacity to take action (regional and global vessel registries, IUU vessel blacklist, reduce size of vessels covered by Monitoring, Control and Surveillance (MCS) regulation, boarding and inspection regulations, prohibition of at-sea transhipment);practice good governance at national level (comprehensive management plans, appropriate legislation enforced); inspect and arrest IUU stateless vessels (national-level action).

(9) That the Commission commence work on the development of criteria for the allocation of TAC and Total Allowable Effort (TAE), as provided for by the Convention.

(10) Additional research must be carried out to reduce uncertainty and indeterminacy attached to key parameters/assumptions and model structure of the present MF-CL models.

References

[1] Williams, P. and Reid, (2005) Overview of tuna fisheries in the WCPO, including economic conditions – 2004. WCPFC-SC1, GN – WP 1

[2] Lawson, T.A. and P. Williams (2005) Estimates of annual catches in the WPCFC Convention Area. WCPFC-SC 1, ST-IP 1.

[3] Greenpeace (2005) Position paper on the conservation and management of highly migratory fish stocks in the WCPO. WCPFC-SC1, GN IP-8

[4] Molony, B. (2005) Estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks. WCPFC- SC 1, EB WP-1

[5] Interim Secretariat of the Preparatory Conference (2004) Management Options for Bigeye and Yellowfin Tuna in the WCPO. WCPFC/PrepCon/ WP 24, April 2004

[6] Hampton et al. (2005) Estimates of sustainable catch and effort levels for target species and the impacts on stocks of potential management measures. WCPFC-SC1, SA WP 10.

[7] Rodwell, L. (2004) FFA initiatives related to the Palau Arrangement, Purse Seine management and the management of Bigeye fishing mortality in the WCPO,. SCTB 17, WP FTWG -6

[8] Lawson, T. (2005) Status of data collection, compilation and dissemination. WCPFC – SC1, ST – WP 1.

[9] Lawson, T. (2005) Update on the proportion of Bigeye in "Bigeye plus Yellowfin" caught by Purse Seiners in the WCPO. WCPFC – SC1, ST – WP 3.

[10] Reid et al. (2005) An analysis of the fishing capacity of the global Purse Seine fleet. *In* Management of tuna

fishing capacity; conservation and spice-economics FAO, Rome

[12] Miyake, P. (2005) A review of the fishing capacity of the Longline fleets of the world. *In*

[12] Joseph, J. (2005) Past developments and future options for managing tuna fishing capacity, with special emphasis on tuna Purse Seine fleets. WCPFC-SC1, FT IP-5 (taken from Management of tuna fishing capacity; conservation and socio-economics. FAO, Rome.

[13]Gillett, R and A. Lewis (2003) A survey of Purse Seine fishing capacity in the WCPO, 198-2003. Admin Rept. AR-PIR-03-04, US Dept of Commerce, NOAA.

[14] Reid et al. (2003) An analysis of fishing capacity in the WCPO and management implications. Marine Policy 27(6): 449-469

[15]Richards, A.H. (2003) Fisheries monitoring, control and surveillance in the WCPO region. Report 03-25

[16] Lewis, A.D. (1995) Distant water fishing nation (DWFN) activity in the Philippines EEZ – a review. Desk study undertaken for the Philippines Tuna Research Project (PTRP). 29p.

[17] Greenpeace (2004) Pirates of the Pacific; Loopholes and solutions in the fight against illegal, unreported and unregulated fishing in the Pacific. Greenpeace Australia Pacific, June 2004

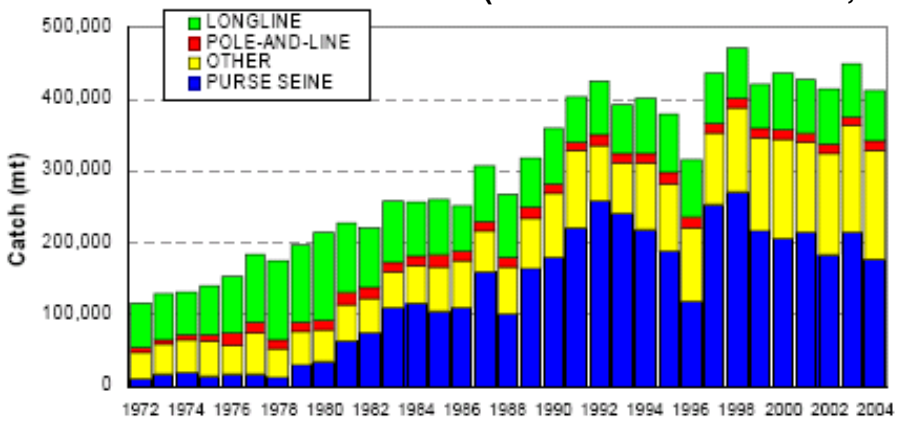
[18] Greenpeace (2005) Ecological criteria for the identification of potential marine reserves.
August 2005 manifesto.

[19] SPC (2002) Overview of Bigeye in WCPO tuna fisheries. ABY WG of the FFC, WP 1.1.

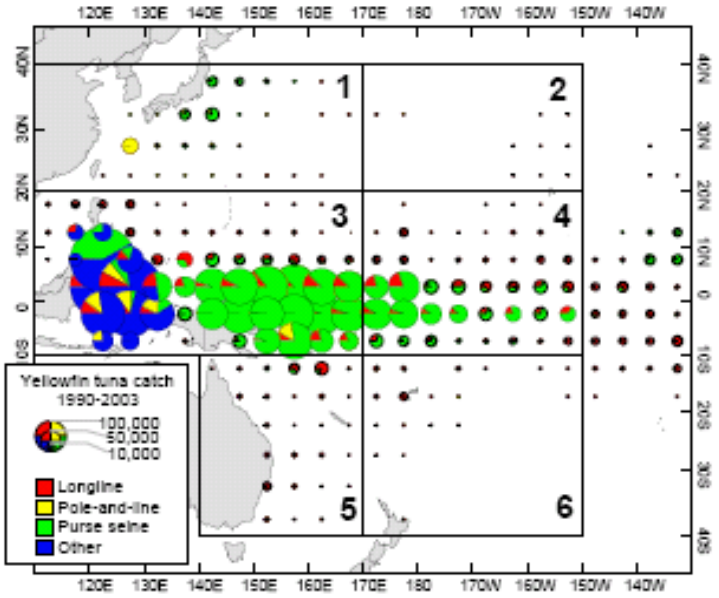
[20] SPC (2002) A comparison of management regimes applied to fisheries taking Bigeye tuna in four oceanic regions. ABY Species Working Group, 4th meeting, Rarotonga, Cook Is. May 2002
21 Scientific Consensus Statement on Marine Reserves and Marine Protected Areas. Symposium on Marine Protected Areas. Annual Meeting of the American Association for the Advancement of the Sciences. Publ. National Center for Ecological Analysis and Synthesis, University of California at Santa Barbara. 12pp
http://www.nceas.ucsb.edu/Consensus/consensus.pdf
22 Halpern, B.S. (2003). The impact of marine reserves: do reserves work and does reserve size matter? Ecological Applications 13 (1): 117-137
23 Roberts C. M. and Sargant H. 2002. Fishery benefits of fully protected marine reserves: why habitat and behaviour are important. Natural Resource Modeling. Volume 15, No. 4 Winter 2002
24 Myers, R.A. & Worm, B. (2005) Extinction, survival or recovery of large predatory fishes. Philosophical Transactions of the Royal Society Series B 360: 13-20.
25 Froese, R. and D. Pauly. Editors. 2005.FishBase. World Wide Web electronic publication. www.fishbase.org, version (09/2005)
26 Lehodey, P., Bertignac, M., Hampton, J., Lewis, A., Picaut, J., (1997) El Niño Southern Oscillation and tuna in the western Pacific. Nature 389: 716-718.

Appendix Figure 1. Features of the WCPO Yellowfin fishery

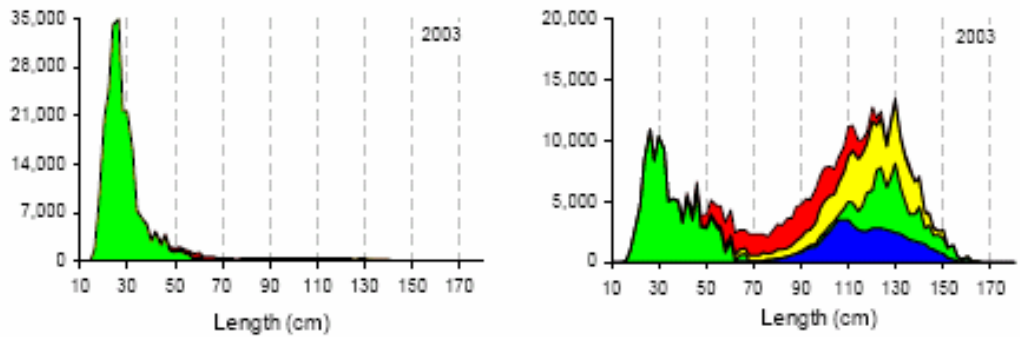
(from Williams and Reid, 2005)



WCP-CA Yellowfin catch by gear



Distribution of yellowfin tuna catch, 1990-2003

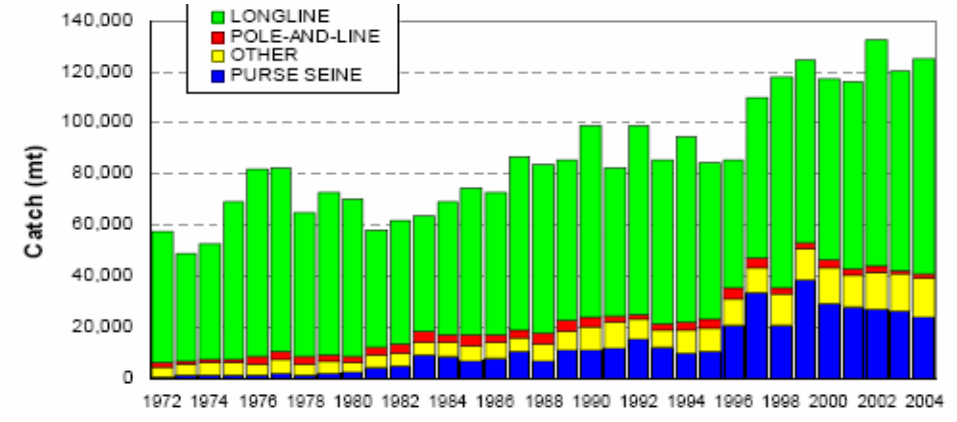


Annual yellowfin tuna catch by gear type, 2003. Numbers (left) and weight

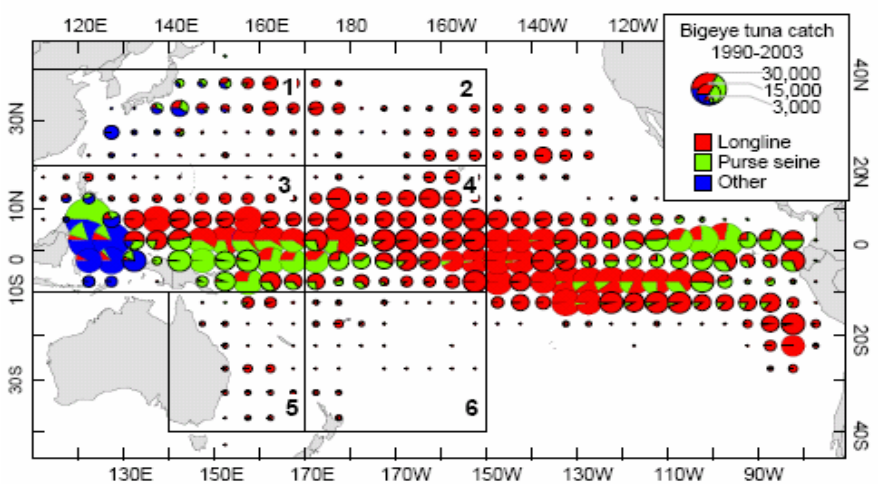
Green – Indo/Phils, red – p/s assoc, yellow – p/s unassoc, blue - longline

Appendix Figure 2. Features of the WCPO Bigeye fishery

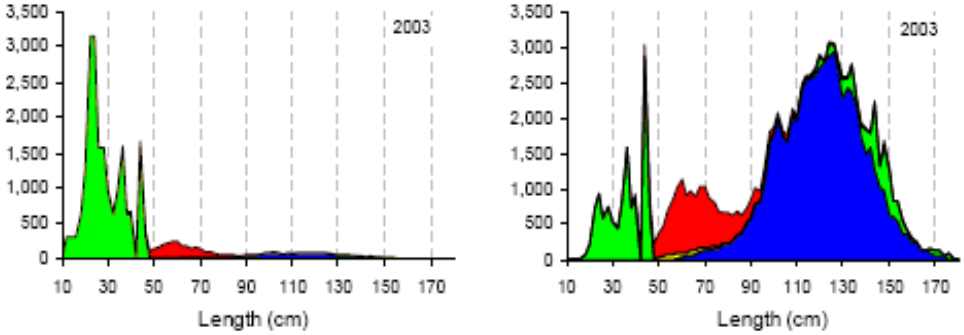
(from Williams and Reid, 2005)



WCP-CA bigeye catch, by gear. 1972-2004



Distribution of bigeye tuna catch, 1990-2003



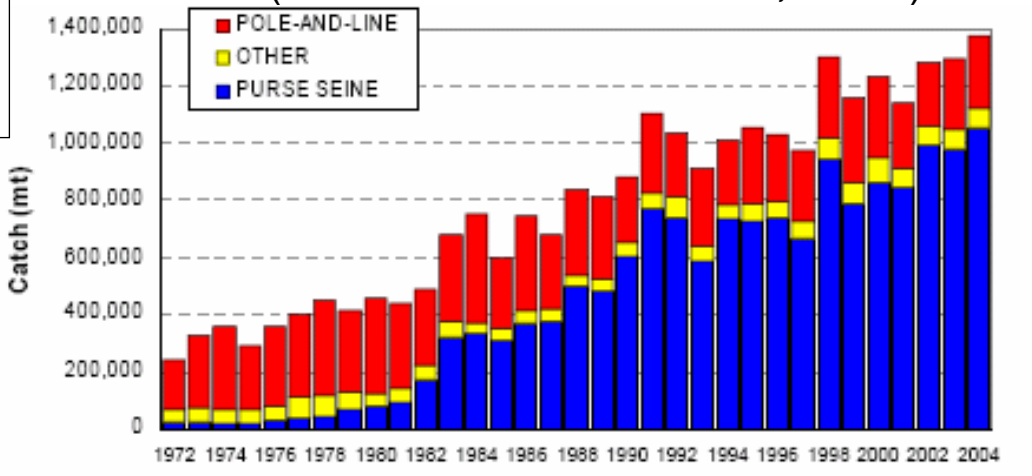
2003 catch of bigeye by length (left) and weight

Green – Indo/Phils, red - p/s assoc sets, blue – longline

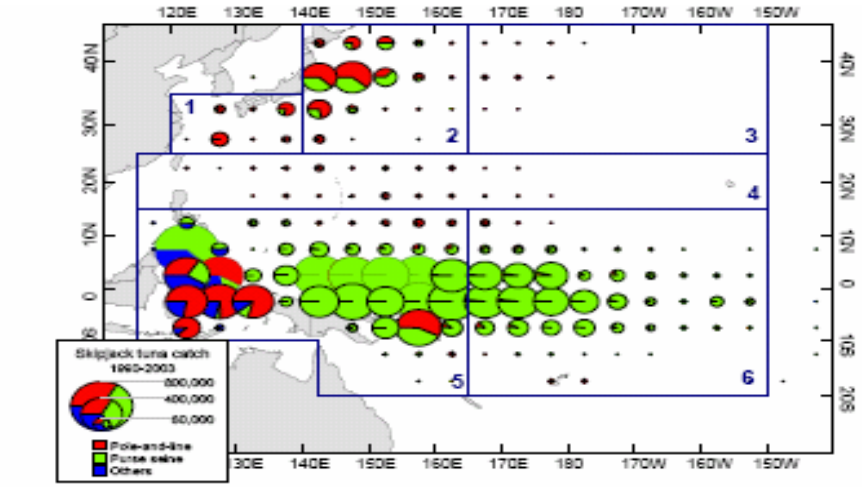
Appendix Figure 3. Features of the WCPO Skipjack fishery

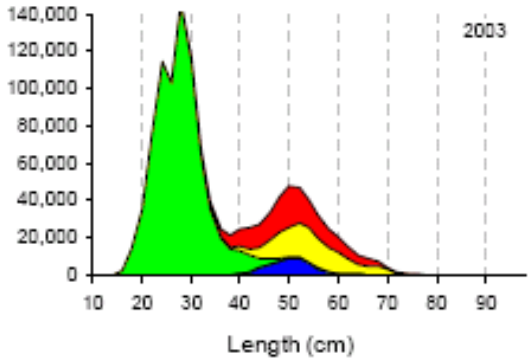
(from Williams and Reid, 2005)

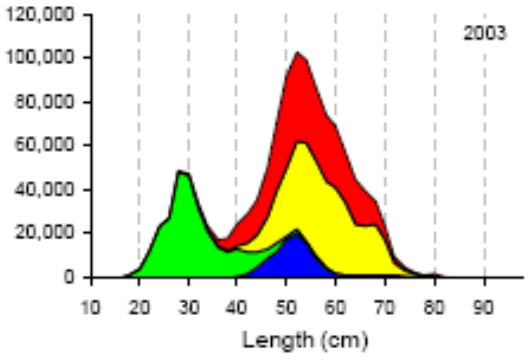
WCP-CA skipjack catch by gear



Distribution of skipjack tuna catch, 1990 -2003







2003 skipjack catch by length (left) and weight

Green – Indo/Phils, red – p/s assoc, yellow – p/s unassoc, blue – pole-and-line