

Potential Allocation Models in the Western and Central Pacific Fisheries Commission

Hannah Parris¹

Abstract

The implementation of *Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean* provides all stakeholders an opportunity to implement a comprehensive management regime that incorporates all tuna stocks and all fishing activity using ecological sustainable development principles and best practice fisheries management.

The central problem facing the signatories to the *Convention* is typical of those facing common-pool resource (CPR) users everywhere: how are the tuna resources to be shared amongst stakeholders, how much tuna should be harvested, where should it be harvested and who should be allowed to harvest it? Arguably, the international dimension of the *Convention* complicates the problem because of the significantly greater diversity amongst stakeholders in terms of size, power and resources available for negotiation, interests and aspirations each hold in the stocks.

This paper argues that addressing the CPR management needs is best achieved by drawing on lessons from the incentive based fisheries management literature and developing management frameworks centered around the explicit and transparent allocation of tuna resources under the rules of the *Convention*. In this paper 3 such approaches to allocation are presented and the equity and technical features of each are discussed.

Key Words: *Western and Central Pacific Ocean, Western and Central Pacific Fisheries Commission, tuna, Pacific, fisheries*

1. INTRODUCTION

The Western and Central Pacific Fisheries Commission (WCPFC) is empowered to determine the allocation of fisheries resources between Contracting Parties (CPs) for which it is responsible and considerable interest in potential allocation mechanisms have been discussed by Commission members on both a formal and informal basis (WCPFC, 2007; MRAG, 2006). Nevertheless, progress on the discussion of allocation issues in the WCPFC remains stalled, in part, due to political reluctance to explicitly consider the contentious topic of who should bear the burdens of any reduction in fishing effort or harvests. Equally as important is lack of structured concepts about what

¹ Crawford School of Economics and Government, The Australian National University¹.
Contact: Hannah.Parris@anu.edu.au

an allocation regime may look like and what may be the implications for WCPFC members².

Although recognizing this reluctance by Contracting Parties, this paper argues that the explicit and transparent allocation of tuna resources under the rules of the Convention remains a potentially valuable and effective way for the WCPFC to meet its management responsibilities, in particular the sustainable management of stocks, whilst also addressing the aspirations of stakeholders. This paper aims to address the second issue facing WCPFC stakeholders – lack of appropriate structured models around which allocation can be discussed. Drawing on fisheries economics, institutional economics and adaptive management theory³ – as well as contextual factors relevant to the WCPFC -- three alternative allocation regimes that could meet the requirements of the Convention are presented and discussed. The relative performance of each model is then discussed in terms of its equity implications and the technical issues that may influence the choice of operating model.

2. THE IMPORTANCE OF THE WCPFC

The Western and Central Pacific Ocean (WCPO – see Map One) forms one of the world's largest fishing ground for four commercially important species of tuna - yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), albacore tuna (*Thunnus alalunga*) and big-eye tuna (*Thunnus obesus*). Although largely 'owned' by coastal states, the vast majority of whom are Pacific Island Countries (PICs), tuna resources are primarily harvested by distant water fishing nations (Japan, Korea, Taiwan, US) although domestic harvesting by PICs is also significant. Foreign fleets access fishing ground through the purchasing licensing arrangements with regional governments and it is through this process, as well as through their own fishing efforts, PICs seek to gain economically from this valuable resource.

Unlike other fisheries, tuna stocks in the WCPO do not appear to be threatened with imminent population collapse and concomitant declines in fish numbers, but over fishing is occurring and evidence suggests significant threats to future stock sustainability. Recent data suggests that catches of some tuna in the region may have peaked, such as yellowfin tuna, and that some stocks, such as bigeye tuna, may even be overexploited beyond its maximum sustained yield (Langley et al., 2005). Analysis by Reid et al. (2003) also indicates the tuna fleets are characterized by substantial overcapacity, which is a major cause of unsustainability in many of the world's fisheries (FAO, 2002).

² For example MRAG (2006) prepared an allocation paper for the third WCPFC annual meeting, but this was considered by FFA countries to insufficiently cover the range of issues associated with allocation (WCPFC,2007)

³ For an overview of fisheries economics see Gordon, 1957; Bjorndal and Munro 1999 and Kompas, 2005; Wilson, 1982; Davis and Gartside, 2001. An overview of property rights in fisheries is given by Scott, 1999 and Davis and Gartside, 2001. For an over view of institutional economics used here see Ostrom, 1990 and Ostrom et al 1994 and for the adaptive management approach used in this research see Marshall, 2005 and Folke et al 2002).

Since the early 1980s, tuna management has been organised around the principle of PIC ownership of tuna resources through the institution of exclusive economic zone (EEZ) as developed under the United Nations Conference on the Law of the Sea (UNCLOS) (United Nations, 2004; Munro 1990)⁴. PICs have used these internationally recognized rights to pursue a range of strategies in an attempt to capture economic rent from tuna harvesting activities either through their own fishing efforts or by allowing harvesting by DWFN fleets in return for financial compensation (through a government to government licensing system) (Schurman, 1998; van Santen and Muller, 2000). To assist in exploiting these rights Quickly recognising the potential of these EEZ rights, the independent Pacific Island Countries (PICs) responded to receiving these rights through the formation of the Forum Fisheries Agency (FFA), to assist them in the management and regional coordination of these valuable resources.

In recent years the EEZ institution has been challenged by the collective governance principles established under the UN Straddling Fish Stocks Agreement⁵. From the mid-1990s, it was recognised by both PICs and DWFNs that, although PIC have technical ownership over tuna resources within their territorial waters, by virtue of the fact that tuna move between EEZ, and the high seas, they were, in effect, a jointly owned resource (Tsamenyi, 1999; in particular see also the 'Majuro Declaration')⁶. It was thus recognised that management activity (including harvesting) in one area of the WCPO greatly affected the management and harvesting opportunities in other areas, and that, consequently, joint management of the tuna stock as a whole biological entity may be of benefit to all (Sibert and Hampton, 2003). This principle underpins the recently ratified *Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean* (hereafter "*the Convention*"), which is an attempt to re-organise tuna management from that of an individual country basis (as per the EEZ regime) to that of a collective regime, whereby all stakeholders, owners and tuna harvesters, make joint decisions about, or at least coordinate management of, tuna resource⁷. At a minimum, it is hoped that this new Convention can harmonise management arrangements across jurisdictions. Drawing together the FFA states, the 'distant water fishing nations' and other coastal states of the region⁸, this new emphasis on formal cooperation and harmonisation of management regimes essentially

⁴ Tuna habitat spreads across a large area of the WCPO composed of both EEZ of Pacific Island Countries (ocean out to 200 nautical miles) and the high seas between EEZs.

⁵ Formally, this treaty is called the "Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks". The term "UN Straddling Fish Stocks Agreement" is used for the sake of brevity.

⁶ When tuna stocks swim through areas of 'high seas' they are essentially open to be legally fished by all parties. For scientific analysis to support this view see Sibert and Hampton, 2003. A copy of the Majuro declaration can be found at <http://www.oceanlaw.net/texts/majuro.htm>

⁷ See Article 2 and Article 8.

⁸ The full membership of the WCPFC is as follows: Australia, China, Cook Islands, European Community, Federated States of Micronesia, Fiji, France, Japan, Kiribati, Korea, Republic of the Marshall Islands, Nauru, New Zealand, Niue, Palau, PNG, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, USA and Vanuatu. In addition the region's USA, EU and New Zealand Territories also have participatory rights. Belize and Indonesia participate as cooperating non-members.

represents a new regime shift in tuna management across the WCPO (see Aquoru, 2001).

3. BASIS FOR ALLOCATION IN THE WCPFC

The arguments for an allocation based management approach in the WCPFC draws heavily on the economic, legal and political dimensions of the governance space created by the collective management framework of the Convention.

From a legal perspective, the WCPFC is fortunate in that the *Convention Text* itself provides a strong legal basis for pursuing allocation by explicitly empowering the Commission to; inter alia, establish TAC/TAEs (Article 10 (1)), and the ability establish criteria for determining allocation formula. The WCPFC is also unique amongst tuna RFMOs in that Article 10 (3) explicitly sets out what kind of issues must be reflected in any negotiated criteria.

Although mentioned, the WCPFC makes less reference to the economic dimensions of fisheries management and the economic basis of allocation used in this paper draws, instead, from the literature. Allocation in this paper is considered within the context of broader incentive based management framework. The later, in turn, is defined here as the explicit identification of a management goal for the fishery (e.g. achieving maximum economic yield) and the unambiguous statement of what actions are required, permitted or forbidden, and by whom, with respect to the tuna resources – that is the ‘rules of use’ of the resource. The economic case for allocation based approach is extensively explored in the fisheries economic literature and lie primarily in its ability to construct a more robust basis for ensuring system sustainability, through linking strategic long term goals with day to day management activities, to provide incentives for stakeholders to work towards this outcome and to provide security of access to resources (Kompas, 2005; Grafton et al., 2005; Moloney and Pearse, 1979). These benefits revolve around successful resolution of the allocation question, which must be determined in a way which provides sufficient economic rewards for stakeholders to participate, or at least not cheat on established fishery harvest or effort targets.

In contrast to the legal basis, the political drivers towards an allocation based regime are somewhat slow to progress. One reason for this is the reluctance revolves around the need for an allocation regime to explicitly consider the difficult issues regarding equity between members and its subsequent debates on the contentious top of who should bear the burdens of any reduction in fishing effort or harvests. Another reason is that the current suite of WCPFC contain within them an implicit allocation using the broad mechanism of the ‘status quo’ to determining relative shares between CPs. For many of the more powerful and well organised members of the WCPFC this has produced a favorable outcome -- for example with the adoption of the Vessel Day Scheme (WCPFC, 2005) which grants significant purse seine rights to the PNA Group of the FFA -- and, naturally, these CPs reluctant to open discussions on allocations lest, they perceive, they lose political and economic ground.

4. ALLOCATION FRAMEWORK AND KEY PRINCIPLES TO ADDRESS MANAGEMENT NEEDS

Allocation is an inherently political and subjective process and it is recognized that decisions regarding the final allocation pattern in the WCPFC will be the outcome of an intense political negotiation. These negotiations will inevitably center around the key decisions of ‘what’ is allocated and ‘how’ it is allocated and to ‘whom’ and many factors – theoretical ideas about ‘good’ fisheries management and empirical factors in the WCPO itself – will influence the outcome. *Article 10 (3)* of the Convention provides some guidance to negotiators, but the clauses in this text are difficult to use in deriving an allocation formula primarily because of their ambiguous meaning and the difficulty in quantifying them⁹.

To seek progress on this issue, this paper argues that the idea of ‘allocation’ should be viewed, instead, within the context of a broader management regime centered around three interrelated issues:

- How much fish should be harvested OR how much fishing effort should be allowed in the fishery (i.e. what is the TARGET?)
- If the amount of fish harvested or effort allowed in the fishery is limited (due to the TARGET) who should be allowed to fish and how much should each be allowed to harvest? (i.e. what is the ALLOCATION process?)
- Once CCMs receive their ALLOCATED UNIT, what other rules may the WCPFC need to implement to allow CCMs to pursue their own tuna development strategies? (for example, does the WCPFC require RULES OF USE to allow for trading of allocation or other restrictions on fishing activity?).

These three issues, and their relationship, are summarized in Diagram One. These questions, and Diagram One, can be used by the Commission’s members to guide analysis and discussion about allocation and its relationship to the broader conservation and management decisions of the WCPFC. Although only the ‘allocation’ itself (i.e. the second issue) is often discussed in isolation, it is important to note that all three issues are necessary for an allocation regime to work. This is because allocation itself is meaningless without a cap, i.e. the TAC or TAE, on total amounts of permitted activity within the fishery (however defined). This cap, in turn, is the critical policy goal that provides resource security over the long term within the fishery -- without which the allocated unit becomes under-valued or even worthless (i.e. there is no value in holding resource rights to a fishery that has no fish!). The rules in use determine how the allocation may be used (for example can the allocations be traded between CPs?) and thus provides the policy framework within which individual CMMs can pursue different resource use strategies with their allocated unit. Depending on policy choices, rules in

⁹ For example it is unclear how to quantify the clause 10 (3) (i) which states (i) “the geographical situation of a small island developing State which is made up of non-contiguous groups of islands having a distinct economic and cultural identity of their own but which are separated by areas of high seas;”

use can also actively manage fleet capacity and therefore ensure that the over regime provides economic profitability and biological sustainability.¹⁰

ADD DIAGRAM ONE HERE

The Parties to WCPFC have a wide range of choice when determining the policy choices for each component of this framework. Some options that may be summarized in Table One and are discussed briefly below. These are not the only options, but were selected because they are considered to be options that suit the particular circumstances of the WCPFC, in particular the needs of the Pacific states.

Element in Management Regime	Key Ideas Used in Models
Target Selection	<ul style="list-style-type: none"> • Permanent targets and shorter term goals <ul style="list-style-type: none"> – Permanent biomass goal – Short run TAC/TAE adjusted to meet biomass goal (temporary units)
Allocation Principles	<ul style="list-style-type: none"> • Harvest/effort expended in EEZ is allocated to coastal state • Harvest/effort expended on HS allocated proportionally to flag states
Rules of Use	<ul style="list-style-type: none"> • Units allocated permanently; defined as property rights • Rules of use: <ul style="list-style-type: none"> – Allocation units usable throughout WCPFC-CA (?) – Trading of temporary units – Pooling of units – Coastal states retain rights of access – Link vessel register privileges with fulfilling MCS responsibilities.

As the remainder the paper will focus on alternative allocation formulas, only the allocation principles will be considered very briefly here. As noted above, the WCPFC existing conservation and management measures carry with them an implicit allocation based on the ‘status quo’ pattern of fishing effort and harvest across the Convention Area. A key component of these measures is the principle – as reflected in the Vessel Day Scheme – that all fishing activity that takes place within the EEZs of member states is within the control of the coastal states. This view is reflected in the Text of the Convention and forms the fundamental political position of the FFA states. As a consequence, these principles for determining allocation – although unique in international fisheries management – are considered the only politically acceptable option in the WCPFC.

¹⁰ As allocation occurs at an international level to CPs, allocation in and of itself will not ensure appropriate management of fleet capacity if, for example, CPs chose to hold units of TAC or TAE ‘in trust’ and create a competitive race to fish between vessels.

4.1. Three variations in allocation models

Based on these key principles, the following three alternative allocation based management regimes are presented, with preliminary results from the allocation calculations discussed in Section 3. Diagram Two sets out the basic methodology used to develop these allocation estimates.

Insert Diagram 2 here

4.1.1. Variation One: Effort Based Allocation using current WCPFC measures

The objective of this “Effort Based” model is to develop an allocation mechanism that reflects the implicit allocation of effort (and in the case bigeye tuna, harvest levels) as implied in the current set of WCPFC conservation and management measures (CMMs). The fishery is managed through a total allowable effort (TAE) target linked to estimates of long run profitable effort collaborated to achieving the maintenance of long run biomass goals.

The key CMMs incorporated in this model are:

- CMM 2005-01 Yellowfin tuna and bigeye tuna – VDS essentially reflects the precedence set in WCPFC CMM 2005-01¹¹ which allocates purse seine fleet effort to the PNA coastal states as described under the Vessel Day Scheme (Pacific Islands Forum Fisheries Agency, 2007).
- CMM 2005-01 – allocation for bigeye tuna for long line fleets.¹²
- CMM 2005-03 – southern albacore tuna

This model thereby represents the *minimum change* from the status quo and aims to achieve sustainable levels of harvest (and potentially effort) through the indirect method of controlling fishing effort. Under this model the fishery operational target is set through the establishment of a total allowable effort level (TAE) for the purse seine, fresh and frozen long line and pole and line fleets.

4.1.2. Variation Two: Harvest Based Model

Under this alternative the fishery is managed through the establishment of a total allowable harvest level (TAC) for skipjack tuna, yellowfin tuna, bigeye tuna and southern

¹¹ Conservation and Management Measure (CMM) 2005-01 For big eye tuna and yellow fin tuna in the Western and Central Pacific Ocean sets out rules limiting total level of fishing effort for these two species to approximately 2004 levels. A major strategy for its implementation is the Vessel Day Scheme (VDS) as developed by certain FFA countries, and ‘compatible measures’. The VDS operates so as to set a Total Allowable Effort (days) for purse seine vessels and allocates these days to coastal state parties participating in this agreement (Joseph, 2006). Consequently, it can be interpreted that CMM 2005-01 implicitly provides all allocation of effort taken within zones to the coastal state.

¹² That is, assuming that all Parties caught, in the future, the equivalent of their average 2001-2004 catch or 2000 tonnes. Since not all Parties actually catch this amount, this allocation mechanism is essentially allowing for an expansion in the bigeye tuna harvests.

albacore tuna stocks and allocation calculations are based on historical spatial harvest patterns. The years 1997-2005 were chosen as the base years for determining the relative shares as this reflected both a period of several ENSO cycles in the Pacific, which alter the geographical spread of skipjack tuna harvests (Lehodey 2001), and the scope of the time series used in the analysis. However, to explore the sensitivity of the results

In addition to allocations made to individual Parties of the WCPFC, this model explicitly allocates two separate global 'pools' of harvest rights that are held by the Commission as a whole. The first allocation 'pool' is made to cover harvests taken by fishers (such as subsistence fishers) whose target stocks are biologically part of the WCPO tuna stocks but for some reason are not institutionally incorporated within the WCPFC allocation based management regime (for example, artesian catches or catches taken in Indonesian waters). This ensures that catches taken from non-covered sources do not become a source of 'leakage' for the system, and thus undermine broader efforts to achieve stock sustainability. Following on Chand et al (2003), the second pool is to allocate directly to the WCPFC Secretariat, who can then auction the TAC for fund raising purposes, for capacity buyback schemes or to a 'development/capacity fund' for SIDS members of the Commission.

4.1.3. Variation Three: Biomass allocation model

Under this alternative, the fishery is managed through the establishment of a total allowable harvest level (TAC) for skipjack tuna, yellowfin tuna, bigeye tuna and southern albacore tuna stocks but the allocation formula is based on the expected spatial distribution of biomass throughout the Convention Area. The years 1995-2005 were chosen as the base years for determining relative shares as this reflects the impacts of several ENSO cycles in the Pacific, as well as recent levels of biomass available in the fishery.

As it is based on expected biomass, rather than historical effort or harvest history, the method of calculating these shares is significantly different from the previous two models. This allocation mechanism calculates relative shares based on the relative sizes of coastal state EEZs and the estimates of sub-region biomass as estimated in the MFCL model (taken from Hampton et al, 2006a, 2006b; Langley et al 2005a, 2005b).

5. ALLOCATION SHARES: RESULTS AND COMPARISON TO CURRENT FISHING ACTIVITIES

The results for the three allocation models are set out in diagrams 4, 5 and 6. For conciseness, the results for individual countries are grouped together with CPs of similar interests although it is acknowledged that this does mask some differences within groups as actual shares for individual countries may differ significantly from what

is suggested by group totals. These groups are: PNA Countries¹³, Other FFA Countries, DWFN, Other WCPFC and Indonesia (and disputed areas for the Biomass model).

ADD DIAGRAMS 3, 4,5 HERE

In considering issues regarding allocation, debate often centers around the relative performance of the new management regime compared to the existing situation. To this end, the following comparisons were made:

- Biomass and Harvest Based Models compared to proportional share of harvest in 2005 harvests – allocated to each country using same allocation rules; and
- Effort based Models, compared to the level of effort in the purse seine fleet in the fishery in 2005.

These results are set out in Figures 6,7,8,9,10

ADD DIAGRAMS 6,7,8,9,10 HERE

As indicated in the results, there are two general patterns emerging from the use of the allocation principles supported by the FFA states. These are:

- Each species is allocated according to different patterns, but, in general, the majority of the allocation goes either to the PNA Group and/or the DWFN group and both groups dominate the allocation accruing to the “Other WCPFC” country and “Other FFA Countries” group with the later doing particularly poorly. Notable exceptions are the allocation for yellow fin and albacore tuna in the Harvest Based Model and in the Fresh Long line and Pole and Line Fleets in the Effort Based Model.
- When comparing the allocation patterns compared to the status quo at in the year “2005”, the general pattern suggests a shift of available resources away from the PNA countries and towards the “DWFN” and “Other FFA Group”, although albacore tuna is the exception, where the PNA, Other FFA and Other WCPFC Country groups gain at the expense of the DWFN group.

It is acknowledged that use of alternative base lines in the underlying data set could produce alternative outcomes and these options are intended as extensions to this current paper.

6. DISCUSSION

6.1. *Distribution of ‘Tuna Wealth’ and Equity*

The underlying coastal state/high seas allocation principle in each of these models assumes that this approach will produce an outcome that directs the largest share of

¹³ The PNA Group is a sub-group of countries within the FFA that uniquely identify and cooperate on the basis of their shared interests in the purse seine fishery. They differ from the other FFA members whose interests tend to lie in the long line fisheries. For more details see Aqorau and Bergin (1997).

tuna resources towards the FFA states, with the PNA states being particularly advantaged. These results are, therefore, somewhat surprising in the sizeable allocations that each scenario provide to both the DWFNs, to other WCPFC countries and to Indonesia, in some cases on more favorable terms than the FFA countries.

One explanation for observed allocation patterns in the Harvest and Effort Based Models arises from the choice of using recent historical catch and effort data as the basis for allocation. As this data reflects actual recent activity, then the allocation patterns using the data will also mirror this history — it is therefore unsurprising that the DWFN, which dominate recent fishery activity, are also dominant in the allocation formula. More generally, however, three factors contribute to the observed allocation patterns. First, is that Japan, Taiwan, the US are coastal states as well as being DWFNs – they therefore receive allocations from both the EEZ pool and the high seas pool. Second, that Indonesia and the Philippines are also significant coastal states and third, that Japan and Taiwan, and to some extent Korea, dominate high seas catches and effort for most gear types and for albacore tuna.

Clearly, each model results in different outcomes for FFA countries and evaluation of whether this is a ‘good’ or a ‘poor’ outcome depends on individual countries actual and relative allocations (compared to current situation and compared to other groups) and on the current and aspirational resource use strategies. But the unevenness of the allocation results raises some challenging questions for the WCPFC.

Primary among these is the implications for allocation arising from Article 30 of the *Convention* that requires that the WCPFC does not ‘place an undue burden on the SIDS members of the Commission in meeting conservation requirements’. As the different allocation mechanisms provide different relative shares to SIDS members both relative to each other and compared to 2005 it becomes a matter of interpretation to determine whether this approach is ‘unduly fair’. For example, in some instances (say comparing the “Other FFA Group” and the “PNA Group”) these allocations provide an increase in the share of the fishery for some, while representing a decrease in share for others.

Some of these ‘fairness’ issues could be managed through the use of appropriately crafted rules of use. For example, by allowing trading of allocated units and allowing CPs to use, or sell for use, their allocation units for use throughout the entire Convention Area this could increase the value of the unit and address some of the revenue generating concerns of SIDS members. Alternatively a case could be built around trading off the quantum of allocation for more secure rights either to access the fishery or security over the resource in general – but whether could be considered as ‘fair’ in the context of Article 30 is again a matter of interpretation.

One of the challenges of these results is that they underscore the unevenness in distribution of tuna wealth amongst the WCPFC and highlights the obvious point that a ‘formula’ approach will not lessen the need for a political debate – in the case of the WCPFC framed by article 10 (3) of the Convention – but it will provide a starting point for the inevitable arguments.

6.2. *Issues with a 'Technical Approach'*

In evaluating these models, several additional technical factors may alter the evaluation of preferred model. First, the Biomass Model adopts a GIS based spatial analysis using outputs from Multifan-CL. The technical nature of these models reduces the transparency of the allocation calculation and limits the modeling to the parameters set out in scientific model (which was construction for other purposes) – for example not incorporating skipjack tuna harvests south of 20⁰S and therefore underestimating potential allocations to Australia and New Zealand. The Biomass Based model also raises the issue of what to do with allocations associated with areas of the WCPFC-CA that are under disputed or joint jurisdiction.

Second, in delivering a sustainability outcome, it is also apparent that a TAC based model provides a more reliable link to achieving long run biomass goals, than does a TAE approach, which provides only an indirect relationship between permitted effort and biomass outcomes. The later is due to, in part, the inability for managers to accurately predict the level of harvest taken by vessels based on effort expended – primarily due to variations in gear types and effort creep over time. However, where catch reporting accuracy and monitoring issues are present, a TAE based policy tool can be easier to implement than a TAC.

A final factor is data quality. Publicly available data was used in the construction of these models, and although data used was considered the 'best available' several assumptions were adopted to enable calculations to be undertaken. Key data assumptions used were:

- Spatial effort data was not available for either long line fleets or the pole and line fleets. Therefore assumed that the spatial distribution of catch for these fleets was a reasonable proxy for this effort data – thereby assuming a close to one to one relationship between effort and catch.
- Some effort data related to domestic Japanese and New Zealand purse seine fleets was estimated to cover effort expended in national zones for this fleet.
- In the biomass model, species was uniformly mixing in the regions set out in the MFCL model.

7. Conclusion

Although an infinite number of management options could be considered for the WCPFC, this paper sets forth the argument for an incentive base approach and highlights three possible management frameworks that could be used to implement it in

ways that are consistent with the WCPFC Convention Text and the needs and aspirations of WCPFC Parties. The management models discussed in this paper do not absolve the WCPFC of the inevitable and difficult political decisions, particularly around the equity of alternative allocation formulas, that need to be made with regard to the tuna stocks, but use of these models provide a clear framework for decision processes.

It is likely that the need to implement the targets and allocation approach outlined in this paper will become more apparent as the pressure by industry and other stakeholders on the WCPFC to maintain stock viability increases. The models outlined here represent a pragmatic approach, blending the best of theory with the practical realities of the fishery and its stakeholders. However, these represent at best, a 'start' and significantly more analysis is required on the actual costs and benefits of each model for each Parties.

The ideas expressed here are unusual in the context of an regional fisheries management organisation – but the Pacific has a strong history of leading institutional development in international fisheries. They now have another chance, given the political will.

References

- Carlsson, L., & Berkes, F. (2005). Co-management: concepts and methodological implications. *Journal of Environmental Management*, 75(1), 65-76.
- Chand, S. G., R.Q. & Petersen, E. (2003). Multilateral Governance of Fisheries: Management and Cooperation in the Western and Central Pacific Tuna Fisheries. *Marine Resource Economics*, 18, 329-344.
- Davis, D., & Gartside, D. F. (2001). Challenges for economic policy in sustainable management of marine natural resources. *Ecological Economics*, 36(2), 223-236.
- Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio*, 31(5), 437-440.
- Grafton, R. Q. (1996). Individual transferable quotas: theory and practice. *Reviews in Fish Biology and Fisheries*, 6, 5-20.
- Grafton, R.Q., Arnason, R., Bjorndal, T., Campbell, D., Campbell, H.F., Clark, C.W., Connor, R., Dupont, D., Hannesson, R., Hilborn, R., Kirkley, J.E. Kompas, T., Lane, D.E., Munro, G.R., Pascoae, S., Squires, D., Steinshamn, S.I., Turriss, B.R. and Weninger, Q (2005) Incentive-Based Approaches to Sustainable Fisheries available Economics and Environment Network (EEN) Working Paper, EEN0508. Available for download from <http://een.anu.edu.au/papers.html>
- Grafton, R. Q., Kirkley, J., Kompas, T. and Squires, D. (2006). *Economics of Fisheries Management*: Ashgate.
- Hampton, J., Langley, A., Kleiber, P. (2006). Stock Assessment Of Bigeye Tuna In The Western And Central Pacific Ocean, Including An Analysis Of Management Options. *Scientific Committee Second Regular Session 7-18 August 2006 Manila, Philippines*. WCPFC-SC2-2006/SA WP-2
- Hampton, J., Langley, A., Kleiber, P. (2006). *Stock assessment of yellowfin tuna in the western and central Pacific Ocean, including an analysis of management options*. *Scientific Committee Second Regular Session 7-18 August 2006 Manila, Philippines*. WCPFC-SC2-2006/SA WP-1
- Marine Resource Assessment Group. (2006). *Allocation issues for WCPFC tuna resources: A Report for the WCPFC Secretariat*. available at www.wcpfc.int
- Kompas, T. (2005). Fisheries Management -- economic efficiency and the concept of 'maximum economic yield'. *Australian Commodities*, 12(1), 152- 160.
- Lehodey, P. (2001). The pelagic ecosystem of the tropical Pacific Ocean: dynamic spatial modelling and biological consequences of ENSO. *Progress In Oceanography*, 49(1-4), 439-468.
- Langley, A. and Hampton, J.,. (2005b). *Stock assessment of albacore tuna in the south Pacific Ocean*. Noumea, New Caledonia. 1st Meeting of the Scientific Committee of the

Western and Central Pacific Fisheries Commission WCPFC–SC1 Noumea, New Caledonia 8–19 August 2005

Langley, A., Hampton, J. and Ogura, M. (2005). *Stock assessment of skipjack tuna in the western and central Pacific Ocean*. 1st Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission WCPFC–SC1 Noumea, New Caledonia 8–19 August 2005

Marshall, G. (2005). *Economics for Collaborative Environmental Management: Renegotiating the Commons*. London: Earthscan.

Miller, K. A. (2007). Climate variability and tropical tuna: Management challenges for highly migratory fish stocks. *Marine Policy Special Issue on Climate Change and Fisheries*, 31(1), 56-70.

Moloney, D.G. and Pearse, P.H. (1979) *Quantitative Rights as an Instrument for Regulating Commercial Fisheries* Journal of Fisheries Resources Board Canada, Vol. 36 pp 859 – 866

Ostrom, E. (1990). *Governing the commons : the evolution of institutions for collective action / Elinor Ostrom*. Cambridge ; New York :: Cambridge University Press,.

Ostrom, E., Gardner, R. & Walker, J. (1994). *Rules, Games and Common-Pool Resources*. Ann Arbor: University of Michigan Press.

Pacific Island Forum Fisheries Agency (2007). *Vessel Day Scheme (VDS) Implementation (Parties to the Nauru Agreement)*. Available from www.ffa.int

Western and Central Pacific Fisheries Commission (2005) *Conservation And Management Measures For Bigeye And Yellowfin Tuna In The Western And Central Pacific Ocean*, Adopted at Second Regular Session, 12-16 December 2005.

Western and Central Pacific Fisheries Commission (2006) *Conservation And Management Measures For Bigeye And Yellowfin Tuna In The Western And Central Pacific Ocean*, Adopted at Third Regular Session, 11-15 December 2006.

Western and Central Pacific Fisheries Commission (2007). *Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean Third Regular Session: Final Report*. 11-15 December Apia, Samoa.

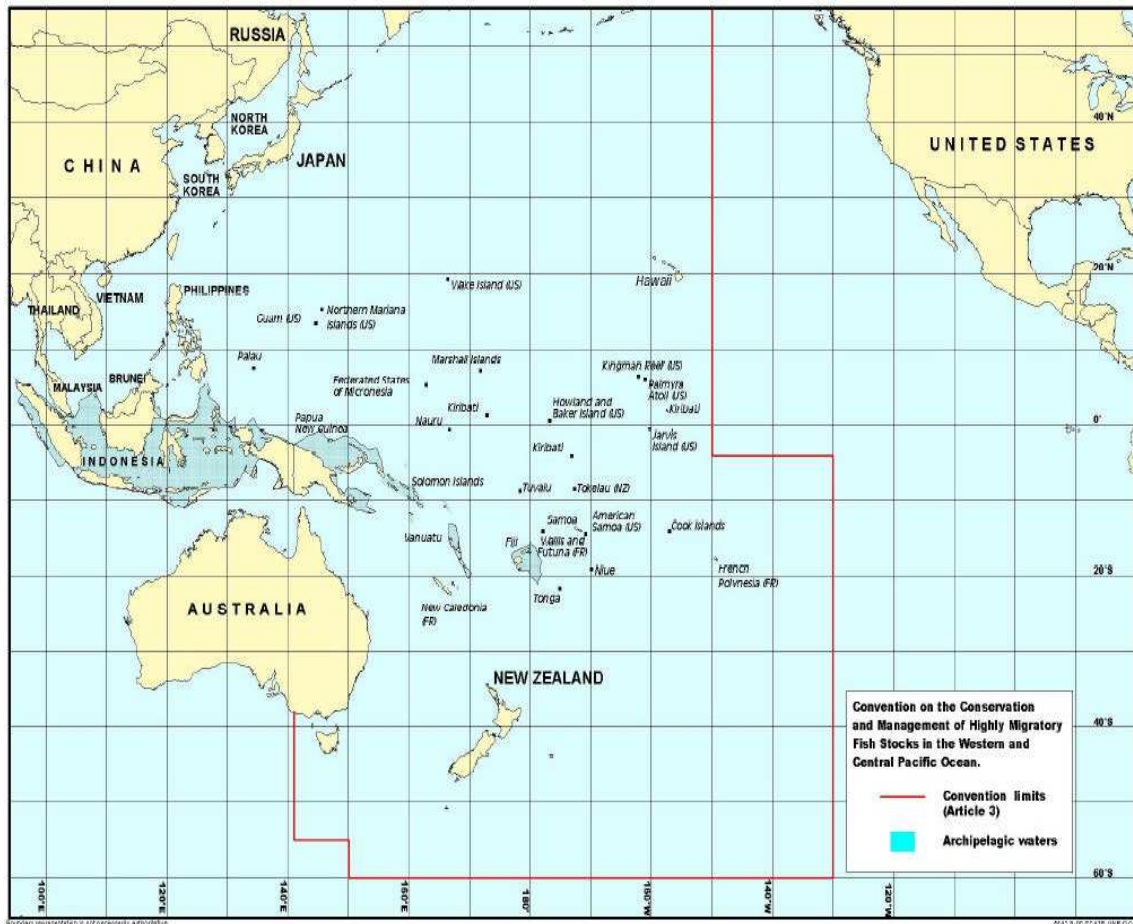


Diagram One: Map of the Western and Central Pacific Fisheries Commission Convention Area.

Source: WCPFC Secretariat

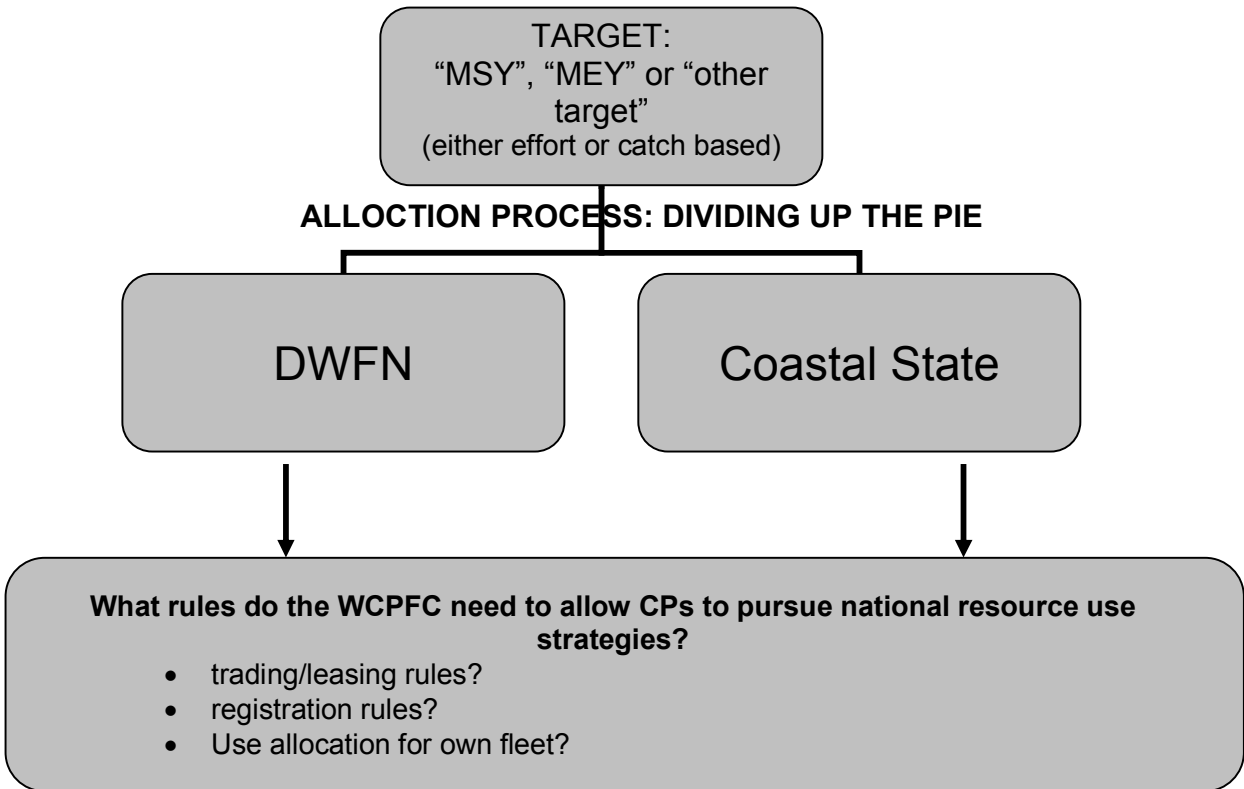


Diagram 1: Key Steps in an allocation based management framework

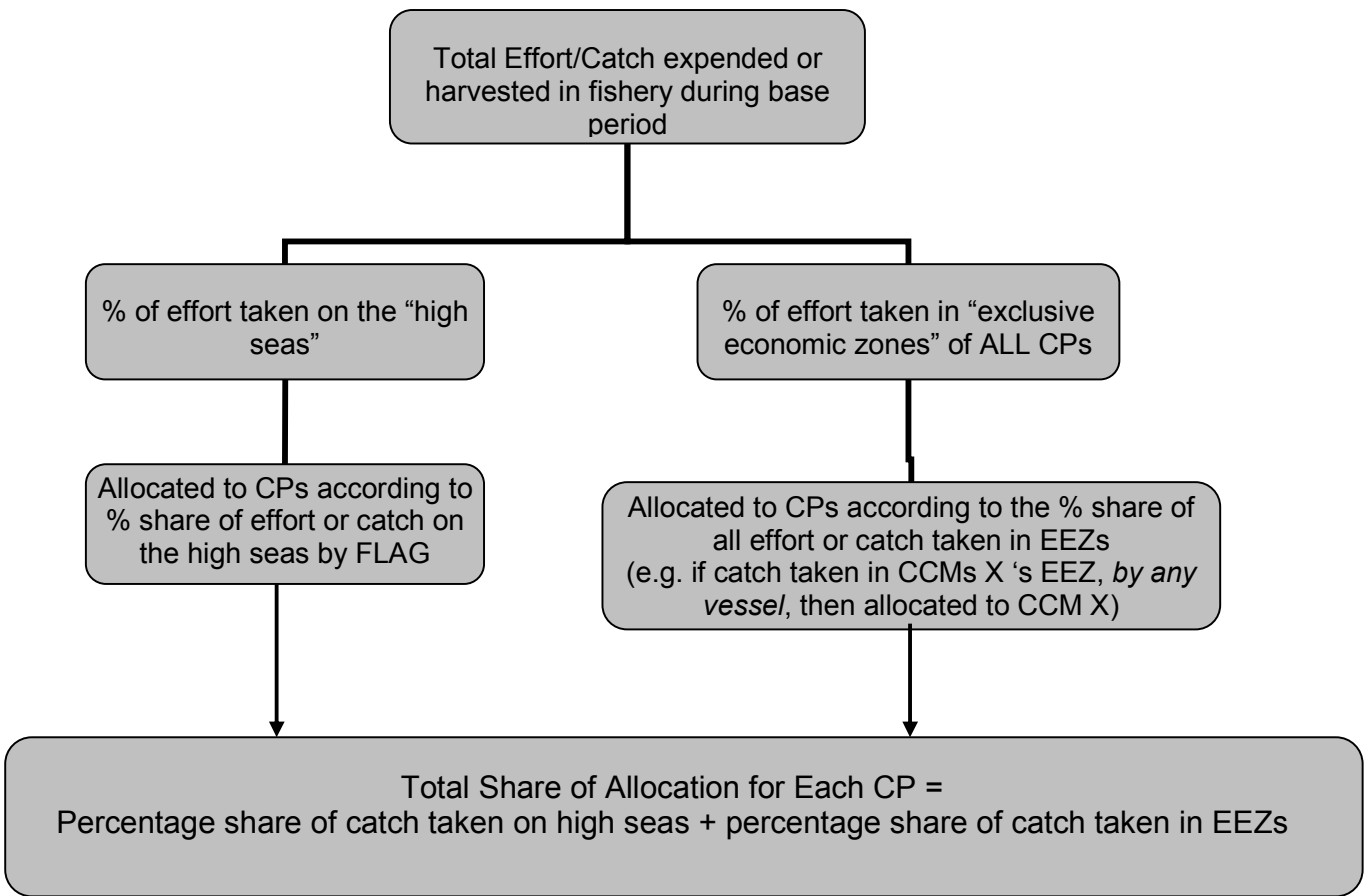


Diagram 2: Key principles in coastal state/high seas allocation model

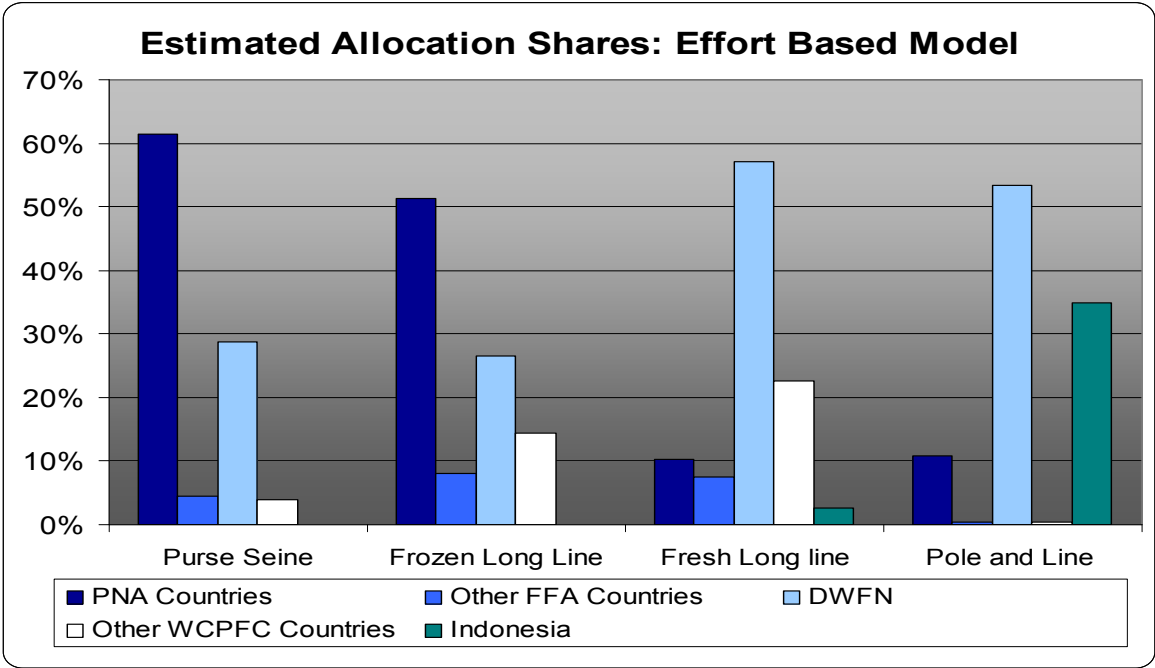


Diagram Three

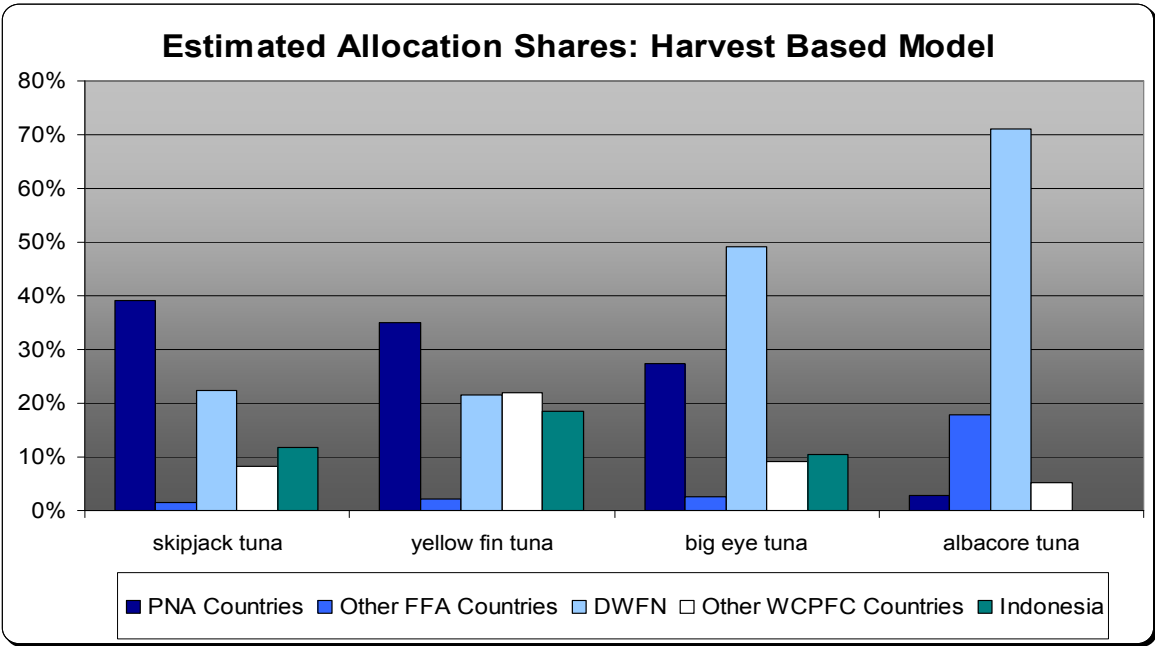


Diagram Four

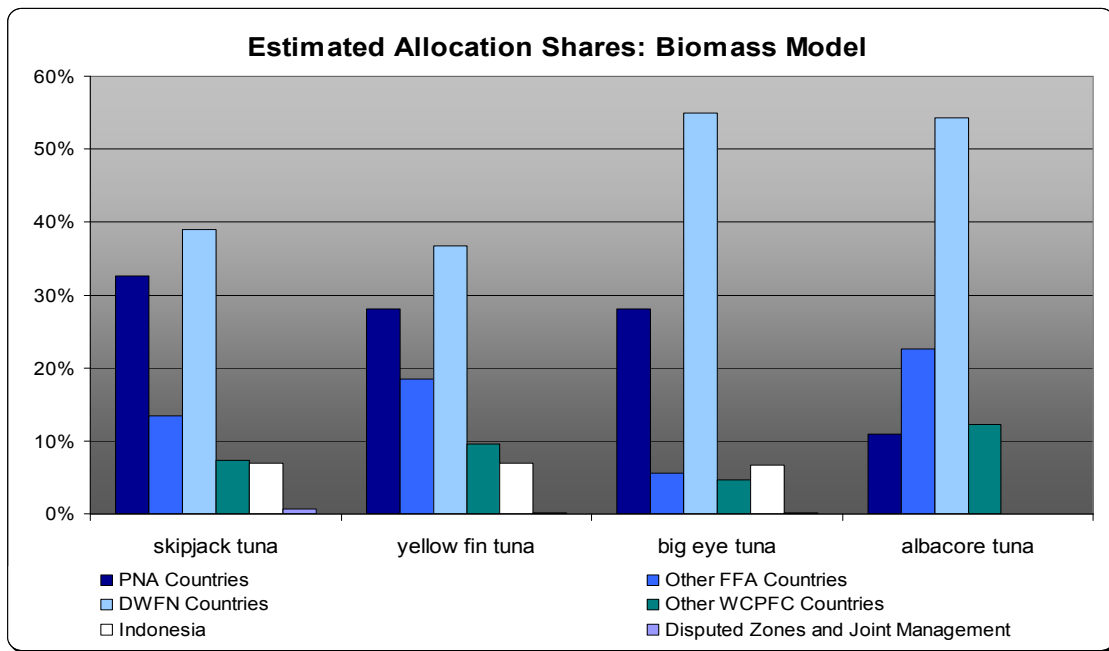


Diagram Five

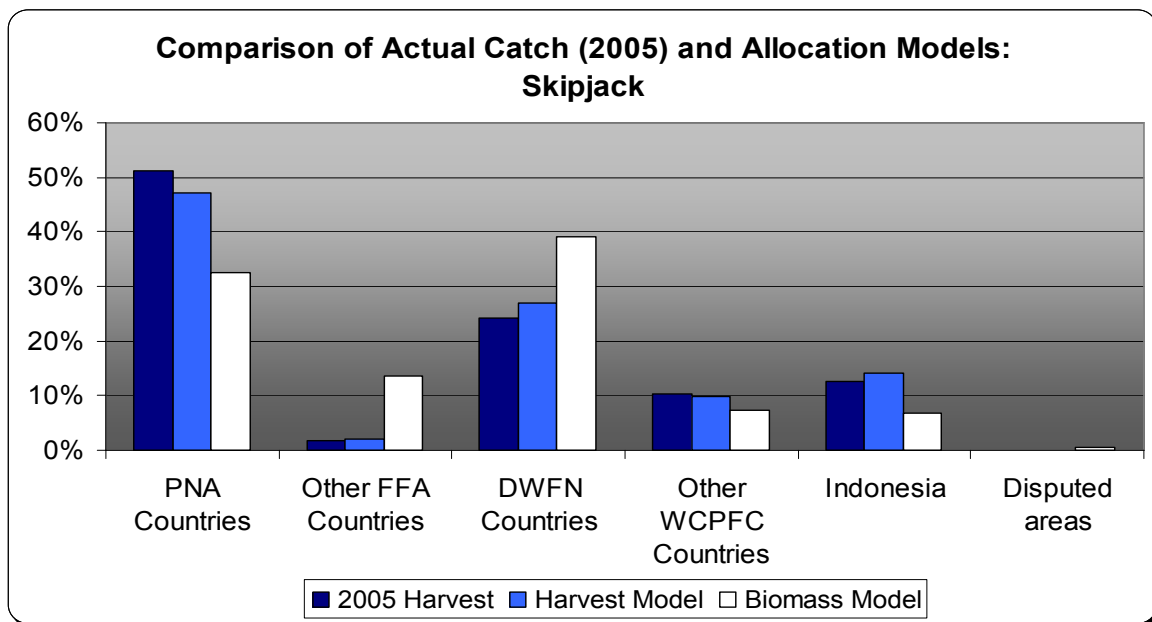


Diagram Six

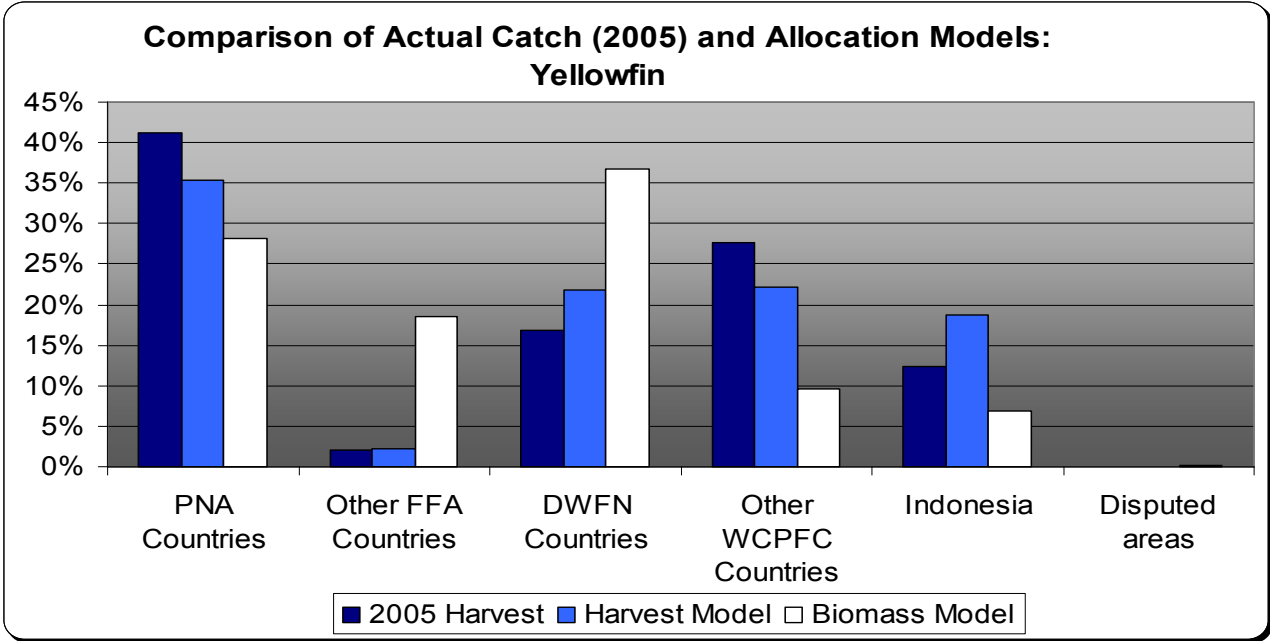


Diagram Seven

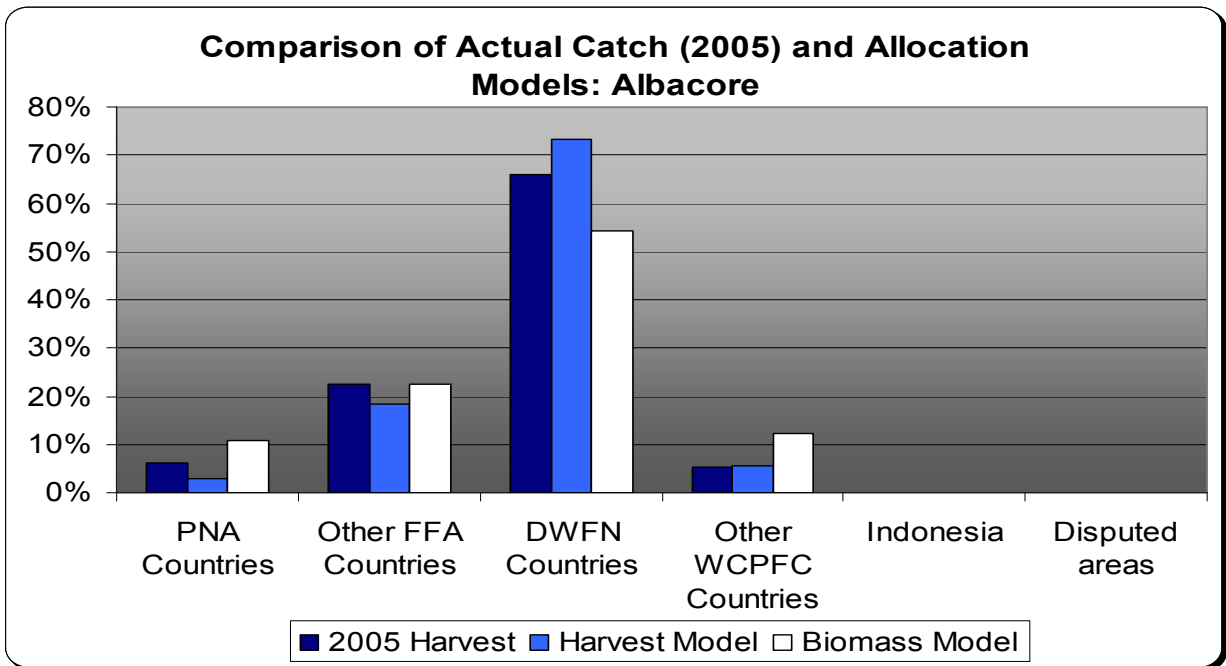


Diagram Eight

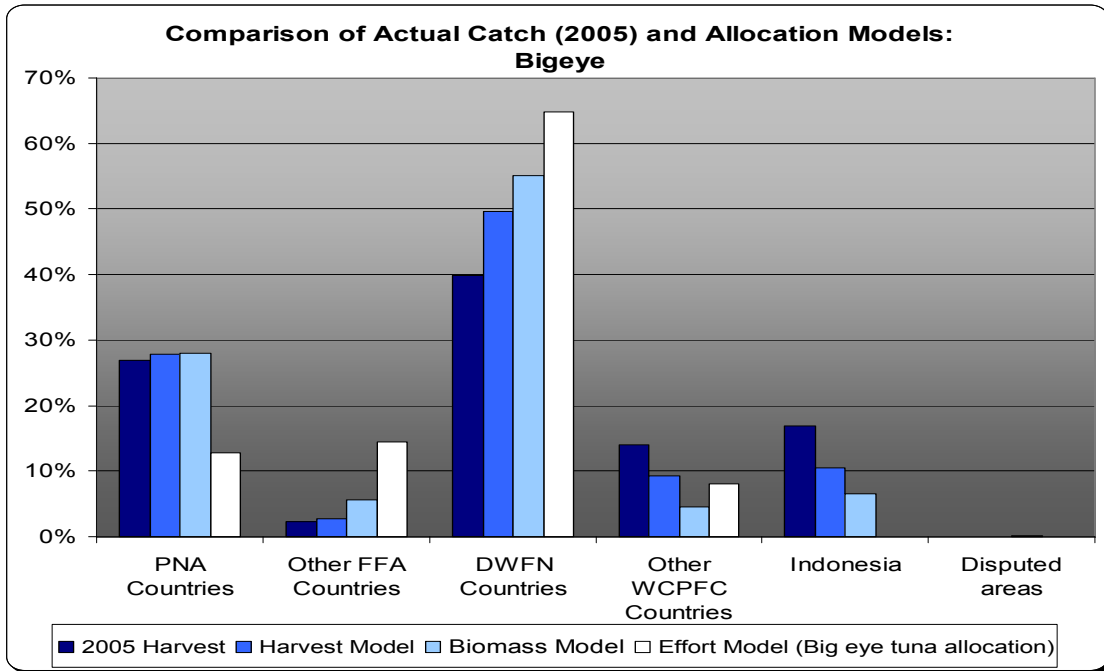


Diagram Nine

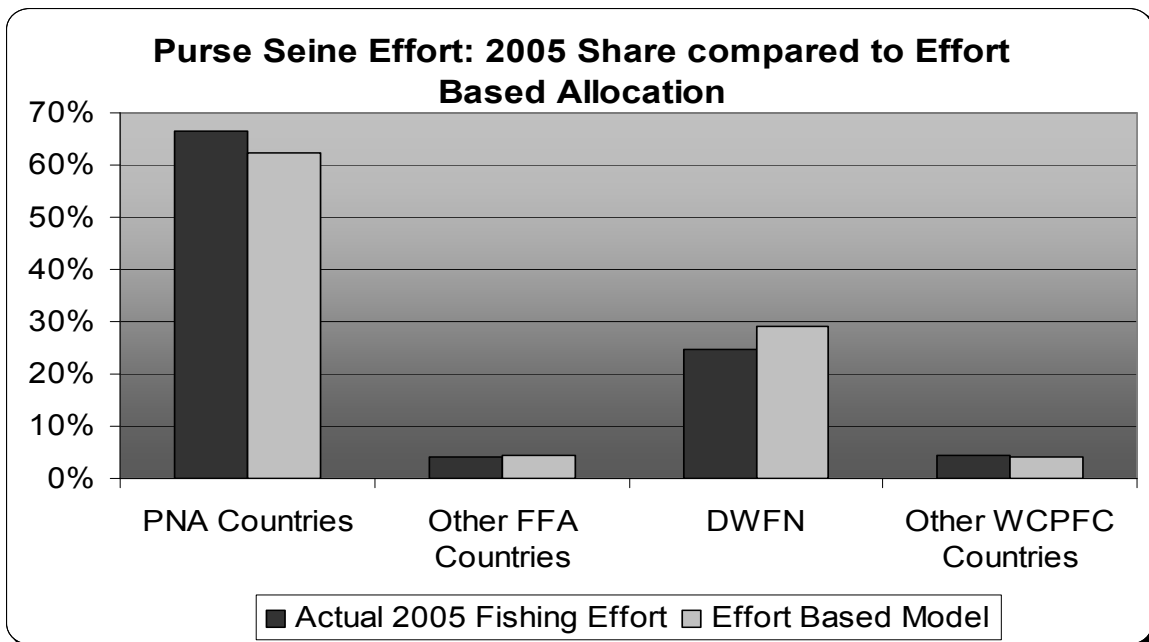


Diagram Ten