Cooperative Resource Management and the Green Growth of the Pacific Marine Economy

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I. Introduction

This paper focuses on one aspect of the Pacific marine economy, namely capture fisheries, because this is where the expertise of the author lies. In recognition that this Forum is sponsored by the APEC Marine Sustainable Center of the APEC Marine Resource Conservation Working Group, I will stress the fact that sustainable management of these resources requires that marine biologists, economists and legal experts cooperate closely with oceanographers and climatologists and other scientists engaged in ocean research.

This Forum emphasizes both green growth and the ecosystem health of the marine economy, implying that the maintenance of the ecosystem health of the marine economy is a necessary prerequisite for green growth. This implies, in turn, that the management of the capture fisheries component of the marine economy must be ecosystem based[1]. Let me commence by discussing what I understand these terms to mean, and then comment on how I and other economists see them related to the management of capture fishery resources.

For definitions of the green economy and of green growth, I turn to the UN Economic and Social Commission for Asia and the Pacific (ESCAP). The UN ESCAP defines a green economy as " --- an economy where economic prosperity can go hand-in-hand with ecological sustainability. ---- in a green economy investing in ecological resources and services-----can be an opportunity for ---- growth, rather than cost and burden on the economy". The UN ESCAP document then goes on to state that "--- green growth is the process of greening conventional economic system and a strategy to arrive at a green economy" (UN ESCAP, 2011, p.1).

For a definition of an ecosystem based fisheries management, I turn to the report of the US National Research Council Committee on Ecosystem Management for Sustainable Fisheries.[2] The Committee, while first pointing out that it is beyond the capabilities of

[1] The author has been informed that the APEC Marine Resource Conservation Working Group and Fisheries Working Group are to be merged into the APEC Oceans and Fishery (OF) Working Group. This is eminently sensible in light of the increasing emphasis being given to ecosystem approaches to the management of marine living resources.

[2] The author served on the Committee.

science to manage an entire marine ecosystem, states that "----ecosystem based management is an approach that takes major ecosystem components and services --- into account in managing fisheries. It values habitat, embraces a multispecies perspective, and is committed to understanding ecosystem approaches" (NRC, 1999, p.2). At a minimum, ecosystem based management moves away from single species management to multispecies management.

With regards to capture fisheries, economists view fishery resources as a component of society's stock of natural real capital, where we define real capital as any real (as opposed to financial) asset that is capable of yielding a stream of economic returns (non-market, as well as market) to society through time. This way of viewing natural resources has gone far beyond the realm of academic economists. It is view that is now strongly promoted, for example, by the World Bank. The World Bank maintains that both the current national income, and the prospects for future development, of any nation rest upon that nation's portfolio of real capital assets. This portfolio is seen to consist of produced, natural and intangible capital assets, with the latter, in turn, to be seen as a mix of human and social capital. Development is to be viewed as a process of real asset portfolio management through time (World Bank, 2005, pp. 1-5).

This leads to the concept of green accounting. Standard national income accounting records investment in produced capital – Gross Domestic Product – but then acknowledges that account must also be taken of depletion of existing produced capital, e.g. through depreciation, hence the concept of Net Domestic Product. Green accounting records investment in and depletion (disinvestment) of natural, as well as produced, capital (World Bank, 2010).

To continue with the World Bank's insistence that natural resources be viewed as natural capital, the Bank goes on to divide the natural capital natural capital into two components, exhaustible natural resources, such as hydrocarbons and minerals, and living, or renewable, natural resources, such as agricultural land, forests and fisheries. Renewable natural resources, unlike exhaustible natural resources, are capable of providing a sustainable flow of net economic benefits into the indefinite future and are, to

quote the World Bank, “truly a gift of nature” (World Bank, 2005. , p. 7). One should also add that one can engage in positive investment in these renewable resources[3].

Marine capture fishery resources constitute a segment of the world’s stock of natural capital, in the form of renewable natural resources. They are thus “truly a gift of nature.”

Viewed in this way, management of capture fishery resources is seen as a problem in asset management, which is fully compatible with the concepts of green accounting, the green economy and green growth. If there is a steady ongoing depletion of capture fishery resources, this involves a steady running down of a component of society’s stock of real capital. No society can hope to survive economically, if it is steadily running down its stock of real capital, whatever the form may take.

With regards to ecosystem based approach to fisheries management, we have seen that, as a minimum, this means that species interactions must be taken into account. This causes no conceptual difficulties. It means that we must think, not of managing single fishery resource assets, but rather as managing portfolios of assets. Taking a broader view of ecosystem based approach to fisheries management means we must recognize that economic returns on these portfolios of assets will be affected by shifting environmental forces through time. The less we know about these forces, the more difficult, the riskier, will be our portfolio management problem through time.

APEC, by definition, is about economic cooperation. In the discussion to follow, I am going to focus on one class of capture fishery resources, internationally shared fish stocks, in which cooperation among states sharing the resource is not merely desirable, but is essential for effective management. The economics of the management of these resource predicts that non-cooperative management of the resources can be destructive, leading not to green growth, but to what we may call black growth, i.e. negative growth. It will be argued, in addition, that one aspect of such cooperation, which has not gained the recognition that it should, is South-South cooperation, co-operation between and among developing fishing states.

[3] In contrast to exhaustible, or non-renewable, natural resources. The rate of investment in such resources by humans is either zero, or negative.

As a final comment, it will be argued that a lack of knowledge of environmental forces influencing capture fishery resources through time will serve to make cooperative management regimes inherently fragile. Fisheries managers ignore oceanography and climatology at their peril.

II. Internationally Shared Fish Stocks and the Pacific

An internationally shared fish stock can be defined as a fish stock that is subject to exploitation by two or more states (or entities). According to the FAO, internationally shared fish stocks account for up to one third of world marine capture fishery harvests (Munro, Van Houtte and Willmann, 2004). APEC member economies, in turn, account for 75 per cent of capture fishery harvests (APEC, Marine Resource Conservation Working Group, 2011). Thus, one can conjecture that an estimate of 75 per cent of world internationally shared capture fish stocks being found within the APEC region is not an estimate to be rejected out of hand.

The legal framework for the management of these shared resources, we should be reminded, is provided by two pieces of international treaty law. They are: the 1982 UN Convention on the Law of the Sea (1982 UN Convention, hereafter), and the 1995 UN Fish Stocks Agreement[4] (UN, 1982; 1995)

The FAO sets out the following categories of internationally shared fish stocks:

1. Transboundary fish stocks – fishery resources that cross the EEZ boundary of one coastal state into the EEZ(s) of one, or more, neighbouring coastal states.
2. Highly migratory fish stocks – highly migratory species, as set forth in Annex 1 of the 1982 UN Convention (UN, 1982), consisting primarily of the major tuna species. In light of their highly migratory nature, these fish stocks are to be found both within the coastal state EEZ and in the adjacent high seas, where they are subject to exploitation by distant water fishing states (DWFSs).

[4] This the popular name for the Agreement. The full title of the Agreement is: 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 Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

3. Straddling fish stocks – all other fish stocks (with the exception of anadromous/catadromous stocks) that are to be found both within the coastal state EEZ and in the adjacent high seas, where they are, like highly migratory stocks, subject to exploitation by DWFSs.
4. Discrete High Seas fish stocks – fish stocks to be found wholly within the High Seas (Munro, Van Houtte and Willmann, 2004).

Two comments are immediately in order. The first is that Category 1 is not mutually exclusive from Category 2 or Category 3. There are many fish stocks that are both transboundary and highly migratory or straddling in nature. The second is that the distinction between Categories 2 and 3, while it remains in international treaty law, is a really a reflection of bargaining that took place during the Third UN Conference on the Law of the Sea, 1973-1982. The distinction can be defended neither on biological nor on economic grounds (Munro, et al., 2004). We shall talk henceforth about highly migratory/straddling fish stocks.

Figure 1 here

The APEC region has numerous examples of all classes of internationally shared fish stocks. To begin with transboundary fish stocks, there are so many that the author would have to confess to being unaware of many of them, particularly in the East Asian, Southeast Asian parts of the region. In the Eastern Pacific, with which this author is more familiar, one would take as examples, Pacific salmon and Pacific halibut shared by Canada and the United States[5], Pacific sardine shared by Mexico, the United States and Canada, and anchovies and Spanish sardines shared by Peru and Chile. The tropical tuna resources of the western and central Pacific are obviously highly migratory in nature, but they are also transboundary in nature, being shared by a large number of coastal states that are members of the South Pacific Forum (Aquora, 2003).

We can be somewhat more definite with regards to highly migratory and straddling stocks, because of surveys undertaken by the FAO. Among the highly migratory resources, we would first include that major tropical tuna resources to be found

[5] Pacific halibut is clearly a strictly transboundary fish stock. The Pacific salmon species, on the other hand typically go far beyond the Canadian and Americans EEZs, during their life cycle. It is, however, contrary to international law to have a directed Pacific salmon fishery outside of the coastal state EEZ (UN, 1982, Article 66). Hence, for our purposes, the resource can be regarded as being strictly transboundary in nature.

throughout the tropical Pacific, such as skipjack, yellowfin, bigeye and albacore. An example of a temperate zone tuna is provided by Southern bluefin tuna. Examples of straddling fish stocks are provided by Alaskan Pollock, orange roughy and Chilean jack mackerel (FAO, 1994).

Discrete high seas stocks are not easy for this author to identify, particularly since many are not yet commercially exploitable. The emerging Regional Fisheries Management Organization (RFMO), the South Pacific RFMO, which extends from Australia and New Zealand to Pacific South America, will undoubtedly encompass several such stocks.

III. Internationally Shared Fish Stocks: Non-Cooperative Resource Management and Black Growth

In our discussion of the management of internationally shared fish stocks, I am, for reasons of length and time, if nothing else, going to give particular, but by no means exclusive, focus to transboundary fish stocks. This category presents the easiest of the management problems, in that the number of states participating in the relevant fisheries is usually small, although there are important exceptions, particularly in the Pacific. Furthermore, the property rights to the fishery resources are unambiguous[6], in marked contrast to highly migratory/straddling fish stocks, let alone discrete high seas, fish stocks.

Perhaps the most significant characteristic of internationally shared fish stocks – transboundary and others - is that there is, with very few exceptions, a strategic interaction between and among the states (entities) exploiting the resources. Consider a transboundary fish stock shared by two neighboring coastal states, I and II. The harvesting activities of the coastal state I fleet can be expected to have an impact upon the harvesting opportunities available to the coastal state II fleet, and vice–versa – hence the strategic interaction. There is nothing particularly unique about fisheries. This characteristic is found in all other shared natural resources as well, such as the atmosphere and water.

[6] Fishery resources within the coastal state EEZ can be regarded, to all intents and purposes as the property of the coastal state (McRae and Munro, 1989). Fishery resources that are strictly transboundary - EEZ to EEZ, without extending into the adjacent high seas, can be seen to be owned by the relevant coastal states on a condominium basis (McRae and Munro, *ibid*.).

Economists studying the economic management of internationally shared fish stocks have no choice, but to incorporate such strategic interaction into their analysis. The economics of the management of internationally shared fish stocks is, as a consequence, a blend of the standard fisheries economics applied to the fisheries of a single state , and the theory of strategic interaction (or interactive decision theory), more commonly known as the theory of games.[7] Economists studying other shared resources, e.g. water resources, the atmosphere and pollution, do, of course, also find themselves compelled to incorporate game theory into their analysis.

Game theory is becoming increasingly widely used in many different branches of economics, as well as being used in numerous other fields, such as legal studies, international relations and evolutionary biology. As an indication of the growing importance of game theory, the Nobel Prize in Economic Sciences has now been awarded twice to specialists in game theory. The first was a joint award in 1994, with one of the recipients being John Nash, who laid the foundation for much of the game theory used in economics. The second, also a joint award, was given six years ago, in 2005. The press release announcing the awarding of the Prize for 2005 to Laureates Thomas Schelling and Robert Auman, reads as follows:

> Why do some groups of individuals, organizations and countries succeed in promoting cooperation while others suffer from conflict? The work of Robert Aumann and Thomas Schelling has established game theory – or interactive decision theory – as the dominant approach to this age-old question. (Nobelprize.org, 2005).

This age old question, in a fisheries context, is, of course, precisely the one that confronts us in the management of internationally shared fish stocks.

For the purposes of this paper, we need only a broad overview of game theory – theory of strategic interaction – and the insights which the theory

[7] The name comes from the fact that games, e.g. card games, were often used to illustrate the theory. In some ways, the name is unfortunate, in that it creates the impression that the theory is confined to frivolous issues, which it most definitely is not.

can offer us, when dealing with the issues before us.[8] We do, nonetheless, require some basic terminology.

To begin, those engaging in the strategic interaction, e.g. coastal states sharing a transboundary fishery resource, are referred to as "players. The "players" are assumed to be rational and to have various courses of action open to them, which are referred to as "strategies." The expected return to a player, in following a particular strategy, is then referred to as a "payoff." The size of the expected return or "payoff" will, needless to say, be dependent upon the known, or expected, reactions of other "players." The interaction between, or among, the players, as they execute their strategies, is the game. The stable outcome of a game, if it exists, is termed the "solution" to the game. Finally, the game may be a "once only" affair, or it may be repeated, or it may change through time and thus be dynamic.

There are two broad categories of games, these being competitive, or non-cooperative, games, and cooperative games. In a cooperative game, the "players" are assumed to be motivated entirely by self interest, but have some incentive to attempt to cooperate. Of critical importance is the fact that "players" are able to communicate with one another effectively. In competitive, non-cooperative, games, the lines of communication between and among the "players" are, more often than not, faulty, or are simply non-existent.

Having said all of this, however, it must be emphasized in passing that open lines of communication, between and among "players", do not, in of and by themselves, guarantee a stable solution to a cooperative game. Communication among "players" is a necessary, but not sufficient, condition for a stable outcome (solution) to the cooperative game.

In examining the economics of the management of transboundary and other internationally shared fish stocks, economists have two questions that they must attempt to address:

1. the consequences, if any, of the relevant states not cooperating in the management of the resource;

[8] A fuller discussion, in a fisheries context, is provided by Munro, Van Houtte and Willmann, 2004.

2. the conditions that must prevail, if a cooperative management regime is to succeed over time.

If, upon addressing the first question, it is found that non-cooperative management does not carry with it significant negative consequences, then, of course, the second question ceases to be of interest, and can be safely ignored.

With respect to the management of all internationally shared fish stocks, while everyone will surely agree that cooperative management is desirable, there is not a universal recognition that cooperation is essential. This is indicated in the 1982 UN Convention. With regards to transboundary fish stocks, the 1982 UN Convention contains but one article pertaining to the management of these stocks, namely Article 63(1) (UN, 1982). The article imposes a duty upon the relevant coastal states to negotiate over cooperative arrangements for the management of these resources. Importantly, what the article does not do is to impose a duty on the coastal states to reach an agreement. If the states negotiate in good faith, but are unable to reach an agreement, then each state is to manage its share of the resource (i.e. that part occurring within its EEZ), in accordance with the relevant rights and duties laid down by the 1982 UN Convention (Van Houtte, 2003). Hence, non-cooperative management of transboundary fish stocks is legally acceptable, with the clear implication that cooperation in the management of the resources, while being eminently desirable, is not essential.

In the 1982 UN Convention, essentially the same rules apply to straddling fish stocks (UN,1982, Article 63(2); Munro et al., 2004)[9]. This was to change under the 1995 UN Fish Stocks Agreement, when the consequences of non-cooperative management of these resources became unmistakably evident.

[9] Allen (2010) maintains that it was recognized at the time of the Third UN Conference on the Law of the Sea, which gave rise to the 1982 UN Convention, that cooperative management of highly migratory stocks is essential. This reflected in Article 64, which calls upon relevant states to cooperate in the management of these resources within and without the EEZ. It can be argued that what Article 64 really reflects is a reluctance on the part of major DWFSs , at the time, to grant coastal states property right claims to the highly migratory stocks within the EEZ (Munro, et al., 2004). If ensuring cooperative resource management was in fact the real aim, then it was inconsistent not to treat straddling stocks in the same manner.

This then leads to Question 1, the negative consequences, if any, of states sharing a fish stock not cooperating in the management of the resource. In attempting to address this question, economists draw upon the theory of strategic interaction – the theory of games –and turn specifically to the theory of non-cooperative (competitive) games. The key conclusion arising from non-cooperative game theory is that the "players" will be driven inexorably to adopt strategies that they know perfectly well will produce decidedly undesirable results. This outcome is referred to as a "Prisoner's Dilemma" outcome after a famous non-cooperative game developed to illustrate the point (Tucker, 1950).[10]

The basic nature of the "Prisoner's Dilemma" outcome, in a fisheries context, can be illustrated as follows. Consider a transboundary fishery resource shared, once again, by two coastal states I and II. Coastal state I's harvesting activities will have an impact upon II, and vice versa. Both I and II recognize that the resource was overexploited in the past, and that ideally a major resource investment program should be undertaken.

Suppose, however, that there is no significant resource management cooperation between the two. Coastal states I and II do, as the 1982 UN Convention allows them to do. Each manages its respective segment of the resource on its own. Suppose, finally, that the resource managers in I and II are capable of exercising iron control over their respective fleets.

If coastal state I should undertake to restrict harvests in order to "invest" in the resource, the benefits from this action will not be enjoyed by coastal state I alone, but will be shared with II. What assurance does coastal state I have that II will also undertake to conserve and invest in the resource? Since there is no cooperation, the answer is none. It is only too possible that II would be content to "free ride" off of I's resource investment efforts. In these circumstances, it is likely that coastal state I will conclude that the return on its resource investment would be less than the cost , and that its best course of action ("strategy") is to do nothing. II could be expected to come to the same conclusion[11].

[10] Those interested in a technical discussion of the Prisoner's Dilemma and its application to fisheries are encouraged to turn to Munro, Van Houtte and Willmann, 2004, Appendix.

[11] In an empirical study of the small pelagic fishery resources shared by Peru and Chile, M. Agüero and E. Gonzalez raise the following question. Suppose that the two states do not cooperate, and that initially both the Peruvian and Chilean small pelagic fisheries are open access. As a consequence, the fishery resources are overexploited. One of the two states changes its policy. It now exercises full control over its share of the fisheries, and proceeds to "invest" in the resources by restricting harvesting. There continues to be no

Worse, coastal state I has to allow for the possibility that II might deliberately deplete the resource. If coastal state I seriously believes this, then it could decide that its best strategy is to strike first. Once again, II could follow the same line of reasoning.

For a real world example, we turn to the author's part of APEC region and the transboundary stock, Pacific salmon, shared by Canada and the United States. Historically, Pacific salmon was the most important fishery resource for the fishing industries of the American states of Washington, Oregon and Alaska, and the Canadian province of British Columbia. The resource is shared, because American fishermen inevitably intercept (i.e. harvest) salmon produced in Canadian rivers and streams, while Canadian fishermen inevitable intercept American produced salmon.

Figure 2 here

The United States and Canada, let it be emphasized, are two developed coastal states with extensive fisheries management resources and experience, and with close cultural ties. The two came together in the late 1960s to cooperate in the management of all Pacific salmon fishery resources from northern California to the Gulf of Alaska. The negotiations were long, arduous and difficult. A successful conclusion was not reached until 1985. What drove the negotiators on was the manifestation of the "Prisoners' Dilemma."

Pacific salmon is an anadromous species, which breed is fresh water habitats, spends much of its life cycle in the ocean and then returns to its fresh water habitat to spawn and die. Many salmon, however, do not survive the river and stream return journeys to their habitat, and thus do not spawn. It was believed, at the time, that salmon production could be increased substantially through enhancement projects (e.g. fish ladders) on major salmon rivers, such as the Fraser River, which empties south of Vancouver, British Columbia, and the Columbia River, which marks the boundary between the states of Washington and Oregon. If Canada and the United States both engaged in such

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cooperation between the two states. The other state does nothing. What would be the outcome? Agüero and Gonzalez demonstrate that the virtuous resource investing state would actually be worse off than if it had done nothing, while the unvirtuous state would enjoy a bonanza (Agüero and Gonzalez, 1996, pp.30-32).

projects, the mutual benefits could have been impressive. Each country deliberately held back from enhancement projects, however, for fear that the other would "free ride" on its efforts (Munro, McDorman and McKelvey, 1998).

In addition, there were outbreaks between the two countries of Pacific salmon "fish wars," which the American legal expert, Thomas Jensen, defines as deliberate overexploitation of the fishery resource for the purpose of denying harvest opportunity to the other party or parties (player or players) (Jensen, 1986, p. 18). When negotiations finally reached a successful conclusion in 1985, in the form of the Canada-United States Pacific Salmon Treaty, Jensen commented that the Treaty could best be described as a "peace treaty memorializing the end of the Pacific salmon war" (Jensen, 1986, p. 372).

Our example has been that of a transboundary stock. Exactly the same problem arises in the non-cooperative management of highly migratory/straddling stocks and discrete high seas stocks, and often does so in a particularly virulent form. In the case of highly migratory/straddling stocks, prior to 1995, ambiguity about the rights and duties of coastal states, as opposed to those of DWFSs, with respect to the high seas segments of the resources meant that, more often than not, non-cooperative management was the norm (UN, 1992; Munro et al., 2004) An example of the consequences of non-cooperative resource management is provided by the case of Alaska pollock in the Bering Sea.

Alaska pollock historically has been the largest single species harvested in the North Pacific, large concentrations of which are to be found in the Bering Sea (FAO, 1994). The Bering Sea component constitutes a straddling stock by virtue of the fact that there exists a high seas enclave between the Russian and American EEZs, the "Doughnut Hole." The pollock resources in the Doughnut Hole were exploited by the two coastal states, and a number of distant water fishing states (DWFSs). Cooperative management of the straddling stocks was non-existent. Non-cooperative management led to the Doughnut Hole pollock fishery becoming what can best be described as a pure open access fishery. The consequence was that the pollock resources therein were more than overexploited; they were, in the words of the FAO, plundered (FAO, *ibid*.) In 1992, the U.S.A., Russia and four DWFSs operating in the region, established the Convention on the Conservation and Management of Pollock Resources in the Central

Bering Sea (1992). Under the Convention, the six states imposed a "temporary" harvest moratorium on the Doughnut Hole pollock resources. The moratorium remains in force at the time of writing, almost two decades later.

Figure 3 here

Such overexploitation, arising from non-cooperative resource management, was to become so severe that it lead ultimately to the 1995 UN Fish Stocks Agreement. As Munro, Van Houtte and Willmann state, " the overexploitation of straddling/highly migratory fish stocks worldwide [before 1995] bears powerful testimony to the predictive power of the economic analysis of the non-cooperative management of such resources" (Munro, et al., 2004, p. 45). Under the 1995 UN Fish Stocks Agreement, the requirements for cooperation were to be made substantially more demanding than they had been under the 1982 UN Convention.

Under the terms of the 1995 UN Fish Stocks Agreement, highly migratory/straddling fish stocks are to be managed on a region by region basis through Regional Fisheries Management Organizations (RFMOs).The membership in a given RFMO is to be open to all states with a "real" interest in the relevant resource(s), DWFSs as well as coastal states (UN, 1995; Munro et al., 2004)[12].

In any event, the conclusions are clear. In the management of internationally shared fish stocks cooperation is not merely desirable – "a good thing" – it should be regarded as essential[13]. The absence of effective cooperative management carries with it the threat that this form of natural capital will be mismanaged, possibly leading to serious depletion of the natural capital – with the result being, not green growth, but black (i.e. negative) growth.

[12] Examples of RFMOs in the APEC region are: Commission for the Conservation of Southern Bluefin Tuna (CCSBT), Inter-American Tropical Tuna Commission (IATTC), South Pacific Regional Fisheries Management Organization (SPRFMO), Western and Central Pacific Fisheries Commission (WCPFC)

[13] There are a few exceptions to this rule. Accepting this, one cannot, however, safely assume, a priori, that cooperative resource management is unnecessary for a particular shared fish stock.

III Cooperative Management of Internationally Shared Fish Stocks and Time Consistency

The point has now been made that, with respect to internationally shared fish stocks, green management, green economic growth, is in most cases not going to be achieved in the absence of effective cooperation. Thus, Question 2 on the conditions that must prevail, if a cooperative management regime is to succeed over time, must be addressed head on. First, however, we must state exactly what we mean by cooperative resource management. This was done for us by, by John Gulland, of the FAO, over 30 years ago, as the Third UN Conference on the Law of the Sea was entering its last phase (Gulland, 1980).

Gulland commences by making a distinction between cooperation at the *primary* level and at the *secondary* level. Cooperation at the *primary* level involves cooperation consisting of scientific cooperation alone. Cooperation at the *secondary* level involves active management, which, by definition, requires the establishment of coordinated joint management programs (Gulland, 1980). The 2002 Norway-FAO Expert Consultation on the Management of Shared Fish Stocks concluded that the primary level of cooperation is seldom sufficient in of and by itself. Cooperation must, with few exceptions, move forward to the secondary level (FAO, 2002), which is a far more formidable undertaking.

Having said this, the primary level cooperation must not be dismissed as being of little value. Given the recognized need for an ecosystem approach to fisheries management, scientific cooperation at a broad level is of critical importance. Furthermore, the primary level cooperation, in creating transnational trust among scientists, can be seen as providing the foundation for the secondary level of cooperation.

In turning to the secondary level of cooperation – "active management" – we have first to decide what we mean by a cooperative resource management regime, involving "active management", that is successful over time. The OECD states that such a regime is one that will achieve the following goals:

i. a stable cooperative agreement that is "time consistent"
ii. sustainability of the resource stock over time

iii. optimum utilisation of the resource (including maximizing resource rent from the resource) (OECD, 2009, p.18)

Goal (i) is key. If the cooperative agreement, arrangement, is not stable over time, there is no hope of achieving goals (ii) and (iii).

John Gulland maintains that, if the secondary level of cooperation is to succeed, by implication if the OECD goals are to be realized, it is necessary that the cooperating states/entities deal effectively with the following:

a) allocation of harvest shares among the participating states (or entities);

b) determination of an optimal management strategy through time, including *inter alia*, the determination of optimal global harvests over time;

c) implementation and enforcement of coordinated management agreements (Gulland, 1980).

In exploring the conditions necessary to achieve the OECD's key goal (i), a stable cooperative management agreement (through time), economists turn to the theory of cooperative games, which is essentially a theory of bargaining. In the theory of cooperative games, to repeat, it is assumed that the "players" are motivated by self interest alone. If they cooperate, it is because each believes that it will be better off under cooperation than it will be under competition. In passing, one piece of jargon that we will find to be useful is "cooperative surplus", which is the difference between the sum of the payoffs to the "players" under cooperation and the sum of the payoffs that they would enjoy under competition.

There are, according to the theory of cooperative games, two basic conditions that have to be met, if the solution to the cooperative game is to prove to be stable over time. Once stated, the two conditions sound stunningly obvious, although they are often ignored in practice. First, there must exist no alternative solution, or outcome, to the

game that would make at least one player better off, without harming the others. This is often referred to as the collective rationality condition. Secondly, and very importantly, each and every player must be convinced, now and at all times in the future, that its payoff from cooperation is at least as great as the payoff it would enjoy under competition. This is referred to as the *individual rationality* condition.

If we look at Gulland's list of requirements for secondary level cooperation, it can be seen immediately that the individual rationality condition has little chance of being satisfied, if Gulland's requirement c) – implementation and enforcement - is not realized. Suppose that enforcement is weak, meaning that there are no effective guards against cheating.

To see the consequences, consider a prospective member of a cooperative resource management arrangement (player), which is convinced that it will receive a "fair" allocation of the economic returns from the fishery, but which is also convinced that cheating will not be effectively controlled. The prospective member (player) could well calculate that its payoff from cooperation would be less than what it would enjoy under competition. It would then refuse to cooperate. Other prospective members of the cooperative arrangement are likely to make the same calculation and arrive at the same conclusion. The cooperative arrangement would then be stillborn.

Realizing Gulland's requirement c) is critical, if the individual rationality condition is to be satisfied, but it is not sufficient to ensure that this condition will be satisfied. To do so, we may have to turn to Gullands' requirement a), pertaining to allocation of harvests. If the allocation of the economic returns from the shared fishery is to be determined solely by allocating harvests, the individual rationality condition may not be satisfied. Essentially the scope for bargaining could prove to be too narrow. More and more attention is now being given to the use of "side payments", which are essentially transfers, between and among players. The "side payments" (transfers) may be monetary or non-monetary in form. The FAO has also referred to "side payments" as "negotiation facilitators"[14] (FAO, 2002).

[14] One problem faced by the theory of games is its terminology. Some at the 2002 Norway-FAO Expert Consultation on the Management of Shared Fish Stocks found the term side payment suggestive of bribes and corruption. The euphemism "negotiation facilitators" was preferred.

For our purposes, let us define an international fisheries cooperative game *without* side payments as one in which the economic returns to a given player (coastal state or DWFS) arising from the fishery are determined solely by the harvests of the player's fishing fleet. If side payments are allowed, then the focus of allocation shifts to that of dividing the net economic returns from the international fishery among the players. Among Pacific fisheries, subject to international cooperative management, side payments have appeared, as we shall indicate, in the Canada-US Pacific Salmon Treaty (Canada, Department of Fisheries and Oceans, 2009), although they are certainly not labeled as such, and have come up for discussion in the management of fisheries, within the purview of the Western Central Pacific Fisheries Commission (Lodge, Anderson, Løbach, Munro, Sainsbury and Willock, 2007; Reid, 2006).

Keeping this in mind, we did state earlier that the *individual rationality* condition is stunningly obvious. Is there any real evidence of cooperative international fisheries management agreements in which this condition is not being met? The answer is yes. A Pacific example is provided by the Inter-American Tropical Tuna Commission (IATTC). In recent study on the tuna RFMOs, carried out for the FAO, the former Director of the IATTC concludes, after a lengthy analysis of this RFMO, that the *individual rationality* condition is, in fact, **not** being met within the IATTC (Allen, 2010). This should be a cause for considerable concern.

Figure 4 here

Gulland's requirement b) relates to the OECD's goal (iii), optimal utilization of the resource over time. This goal can be difficult to fulfill, if the states sharing the resource have different management goals. The states, if rational, will all want to conserve the resource, but because the states may differ in any number of ways, their perspective of what constitutes an optimal harvest program through time, may differ. As the FAO noted decades ago, one state sharing the resource may opt for a resource management program leading to the maximum sustainable yield (harvest) through time, while its partner(s) may opt for a stock denser than that associated with maximum sustainable yield, because of the harvesting cost advantages associated with the denser stock.

These harvesting cost advantages would come at the price of less than maximum sustainable harvest through time (FAO, 1979).

It has been argued that where there are differences in management goals, it is invariably the case that one player (or players) places a higher value on the resource than the other(s) (Munro, 1987). Maximizing the economic returns of the fishery through time obviously calls for the management preferences of the player(s) placing the highest value on the resource to predominate. In order for what we might call the *optimum optimorum* to be achieved, the player(s) placing the highest value on the resource will have to be prepared to compensate the other players. This has come to be known as the *Compensation Principle* (Caddy, 1997; Munro, 1987; Munro, et al., 2004).

The *Compensation Principle* is, of course, impossible to put into effect, if allocations between and among the coastal states (entities) are based solely and rigidly upon divisions of the total allowable catch, with each player's economic return from the fishery being determined solely by the harvests of its fleet. The solution, once again, is to turn to "side payments".

Along with the two basic conditions for a stable cooperative fisheries game, and hence for a stable cooperative fisheries resource management arrangement, there is a third condition, the importance of which has only recently been fully recognized. This is a dynamic condition, which in the jargon of game theorists goes under the name of "time consistency"[15]. The basic idea is that a cooperative resource management arrangement, which may appear to be perfectly stable at the present time, could prove to be unstable in the future, because it lacks the resilience to withstand unpredictable shocks, be those shocks environmental, economic, political or other – hence the arrangement is not consistent through time.

For an example, we return yet again to the Canada-US Pacific Salmon Treaty. In the cooperative fisheries game that is the Treaty, it is reasonable to regard Canada as a single player, because, within Canada, jurisdiction over marine fisheries rests wholly with the federal government. In the United States, on the other hand, significant power rests with the individual states. The United States was, and is, therefore, not a single player,

[15] See the OECD's goal (i).

but what can be seen as a four player coalition, consisting of the states of Washington plus Oregon, the state of Alaska, the U.S federal government, and because of key US federal court decisions regarding the allocation of salmon harvests off of Washington/Oregon, the 24 Treaty Native American tribes of Washington, Oregon and Idaho.[16] The cooperative game is a two stage one, in which the players in the American coalition bargain among themselves, and, upon achieving a consensus, proceed to bargain with Canada.

The Alaskans have always had the least to gain from the Treaty, and indeed the Treaty negotiations temporarily ground to a halt in the early 1980s, because of Alaskan dissatisfaction. Through a complex bargaining process, the problem was resolved and the Treaty came in to place in 1985.

At the time of the signing of the Treaty there was a rough balance between Canadian "interception" of American produced salmon, and the American "interception" of Canadian produced salmon. It was recognized by all that the cooperative surplus was substantial, and it appeared that the allocation of the economic benefits from the fishery were more or less fair (Munro, McDorman and McKelvey, 1998).

What was not recognized at the time was that there was a climate regime shift underway. This climate regime shift was to have a decidedly negative impact upon salmon stocks off Washington, Oregon and southern British Columbia, and a decidedly positive impact upon salmon stocks off of Alaska. The equitable division of benefits was upset, and the Treaty was thrown into disarray, with Alaska effectively being pitted against Canada, Washington/Oregon and the American Treaty tribes. To all intents and purposes, the individual rationality condition, with respect to Alaska, was not being met (Miller, Munro, McDorman, McKelvey and Tyedmers, 2001; Miller and Munro, 2004). There is no evidence that the Treaty was breached; that the Alaskans overtly acted in violation of the Treaty. The Alaskans did, nonetheless, find means of "throwing sand in the gears."

[16] The term comes from an 1854 treaty between the tribes and the American government involving, among other matters, fishery rights.

The cooperative resource management arrangement proved to lack the resilience to withstand the major environmental shock in the form of the climate regime shift. One weakness of the Treaty was that bargaining between Canada and the American coalition was constrained by the fact there was no allowance whatsoever for side payments (Miller, et al., 2001).

After almost six years of treaty paralysis, Canada and the United States signed the Pacific Salmon Agreement in 1999 (U.S. Department of State, 1999) designed to "patch up" the Treaty. The Treaty was formally renewed a decade later, on January 1, 2009. Interestingly, both the Agreement and the renewed Treaty contain provisions for side payments, although, of course, they are not labelled as such (Miller et al., 2001; Canada, Department of Fisheries and Oceans, 2009).

Two related conclusions immediately follow from this example. The first is that the example demonstrates the importance of an ecosystem approach to fisheries management. It is not enough to focus on the current state of the resource. Shifts in the aquatic environment had can have a profound effect on the stability of the fisheries management regime.

The second is that the example demonstrates the importance of uncertainty. Uncertainty can never be eliminated, but it can be mitigated. This brings me back to my earlier point about the importance of the work of scientists, in addition to marine biologists, such as oceanographers and climatologists to fisheries management. These other scientists can never be expected to provide accurate predictions of events such as climate regime shifts, but their research can enable fisheries managers to anticipate such events, and to plan accordingly.

With respect to highly migratory/straddling fish stocks, there are complications arising that are not encountered in the management of transboundary fish stocks. These arise due to the fact that the property rights to the resources in the high seas under RFMO jurisdiction are, at this stage, lacking in clarity. In particular, the threat of unregulated fishing and the so called new member problem have to be addressed. For reasons of length, we shall not attempt to discuss them here[17].

[17] The interested reader is encouraged to turn to Lodge et al., 2007, and Munro, 2011.

There is, however, one additional condition pertaining the cooperative management of highly migratory/straddling fish stocks upon which we shall comment. This is the fact that there is increasing recognition of the fact that effecting cooperation within given RFMOs is not sufficient. What is required is inter-RFMO cooperation[18]. This is now beginning to take place, particularly among the tuna RFMOs (Lodge, et al., 2007; Miller, Golubtsov, and McKelvey, 2010).

To this stage, we have referred only briefly to Category 4 of internationally shared fish stocks, namely discrete high seas fish stocks. There is little that one can say at this stage about these fish stocks. Munro, Van Houtte and Willmann describe them as the "orphan" fish stocks of the ocean (Munro, et al., 2004, p. 57). Many of the stocks have been protected to date, by virtue of the fact that it is too costly to exploit them on a commercial basis. The history of world fisheries assures us that, with the ongoing advance of fisheries technology, this protection will disappear over time.

Probably the only viable solution is to ensure that the discrete high seas stocks are encompassed by RFMOs. Fortunately, there are signs that this is beginning to take place. As noted earlier, there is a RFMO, which is currently in the process of being established, namely the South Pacific Regional Fisheries Management Organization (SPRFMO), which extends from Australia and New Zealand to the Pacific coast of South America. The purpose of the SPRFMO is to conserve and manage non-tuna high seas fisheries resources in the region. Many, if not most, can be categorized as discrete high seas fish stocks (South Pacific Regional Fisheries Management Organization, 2011).

Figure 5 here

Given all of the requirements for successful cooperative resource management, it is worth asking whether there is really much hope of effective long term cooperative management of the resources under consideration. The question is easy to answer for transboundary stocks, because there are many examples of successful transboundary

[18] Why? The problem of unregulated fishing -unsanctioned fishing by non-RFMO members in areas under RFMO jurisdiction – is one important reason. Vessels engaged in such practices will move from RFMO to RFMO. Next, some fishery resources will move from one RFMO to another. Further, the RFMOs have many other problems in common.

cooperative fisheries management arrangements. The cooperative management of highly migratory/straddling stocks and of discrete high seas stocks is a different matter, since this is a much more difficult undertaking than the cooperative management of transboundary stocks.

There exists a school of thought, which can be referred to as the extreme pessimism school. The school is exemplified by the well known marine biologist, Ray Hilborn. Writing in a journal published by the Royal Swedish Academy of Science (*AMBIO: A Journal of the Human Environment*), Hilborn states that "--- the existing governance regimes for high seas fisheries have failed *totally* [italics added]" (Hilborn, 2007, p.301). While there are certainly examples of RFMOs that have not been successful, there are counter examples. As an example of successful RFMO cooperative management, I am going to turn to an Atlantic straddling stock case[19]. While the example is from the Atlantic, it is fully relevant to the Pacific.

The case involves a pelagic resource, known as Norwegian Spring Spawning, or Atlanto-Scandian, herring. When robust, it is one of the largest and most valuable fishery resources in the North Atlantic. When in this state, it migrates between Norway and Iceland and is exploited by these two states and Russia, along with the Faroe Islands and the European Union. It is straddling stock by virtue of the fact that the resource travels through a high seas enclave, while migrating between Norway and Iceland.

In the late 1960s and early 1970s, the resource was subject to weak international management. Under this weak management, rapid technological developments in herring fishing, combined with adverse environmental conditions, led to massive overexploitation of the resource. Scientists maintain that the minimum safe level of the spawning stock biomass (SSB) of this resource is 2.5 million tonnes[20]. It is estimated that by 1972, the SSB had fallen to 2,000 tonnes. The resource had come perilously close to extinction (Bjørndal, 2008).

[19] It is always risky to make sweeping, all encompassing, propositions. All that is needed to upset such a proposition is to come forth with one counter example.
[20] Scientists at the International Council for the Exploration of the Sea (ICES).

The remnants of the stock were confined to Norwegian waters. Norway declared a harvest moratorium, which remained in place for 20 years. By the mid 1990s, there were clear signs that the resource had recovered, and that it was recommencing its migratory pattern. The harvest moratorium was lifted.

The five states/entities involved in exploiting the recovered resource in the 1990s needed no lectures on the Prisoner's Dilemma. They recognized the grave dangers associated with non-cooperative management of the resource. In 1996, the aforementioned five established a cooperative management arrangement under the framework of the 1995 UNFSA. While the official RFMO is North East Atlantic Fisheries Commission, the de facto RFMO consists of the five (Munro, 2011).

What is the state of the resource now? The answer is that currently the SSB of the resource is estimated to be in the order of 9 million tonnes, almost four times above the critical minimum (ICES, 2010). The resource, overall, is at levels not seen since the halcyon days of the 1950s (Sandberg, 2010). In terms of the economics of the fishery, Bjørndal (2008) shows that the resource management regime is not perfect, that the economic return from the fishery - the resource rent - , and thus the "cooperative surplus", could be increased. Be that as it may, Bjørndal, along with Per Sandberg[21], go on to state that the ongoing resource rent is substantial, and is at a level, which would have seemed beyond the realm of possibility three decades ago (Bjørndal, 2008; Sandberg, 2010).

IV South-South Cooperation and the Management of Internationally Shared Fish Stocks

We turn now to what may seem a rather unusual form of fisheries cooperation, South-South cooperation, which I take to mean cooperation between and among developing fishing states[22] in the APEC region, within and across sub-regions. There is a history of initiatives in such cooperation, in the not so distant past, which yielded significant results.

[21] Sanberg is an economist with the Norwegian Directorate of Fisheries.
[22] We should properly include NICs (newly industrialized countries). The boundary between developing states and NICs is not a clear-cut one.

The question that I shall raise is whether there is scope for such cooperation in the post-RFMO regime world. First let me comment on the history.

The history begins in the mid-1980s, a decade before the 1995 UN Fish Stocks Agreement, and a few years before the establishment of APEC. APEC's predecessor, the PECC had among its task forces, the Task Force on Fisheries Development and Cooperation, with the author serving as Coordinator. The underlying theme of the work of the Task Force was the management of fishery resources under the New Law of the Sea. Members of the Task Force from developing coastal states urged the Task Force to explore, not just North-South cooperation in fisheries management, but South - South cooperation, as well. At that time, there were three sub-regional groups of developing coastal states within the Task Force's purview, namely Southeast Asia, the Pacific Island States of the western and central Pacific, and the coastal states of Pacific Latin America.

The suspicion was that developing fishing states could assist one another. They were (and are) similar because they were developing tropical/semi-tropical states and had a fishery resource that was common to all three sub-regions, namely tuna. At the same time, the sub-regions differed in terms of their fisheries management strengths.

The proposal to explore opportunities for such fisheries cooperation was put into effect, with generous funding from Canada. This led to two exploratory conferences, with the first being in Manila in 1987, designed to bring together the Southeast Asian coastal states and the Pacific Island States. Pacific Latin American coastal states had observer status at the conference. A second conference followed in 1988, held in Lima, designed to bring together the coastal states of Pacific Latin and the Pacific Island States, with the Southeast Asian coastal states having observer status. The organizer of the Lima conference from the Peruvian side was Dr. Ulises Munaylla Alarcon (Munro, 1995).

The two conferences fully validated the suspicions. The three sub-regions did indeed differ, and there was considerable scope for cooperation (Munro, 1990; 1995). The conferences also revealed that the three sub-regions had been isolated from one another, as far as fisheries were concerned. Two informal bodies designed to coordinate inter-sub-regional fisheries cooperation were established, the Western Pacific Fisheries

Consultative Committee (WPFCC), based in Manila, and the Trans- Pacific Fisheries Consultative Committee (TPFCC), based in Lima (Munro, 1995).

Two useful examples of the South-South cooperation that was supported come from the western half of the Pacific. In the western Pacific, the then South Pacific Commission (SPC)[23] was found to be the most advanced in tuna research in that area. Arrangements were made for scientists from Southeast Asia, e.g. Indonesia and the Philippines, to study with the SPC. Secondly, if has long been suspected that the Pacific Island States share tuna resources with Indonesia and the Philippines. It had hitherto not been possible to mount a research program to assess the extent of the sharing. Due to efforts of the WPFCC and the Task Force, a research vessel from the SPC gained access to Indonesian and Philippines waters to map the extent of the sharing (Munro, 1995)[24]. The links established between scientists in the two sub-regions, and through the SPC cross sub-region tuna tagging program, were to show their true value with the establishment of the Western and Central Pacific Fisheries Commission (WCPFC) (Elvira Ablaza, PRIMEX; Anthony Lewis, SPC, personal communications).

Figure 6 here

The initiative ground to halt in 1995. Canada decided to reallocate the funding that had been going to this initiative to other purposes, and financial support, regrettably, came to an abrupt halt. Nonetheless, there is, as we have indicated, clear evidence that the impact of this initiative has continued to be felt long after it ceased to be a formal PECC initiative.

The question, which now arises, is whether it is worth while attempting to develop further this form of cooperation in the post –RFMO era. The fishery resources common to all three sub-regions in the PECC initiative did, and does, consist of tuna. These resources are, as we have indicated, now under the jurisdiction of two RFMOs, the IATTC and the WCPFC. The tuna RFMOs are attempting to cooperate, which means, inter alia, cooperation among their scientific committees. Hence, South-South cooperation in the

[23] Now the Secretariat for the Pacific Community.
[24] The mapping revealed that the Pacific Island States shared tuna resources with the Philippines to a moderate degree, and with Indonesia to a massive degree (Munro, 1995).

APEC region, with respect to the management of internationally shared fishery resources, can take place through these channels, and thus the PECC type of initiative is quite simply passé, or so it might be argued.

The counter arguments are as follows. The first is that the case for South-South cooperation has lost none of its validity. The second is that the aforementioned study on tuna RFMOs carried out for the FAO indicates that, while there is direct cooperation between the IATTC and the WCPFC, this cooperation, to date, has been extremely limited (Allen, 2010). Thus, there is no assurance whatsoever that such cooperation, undertaken through these formal (and cumbersome) channels, would be sufficient.

Thirdly, South-South cooperation, outside the formal RFMO channels, on a bilateral or multilateral basis, is not contrary to the work of any RFMO. Such cooperation among members of a RFMO is common place, and is seen not to detract from the cooperative resource management efforts of the RFMO, but rather is seen to strengthen the RFMO efforts[25]. Thus, the envisaged South-South cooperation, far from undermining inter-RFMO cooperation, could serve to strengthen inter-RFMO cooperation. There is no such thing as too many of channels of cooperation in the management of internationally shared fish stocks.

The South-South cooperation that was fostered under the PECC initiative was focused largely, although not entirely, on marine biology. An ecosystem approach to fisheries management requires that the cooperation be broader than this, including, for example, cooperation in oceanographic research. Consequently, the scope for South-South cooperation may be far greater than was envisaged heretofore[26].

[25] An example comes from the Atlantic case discussed earlier, namely that of the cooperative management of Norwegian Spring Spawning herring. There are several bilateral/multilateral agreements among the members of the RFMO managing the resource. These agreements, far from reducing the effectiveness of the RFMO, are seen as vital to the success of the RFMO (Munro, 2011).

[26] The cooperation that has been referred to thus far is scientific cooperation , i.e. cooperation at the primary level. There are two comments to be made. The first is to recall our admonition not to downplay the importance of cooperation at the primary level. The second is that there is no reason why South-South cooperation should not extend to the secondary level, as well.

If such cooperation is to be extended and fostered, the obvious body to do it is APEC through its emerging Ocean and Fishery (OF) Working Group[27]. To do so could result in a major contribution to the green growth of the Pacific marine economy[28].

V. Some Conclusions

This paper has focused on the management of internationally shared capture fish stocks, which are estimated to account for up to one third of world capture fishery harvests. The APEC region, in turn, accounts for the lion's share of the world's internationally shared capture fish stocks, indeed probably not less that 75 per cent. Thus, the APEC region has internationally shared capture fish stocks in abundance, which must be seen as accounting for a significant part of the Pacific marine economy.

There is close to universal agreement that cooperative management of these internationally shared fish stocks is desirable. There is not universal agreement; however, that cooperative management of these stocks goes beyond being merely desirable, to being essential. Under international law, for example, while states sharing transboundary stocks are required to attempt to manage these resources cooperatively, they are not required to reach an agreement. The economics of fisheries management maintains, and practice confirms, that this casual attitude towards cooperative resource management is wholly unwarranted. Non-cooperative management of internationally shared fish stocks carries with it the risk of very inferior outcomes, including possible severe resource overexploitation, which can lead, not to green growth of the Pacific marine economy, but rather what we have chosen to term black growth.

The OECD maintains that a successful cooperative international fisheries management regime will be characterized by a stable cooperative agreement that is "time consistent". A cooperative fisheries management regime that becomes unstable is at risk of degenerating into non-cooperative, competitive, resource management, with all that that implies. It should be recognized that cooperative resource management regimes are inherently fragile.

[27] See: n.1.

[28] It also follows that North –South, or even North-North, cooperation in the management of internationally shared fish stocks fostered by the APEC OFWG will also contribute to the green growth of the Pacific marine economy.

The most difficult task in achieving stable cooperative resource management regime is that of ensuring that each cooperative resource management regime is “time consistent”, which means that the regime has the resilience to withstand unpredictable shocks, particularly environmental shocks. This requires, inter alia, that a broad range of marine science be brought to bear. The science can never be expected to provide accurate predictions of such shocks, but it can enable the resource managers to anticipate the shocks and plan accordingly. The emerging APEC OF Working Group should be able to play a very constructive role in bringing Pacific marine science to bear on this issue.

Cooperation, it was noted, is beginning to take place between and among RFMOs within the Pacific and elsewhere. This is to be strongly encouraged. Such cooperation can be supplemented and enhanced by less formal cooperation on a bilateral and multilateral basis. One such set of channels, we argued, lies in South-South cooperation in the APEC region. The precedent for such cooperation was established over two decades ago. The case for South-South cooperation today is, if anything, stronger. Once again, the APEC OF Working Group could play a major role in encouraging and enhancing this cooperation, and in so doing make a significant contribution to the green growth of the Pacific marine economy.

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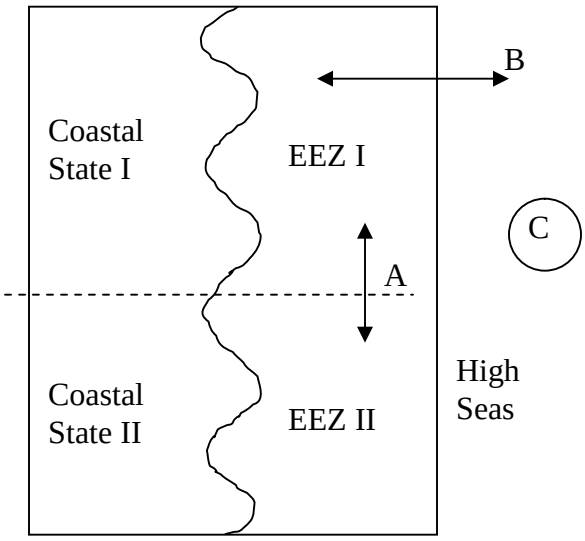

A. Transboundary fish stocks

B. Highly Migratory/Straddling fish stocks

C. Discrete high seas fish stocks

Figure 1: Internationally Shared Fish Stocks

.

Source: Munro, McDorman and McKelvey, 1998

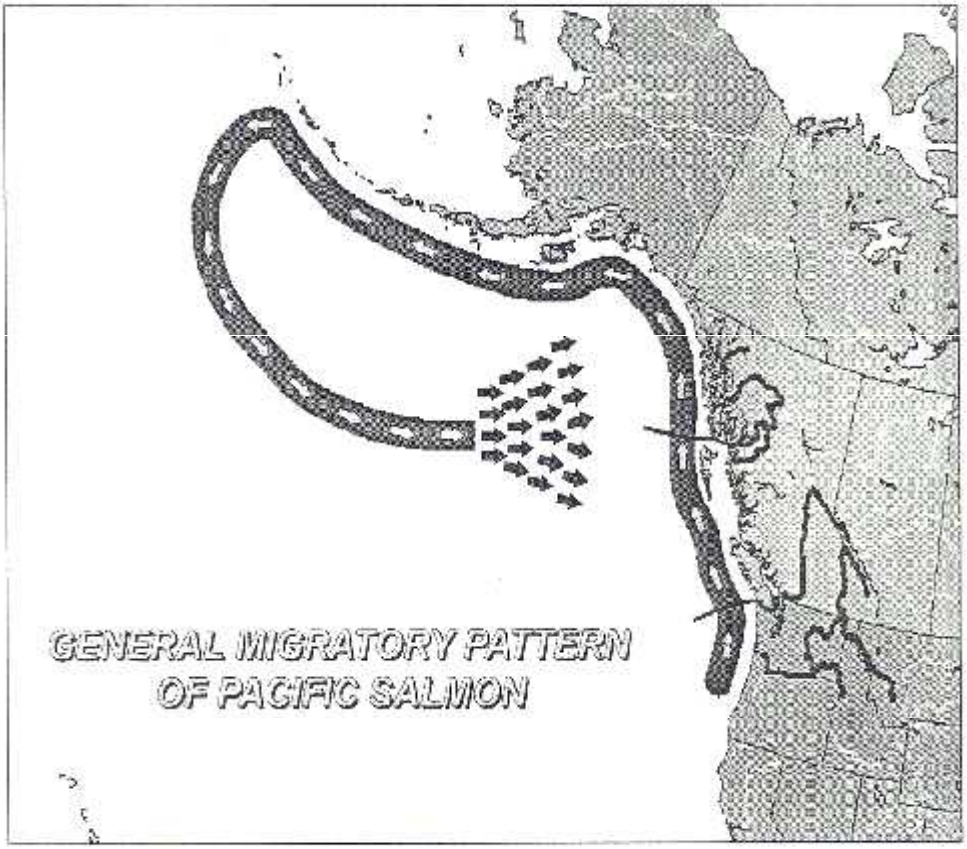

Figure 2

Source: Munro, McKelvey and McDorman, 1998.

Figure 3: Doughnut Hole, Bering Sea

Source: Meltzer, 2005

Figure 4

Source: Meltzer, 2005.

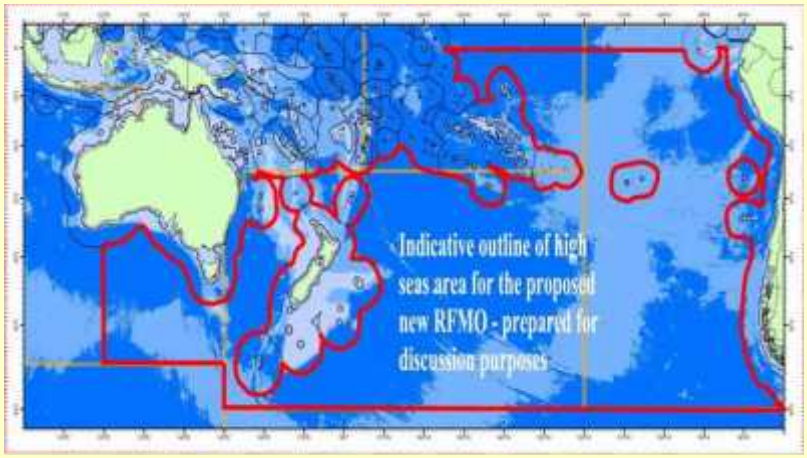

Figure 5: South Pacific Regional Fisheries Management Organization

Source: South Pacific Regional Fisheries Management Organization, 2011

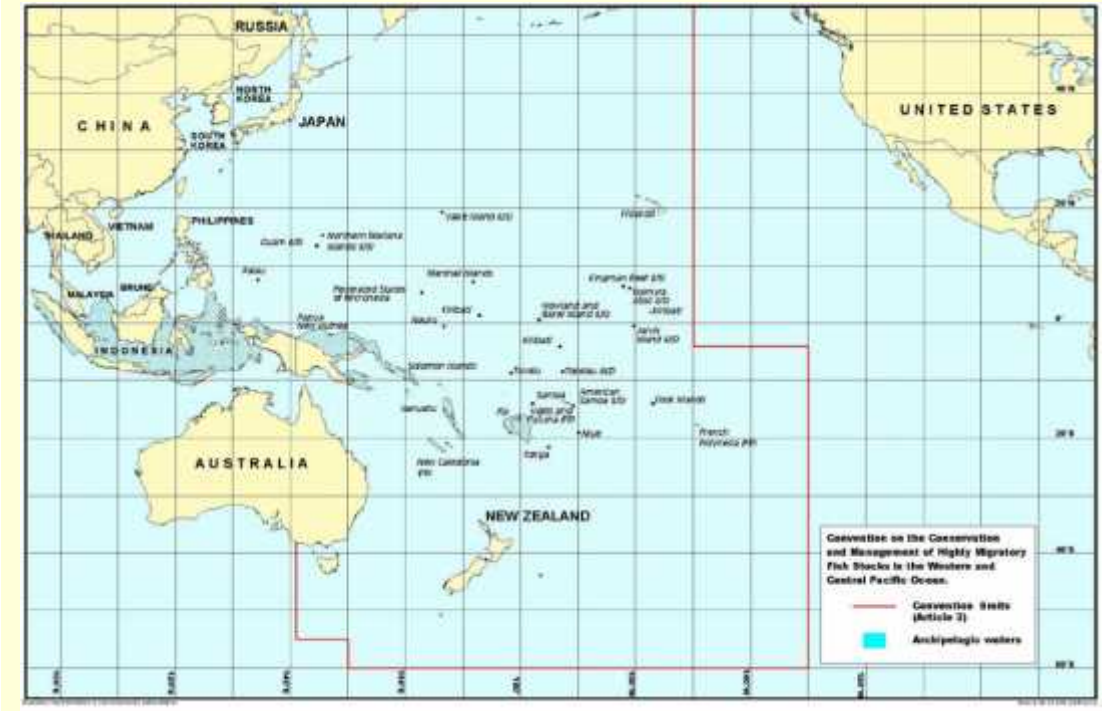

Figure 6: Western and Central Pacific Fisheries Commission

Source: WCPFC, http://www.wcpfc.int/