ADDRESSING THE ISSUES OF FISHING CAPACITY IN THE WORLD TUNA FLEETS

James Joseph

1. Introduction

Tuna fisheries comprise about 5% of the world production of marine fishes, but a much larger proportion of the total value. There is continuing high demand for tunas and this fact results in a continuing and increasing interest in capturing them.

There are 23 stocks of the principal market species of tuna that are the focus of intense fishing pressure. Three of the 4 bluefin stocks are overfished (stock abundance is less than that corresponding to a level at which it can support the maximum sustainable yield (MSY)). Of the 4 stocks of yellowfin, one is in an overfished state and for 3 overfishing (fishing mortality is greater than that corresponding to that level needed to sustain the stock at MSY) is occurring. Of the 4 stocks of bigeye, one is overfished and over fishing is occurring for 2 of them. Of the 6 stocks of albacore, 2 are overfished, and overfishing is occurring for only one of them. All 5 of the skipjack stocks are above the level of abundance corresponding to MSY, and fishing mortality is less than the MSY level.

The simple reason why many of these stocks are in an overfished state and why overfishing is occurring is that there is too much fishing effort; and the reason that there is too much fishing effort is that there are too many boats fishing.

The tuna regional fisheries management organizations (TRFMO) have attempted to correct this situation by implementing a variety of measures to control fishing mortality. These measures have included input controls such as limits on the number of vessels that can fish, closed areas and seasons, and limits on fishing effort, and output controls such as catch quotas and minimum size limits. Many of these efforts have not been successful in curtailing overfishing. As with most if not all command-and-control regulations, perverse economic incentives are established to circumvent regulations rather than positive economic incentives aligned with social goals reflected in the regulations. Moreover, command-and-control approaches hinder economic efficiency since individual vessels cannot alter catches and their operations to best achieve profitability and efficiency.

The purpose of this document is to identify the factors that have made successful management of the worlds tuna resources difficult, and to suggest a variety of approaches that could help to mollify these difficulties. The study concludes that there is too much fishing capacity in the tuna fisheries and that this leads to difficulties in implementing conservation measures. It is suggested that growth in fishing capacity of the world's tuna fleets needs to be curtailed, and eventually reduced. The introduction of a user or rights

based management system is considered as an avenue for resolving many of the conservation, management, and socio-economic problems associated with the fisheries. The advantages of a coordinated effort among the TRFMOs to address these problems are discussed, and recommendations are suggested for development of a coordinated plan of action among the TRFMOs. Much of what follows in this document is taken from Joseph, *et.al*. (2008), and Allen, *et.al*. (In Press). I am also deeply grateful to my friends and colleagues, Dr. Dale Squires and Dr. Robin Allen for the many discussions leading to this document and for the helpful input to its completion.

2. Tragedy of the commons

There are numerous examples in the literature of the failure of management systems to adequately conserve the stocks of fish that they are charged with protecting. About 25 percent of the marine fish stocks of the world are overexploited, and others are rapidly becoming so. The cause of these failures is mostly attributable to the way ocean fisheries have developed historically, particularly those exploited on the high seas, beyond the jurisdiction of coastal states. At first the resources of the sea were thought to be inexhaustible, and then were considered to be a common property of mankind, with unrestricted access to them every individual's right. These concepts have led to overfishing. As long as a fishery is profitable, new vessels enter, which eventually leads to overfishing, declining catches, and declining economic benefits that can reach depletion. However, the decline in catches can lead to higher prices, in which case the fishery continues profitable over the short term and attracts the entry of even more vessels. In addition, some vessel owners, in attempts to secure greater portions of the catch, may increase efficiency of their current vessels or construct more efficient vessels, which, of course, leads to even greater fishing capacity and overfishing. Furthermore, when a fishery becomes unprofitable, government subsidies may be granted to fishermen so that they can continue to participate in what would otherwise be an unprofitable venture. This "tragedy of the commons" (Hardin, 1968) has been a common occurrence in many ocean fisheries. These experiences have led to the realization that the concept of common resource and open access need rethinking. The change that is underway in many fisheries is to move away from these concepts and to assign user or property rights in one form or another to the participants in a fishery. These rights have taken many forms, ranging from simple participatory rights that limit the number of fishermen or vessels that may participate in a fishery to the allocation and "ownership" of individual quotas that can be traded among participants.

3. Too much tuna fishing capacity

In 1995, during the 21st Session of the FAO Committee on Fisheries (COFI), it was concluded that too much fishing capacity was the cause of most overfishing, and that this was threatening the sustainability of the world's marine fish stocks. As a result, FAO developed a Plan of Action for Fishing Capacity which called on all fishing nations and

international fisheries organizations to achieve efficient, equitable and transparent management of fishing capacity worldwide, preferably by 2003, but no later than 2005.

To facilitate this initiative, FAO convened two meetings to define the term fishing capacity. The term capacity is defined and used in many ways, but is generally used to reflect what a vessel can catch, or how much fishing mortality it is capable of generating. Most fisheries scientists use some measure of the size of a vessel or its engine power to define capacity, because they believe it to be related to the ability of a vessel to generate fishing mortality; the fishing industry mostly uses size as a measure of capacity because it is related to how much fish a vessel can catch in a single trip, and economists generally prefer some technological-economic approach using potential output to measure fishing capacity because such an approach can be used to compute optimal inputs. The most common measures of capacity for tuna vessels used by fisheries scientists have been: 1) Gross Registered Tonnage (GRT), which is the total of all the enclosed space within a vessel, and is expressed in tons, each of which is equivalent to 100 cubic feet (ft^3). The GRT of a vessel can be easily changed by changing bulkheads and walls; 2) Net Registered Tonnage (NRT), which is the total of all enclosed space within a vessel available for cargo and expressed in tons. The NRT can also be easily altered by changing partitions; and 3) Fish-Carrying Capacity (FCC), which generally relates to how many tons of fish the vessel can carry when fully loaded. There is a close linear relation between each of the measures. The FCC has been one of the most commonly-used measures of capacity for purse-seine and pole-and-line vessels. It is easily understood by the fishing industry, and generally easy to compute. FCC is a plastic measure which can change with the size of fish that are being loaded on board or the way the fish is packed for quality purposes, therefore, management agencies have had difficulties in fixing the exact value of FCC for individual vessels when regulations and/or monetary assessments have been based on the measure. To get around these problems, cubic meters (m^3) of refrigerated fish storage space, a less pliable measure of how much fish a vessel can carry, is being used more frequently as a measure of capacity. The FAO meetings resulted in a definition of fishing capacity related to potential output. Fishing capacity was defined as the maximum amount of fish that can be produced over a period of time by a fishing fleet if fully utilized, given the biomass and age structure of the fish stock and the present state of technology; in other words, it is the ability of a vessel to catch fish.

Although tuna was not specifically addressed in the plan of action, with financial support from the Japanese Government, in 2002, FAO established a project to address the management of tuna fishing capacity, within which a Technical Advisory Committee was formed to provide technical advice to the project. One of the tasks set about by the members of the committee was to estimate fishing capacity in the world purse-seine tuna fleet. A quantitative technique, Data Envelopment Analysis (DEA) was used to make the estimations for each of the 4 major fisheries: Atlantic, Indian, eastern Pacific, and central and western Pacific (Reid *et al.,* 2005).

For the eastern Pacific (EPO), data for 1998-2002 were used to estimate fishing capacity and capacity utilization by vessel size classes. The authors concluded that overcapacity existed for all size classes and for all modes of fishing, and that capacity increased by almost 50% during the period of the study. For vessels with a carrying capacity greater than

363 tons, which represent the preponderance of the fleet, their catch could have been taken with about 65-70% of the actual fleet that made it. Given these figures the EPO purse-seine fleet could theoretically be reduced from the current level of about 195 thousand ton to 126 thousand ton of carrying capacity without sacrificing catch. (The scientific staff of the IATTC had previously advised the Commission that the optimum carrying capacity for the EPO fleet was approximately 130 thousand ton.)

For the western and central Pacific (WCPO), the study concluded that overcapacity existed for all major national fleets operating in the area. It was estimated that, on average, the purse-seine skipjack fishing capacity was between about 10-35% greater than needed to take the available catch.

For the other two oceans the analyses indicated that there was overcapacity in the purse-seine fleets. Capacity in the Indian Ocean could be reduced by about 23 percent without reducing catch, while a reduction of 13% for the Atlantic would not reduce the catch.[1] Because of data limitations for the Indian and Atlantic, the figures represented extreme lower-bound estimates of capacity.

Purse-seine vessels account for more than 60% of the world production of tuna, and the current fleet could be reduced significantly without corresponding reductions in catch. Longline fleets account for about 14% of the catch of tunas and pole-and-line vessels about 11%. DEA studies have not been undertaken for these later two fleets. However, some studies using more conceptual approaches to evaluating capacity in the longline fishery have been made. Miyake (2005) estimated the size of the world's large-scale tuna longline fleets and their corresponding catches of tuna. He defines large-scale longliners as vessels greater than 200 gross registered tons (GRT) or with overall lengths greater than 35 m; he reported there are about 1600 of these vessels catching about 400 thousand tons of tuna annually. This represents about 240 tons of catch per vessel, which Miyake estimates is the economic break-even point for these vessels. He also notes that it is unlikely that all of the large-scale longliners are currently fishing at their full capacities, due to economic, social and management restrictions, and that if all these restrictions were removed, their potential catches would be greater than 240 tons per vessel. There are also about 1400 small-scale longliners (between 24 and 35 m in length) harvesting about 195 thousand tons of tuna annually. There is also a growing number of longline vessels of less than 24 m in overall length. These vessels, in many cases, are capable of fishing on the high seas and are equipped with super-freezers for *sashimi*-quality product, but because of their size, are frequently excluded from monitoring activities by some of the regional tuna bodies, consequently statistics on their numbers and catches are scarce. Because the numbers of vessels of this type are increasing it is important that they be included in any management initiatives. Although these two studies suffered from limited data availability, the messages were rather clear: that if vessels fully utilized their capacity, there was more fishing capacity in the world's purse-seine and longline fleets that needed to take the available harvest.

The growth in fishing power or technical change aggravates the overcapacity problem by increasing fishing capacity and the overall potential to catch fish. Even if vessel carrying

[1] Over the past few years purse-seine capacity in the Atlantic has declined by nearly one-half.

capacity and vessel numbers remained constant, fishing capacity would continue to grow. Two recent studies for tuna fisheries measured technical change at 3.5 percent per annum for the US and Canadian surface hook and line fishery on northern albacore (Squires and Vestergaard, 2009) and about 2 percent per annum for the major distant water fishing nations' purse-seine fleets in the western and central Pacific Ocean (Kirkley et al. 2009). Annual technical progress averaging 3.5 percent, increases fishing capacity by 41 percent over only 10 years and average annual technical progress of 2 percent increases fishing capacity by 22 percent over 10 years. Simply doing nothing about fishing capacity generates growing pressures on fish stocks as well as adversely impacting economic benefits to the fishery.

Even before these analytical analyses were completed, the tuna industry itself recognized the need to control fishing capacity and created two industry organizations to deal with the issue: the Organization for the Promotion of Responsible Tuna Fishing (OPRT), dealing with high seas longline fleets, and the World Tuna Purse-seine organization (WTPO), for tuna purse-seine vessels.

The Organization for the Promotion of Responsible Tuna Fishing (OPRT) was originally established between an industry association that represents all Japanese high-seas longline vessels, and a similar association representing the Taiwanese longline fleet. Its objectives are to track tuna coming into the Japanese market to ensure that it is from cooperating nations, to monitor the removal and scrapping of vessels and to assist in the reimbursement of Japanese and Taiwanese fishermen for the costs of removing their vessels from the fleet. Longline fleets of Indonesia, the Republic of Korea, the Peoples Republic of China, and the Philippines, among others, have joined OPRT. The target of OPRT was to reduce the large-scale, super-freezing, tuna longline fleet by approximately 20%. A number of longline vessels have been bought-back by the Japanese and Taiwanese longline industries and scrapped, and the target objective of 20% has been achieved. The buy-backs were made by the Japanese and Taiwanese longline industries. Moneys were loaned to the industry groups by the Japanese government on a 20-year pay-back schedule. Currently, most of the large scale longline fleets are members of OPRT. However the number of small coastal longliners less than 24 meters in length, fishing progressively greater distances from shore and taking increasingly greater quantities of tuna and are not members of OPRT, nor are they following the same path of reducing capacity-to the contrary, they are growing in numbers.

There is a similar initiative by purse-seine owners, who have been concerned over the growing number of vessels in the tuna fisheries, the fluctuations in supplies and price, and the intention of nations and individuals to bring new vessels into the fishery. To address these issues several industry organizations representing purse-seine vessels came together to form the WTPO. The world purse-seine fleet is comprised of more than 600 large vessels capable of carrying more than 600 thousand tons of tuna, and the fishing capacity of the fleet is increasing through new additions and increased efficiency. It has been estimated that an additional 30 large purse-seine vessels are under construction and will soon enter the fishery. With this tremendous potential to catch fish, when the supplies of

tunas, particularly skipjack, are abundant, the catches increase sharply. These increases in production tend to outstrip demand and cause ex-vessel prices to decline. Conversely, during years when skipjack abundance is normal, or low, there is more purse-seine capacity than needed to take the available harvest. This has caused serious economic problems in the purse-seine industry, and stimulated efforts on the part of purse-seine vessel owners to do something to bring supply into balance with demand. The WPTO has called for a moratorium on new purse-seine vessels entering the fishery and for the establishment of a world purse-seine and longline vessel register, which would be open only to vessels authorized by their governments to fish. New vessels could enter the register only as replacements for vessels of an equal size removed from the register. So far, such a world register has not been implemented.

4. What's being done

4.1. Current arrangements for controlling capacity

Prior to the work of Reid *et al* (2005) and Miyake (2005), it was recognized that there was more capacity available in the tuna fisheries than was needed to take the available harvest, and that this excess in capacity was making it difficult to initiate and maintain effective management programs tuna fisheries. It had been further recognized that catch quotas, closed areas and seasons, and minimum size limits alone are inadequate to the long-term needs of effective management and conservation, and that such measures must be coupled with limitations on fishing capacity. All of the TRFMOs have begun studies of the problem of overcapacity, and some have initiated efforts to correct it.

4.1.1. Inter-American Tropical Tuna Commission (IATTC)

The first major efforts to limit fishing capacity in the eastern Pacific were initiated in 1999 when carrying capacity limits for purse-seine vessels were assigned to each of the 13 nations involved in the fishery. Criteria used to assign capacity limits to nations were 1) Current fleet size by flag, 2) catches taken within the EEZs of the nations bordering the EPO, 3) landings of tunas from the EPO in each of the 13 countries, and 4) contributions of each of these nations to the IATTC's conservation program. The actual allocations of fleet capacity approximately equaled the capacities of the fleets operating during 1998. There were several coastal states participating in the negotiations that did not have tuna fleets at the time the allocations were being made, so these were assigned limits which would allow them to acquire vessels under the program. The total limit set for purse-seine vessels in the EPO for 1999 was 158 thousand tons of carrying capacity (including current carrying capacity operating in the fishery and carrying capacity for the coastal states to grow into). The capacity of the fleet during 1998 was 138 thousand tons. By the end of 1999 carrying capacity reached 158 thousand tons. It was clear there was a rush to bring new capacity into the fishery before regulations prohibiting new entries could be enacted. The nations could not reach agreement to extend the resolution in its original form beyond 1999. The result was continued fleet growth, and by the end of 2002 it had reached nearly 180 thousand tons.

The Commission continued its efforts to limit fleet growth and the governments reached an agreement to establish a Regional Vessel Register (RVR), which would include a list of purse-seine vessels authorized by their governments to fish for tunas in the EPO. Any vessel fishing in the EPO and not on the RVR would be considered to be IUU fishing. The RVR is closed to new entrants, with the exception of allocations to certain qualifying coastal states without fleets, or with small fleets, but that had aspirations of acquiring vessels. The intent of the program was that capacity quotas would be assigned to individual vessels and not governments, and that vessels could be freely transferable to other flags. If a vessel on the RVR moved to another flag within the EPO the place on the Register would go with it. However, after the establishment of the Register, most members decided to remove vessels that intended to change flags from the Register. This has severely restricted the ability of vessels to change flag. Within a flag, governments generally allow the transfer of places on the Register by owners.

Since its inception in 2002, the RVR program has curtailed unbridled growth in the fishery, but operating within the constraints of the program nations have been able to increase capacity, which is currently near 195 thousand tons; this is about 55 thousand tons greater than the optimum capacity estimated by the scientific staff of the Commission. This growth in nominal capacity is aggravated by increases in economic efficiency due to technical change.

4.1.2. The International Commission for the Conservation of Atlantic Tunas (ICCAT)

ICCAT has a long history of implementing management measures for tunas in the Atlantic. In 1998 the member governments agreed to limit the size of their fleets fishing for northern albacore to 1993-1995 levels and to limit the numbers of their vessels greater than 24 m in overall length fishing for bigeye tuna to 1991-1992 levels. It was also agreed that the limits on the number of vessels would be coupled with a limitation on GRT, so as to not increase total carrying capacity. Specific limitations on the catches and numbers of vessels that could operate in the bigeye fishery were placed on several, but not all, nations with fleets fishing for bigeye in the Atlantic Ocean, *e.g.* the Peoples Republic of China, Chinese Taipei, and the Philippines were assigned fleet limits and catch quotas. One of the problems that ICCAT has had in measuring the effectiveness of the efforts to limit capacity to previous levels, is the availability of information on current numbers of active vessels with which to compare with the base years.

4.1.3. The Indian Ocean Tuna Commission (IOTC)

Early in its history, the members of IOTC recognized that fishing capacity in the Indian Ocean was probably in excess of what was needed to harvest the current catch, and that measures should be considered for limiting capacity. In an effort to initiate the preliminary steps of limiting fishing capacity, in 2002 the Commission approved measures to establish and maintain a Record of Authorized Vessels (RAV) of greater than 24 m in overall length authorized to fish in the Indian Ocean. Nations participating in the agreement could add or remove vessels to or from the RAV, so that the RAV itself does not limit the number of vessels. However, any vessel not on the RAV would be considered to be engaged in IUU fishing. The first directed action to limit fishing capacity was undertaken by IOTC during

2003, when a resolution was approved directing CPC with more than 50 large-scale tuna fishing vessels on the IOTC register of vessels to limit the number of their vessels to the number registered in 2003. The resolution also stipulated that the numbers shall be commensurate with the corresponding overall tonnage capacity of the fleets, and where vessels are replaced the overall corresponding tonnage is not to be exceeded. This measure was expanded in 2005 to include vessels of less than 24 m in overall length that fish in the Indian Ocean outside the EEZs, and the baseline for restricting numbers was changed to 2006. Exceptions to this limitation are made for some nations with fleets under development. In approving this resolution, the Commission expressed concern that the measures taken result in some nations striving to bring their fleet capacities up to the 50-vessel guideline, resulting in an increase in capacity.

In 2007 the Commission approved a resolution requiring all CPC to limit the number of their vessels fishing in the IOTC area of competence for albacore and/or swordfish in 2007-2010 to the number listed in the 2007 IOTC register of vessels. And again in 2009, the base lines for limitations were 2006 for tropical tunas and 2007 for albacore and swordfish.

All of these measures would tend to reduce the number of vessels operating in the fishery because it would make it difficult or impossible for an IUU vessel to operate profitably in the Indian Ocean. However, the methods do not, in themselves, result in a reduction of vessels authorized to fish in the Indian Ocean.

4.1.4. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT)

The CCSBT differs from the other regional tuna bodies in that it is concerned primarily with southern bluefin tuna, and its convention waters are wherever this species is found. The Commission sets a catch quota each year which is allocated among the members. This provided the opportunity for the members to place controls on their vessels fishing for bluefin under the country allocations. In the case of Japan, certain restrictions were placed on the number of longline vessels that could participate in harvesting the allocation. Australia implemented a form of individual vessel quotas in which its share of the overall quota was partitioned among various Australian fishing companies, most of which were involved in farming of bluefin. The companies control the number of vessels involved in harvesting Australia's share, and, because the industry seems to be limiting the number of vessels to reasonable levels, the Australian government has not considered it necessary to place overall limits on the number of vessels. Over the last few years the number of nations fishing for southern bluefin has increased. The Republic of Korea and Indonesia have joined the CCSBT, and the five members share a TAC. An additional quota of 900 tons has been set aside for non-member states fishing for southern bluefin tuna.

In an attempt to stem the growing fleet size and increasing fishing pressure on southern bluefin, and in keeping with the intent of the FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing (IPOA-IUU), the CCSBT has created a record of vessels greater than 24 m in overall length authorized to fish for southern bluefin tuna. The CCSBT considers any vessel that is not on the record and that is fishing for southern bluefin to be engaged in IUU fishing. CCSBT members are urged to take certain actions against such IUU vessels in an attempt to correct the problem. The first

action called for is to seek cooperation of the flag state of the IUU vessel in addressing the problem. If that approach fails, the members are urged to undertake more severe measures, including trade restrictions.

The impact of all these actions by CCSBT should serve to mitigate somewhat the problem of actual or potential overcapacity in the southern bluefin fishery, but, it is difficult to determine precisely the effectiveness of these measures.

4.1.5. The Western and Central Pacific Fisheries Commission (WCPFC)

Since the expansion of distant-water purse-seine tuna fleets fishing in the WCPO, the states of the Pacific island region have been concerned about the management of fishing fleets in their region. This concern contributed to the formation of the FFA in 1979. The creation of a regional register of foreign fishing vessels within the FFA provided a mechanism to monitor and theoretically control, through the sale of licenses, the number of purse-seine vessels authorized to fish in the region. Though the register did not effectively limit the number of vessels operating there, it did provide a mechanism to monitor the numbers that could fish in the region. Because of growing concern over the rapidly expanding number of purse-seine vessels operating in the region of the Pacific islands, the Parties to the Nauru Agreement (PNA) implemented the Palau Arrangement in 1992, which set a limit of 205 vessels that would be allowed to purchase licenses to fish within the EEZs of the PNA. About 80 percent of the purse-seine catch from the WCPO is taken within the waters of the PNA.

During the series of meetings and conferences leading to the creation of the WCPFC a great deal of attention was paid to the issue of fishing capacity and resolutions were adopted urging all states and other entities to exercise reasonable restraint in respect of any expansion of fishing capacity in the area At the December 2006 meeting of the Commission, participating nations agreed to take necessary measures to ensure that the total capacity of their respective other commercial tuna fisheries for bigeye and yellowfin tuna, including purse-seining that occurs between 20ºN and 20ºS, does not exceed the average level for 2001-2004 or 2004. The most recent action taken by the Commission regarding capacity was included in the 2006 Agreement and beginning in 2007 requires all CCM to take the necessary measures to ensure that the total capacity of their respective other commercial tuna fisheries for bigeye and yellowfin do not exceed the average level for the period 2001-2004 or 2004.

Similar to the action taken by the IATTC, measures have been taken by WCPFC to limit the growth in numbers and capacity of vessels fishing for albacore in the Pacific Ocean.

The PNA implemented a program which places limits on the total numbers of fishing days, the vessel day scheme (VDS), or total allowable effort (TAE), that are permitted in the EEZs of its members. The TAE is set by the PNA on the basis of the best scientific, economic and management information and advice. The TAE is partitioned among the PNA into party allowable effort (PAE) with 50% of each parties share being based on the assessed relative 10-year average biomass of skipjack in the waters of the parties and with the remaining 50% being based on the 7-year average annual distribution of the number of vessel days fished in the waters of the parties. Each party would then be free to use its PAE as it wished, either for its own vessels or for licensing foreign-flag vessels.

The VDS does not directly limit fishing capacity or the number of vessels authorized to fish, but because the number of allowable fishing days is limited this could affect how many vessels might fish. The 205 vessel limit[2] established by the Palau Agreement was lifted when the VDS was implemented on December 1, 2007.

4.2. Focusing on the problem of controlling capacity

A series of 4 workshops were held by the FAO Technical Advisory committee mentioned above. These workshops, which concluded that excess fishing capacity existed in all oceans, also examined various options for managing fishing capacity. Conclusions and recommendations from the meeting were:

1) Over the longer term it is important to improve conservation and management approaches of the RFMOs. To this end, country allocations of shares of the TAC and other rights-based approaches should be included among the approaches considered for conservation and management.

2) Implementation or maintenance of an immediate moratorium on the entry of additional tuna fishing vessels into the fishery to limit increases in fleet capacity, without prejudice to the other measures taken by the RFMOs.

3) Creation or maintenance of closed regional registers for all commercial tuna fishing vessels.

4) Since all tuna RFMOs have or are developing vessel registers/lists, in which vessels are not necessarily identified uniquely and may be reported under different names, all tuna RFMOs should adopt a common database and minimum standards for vessel data and to combine their individual registers/lists into a common global vessel list.

5) There is a need for a substantial reduction of existing fishing capacity by all tuna RFMOs, recognizing that the reduction could vary according to the specific circumstances of the regions, the types of fisheries, and the target species.

6) Evaluation of buybacks of vessels, of rights to fish, such as permits, and of gear. Increases in profitability of the fishery due to buybacks should justify any initial loans made to vessel owners, and may be the basis of repayment.

7) Address the elimination of subsidies, economic incentives, and other factors contributing to overcapacity and overfishing.

8) Development of a system of agreed measures to discourage IUU fishing and to ensure compliance with capacity limits.

9) Data that can be used for estimating fishing capacity exist for purse-seine and most long line vessels larger than 24 m, but there is a paucity of data for other parts of the fleet, particularly long line vessels smaller than 24m, therefore states should collect input (vessel numbers, characteristics and efforts) and output (catches) data that are linked together for all parts of the fleet including an expansion of the statistical document systems to include fresh fish or adopt catch certificate system.

[2] During the time it was in effect, the 205 vessel limit was not exceeded.

10) Monitor socio-economic aspects which are directly associated with fishing capacity, including fuel cost, fish price, and diet preferences.

11) Attention be directed to the following topics for future research:

- Investigation of changes in fishing power and productivity of fishing vessels over time.
- Conducting research on methods of fishing directed at one species, particularly skipjack, that minimize the catches of species that are considered to be over-fished.
- Further development of methods to estimate fishing capacity based on stock assessment.
- Investigation of the effects of aggregation of data on fishing capacity estimates and the implications for minimum data standards.
- Investigation of the relationship between fishing capacity and the physical vessel characteristics of the fleet.
- The development of bio-economic models to evaluate options for limiting fleet capacity and assigning user or property rights in tuna fisheries.

In January of 2007 the tuna TRFMOs held a joint meeting in Kobe, Japan to discuss issues of common interest as well as specific actions to improve the functions of each TRFMO, including coordination and collaboration of their activities. The following actions on fishing capacity were agreed to:

- Development, where appropriate, and application of equitable and transparent criteria and procedures for allocation of fishing opportunities or level of fishing effort, including provisions to allow for new entrants.
- Controls, including fishing capacity reduction as appropriate, to ensure that actual total catch, fishing effort and capacity are commensurate with available fishing opportunities in order to ensure sustainability of tuna stocks while allowing legitimate fishery development of developing coastal states, particularly small island developing states and territories.

Subsequent to the FAO workshops, and the Kobe Meeting, two additional meetings were held to examine the problems of overfishing of tuna, excess capacity, and the desirability of moving to rights-based management systems for tuna fisheries. The first of these meetings was on October 10-12, 2006, in La Jolla, California and sponsored by the IATTC, National Marine Fisheries Service (NMFS), and the University of California San Diego (UCSD). The second was also held in La Jolla, May 5-9, 2008 and was sponsored by the World Bank and IATTC, with complementary funding by the NMFS.

The conclusions of these latter two meetings were that overcapacity existed in all tuna purse-seine fisheries and large-scale longline fisheries, and that the problem of overfishing was principally the result of open access fishing and too much fishing capacity. They concluded there is an overwhelming and urgent need to address the problems of overcapacity and open access with respect to international tuna fisheries and called for

studies and programs which could lead to the implementation of capacity controls and rights-based management in international tuna fisheries.

5. What can and needs to be done

There is almost universal agreement among governments, regional tuna bodies and industry that there is more than enough fishing capacity to harvest the available supplies of tuna, and that limits should be placed on the numbers of vessels allowed to fish. Excess fishing capacity and overfishing exist because of the political framework within which tuna fisheries have developed. Specifically they have been considered a common resource to which there has been open access by the citizens of all nations. In some cases this approach has led to overfishing of some stocks, and, if continued, it will likely lead to overfishing of others. Efforts have been made to mitigate these threats of overfishing by imposing catch limits, minimum size limits and closed areas and seasons. These attempts have been only moderately successful because of the difficulty of enforcing them and because of the ever increasing pressures of a growing, competitive, and economically-distressed fleet. In some cases the pressures have been so great that controls have not been implemented, and subsidies have been granted to vessel owners to mitigate severe economic hardship caused by too much capacity. Squires *et al*. (1998 and 2000) have pointed out that overcapacity is wasteful, reduces economic rents, diminishes the economic viability of the industry and makes it difficult for regulators to reduce the total yields from a resource without imposing bankruptcies and job losses.

A partial solution to this problem would be to limit the numbers of vessels that are permitted to fish. Ideally, the limit might be the target fishing capacity, which can be considered as the maximum amount of fish that can be caught over a period of time by a fishing fleet that is fully utilized, while satisfying fishery management objectives designed to ensure sustainable fisheries. As discussed above, most of the major purse-seine fleets are well above this level and so are the fleets of medium and large longline vessels. Before effective programs to limit capacity can be implemented there are some issues that must be considered. These have been discussed extensively by Joseph (2005) and a few are related below.

Of fundamental importance is the need for a change in the way that the politics of resource use in the ocean have been viewed historically. So long as the concept of free access to a common resource prevails, overfishing, or the threat of overfishing, will continue. The vesting of some sort of user or property right to the participants in a fishery makes possible more flexible approaches to conservation of the resource. Fortunately, such changes have been underway during the last several years. These changes have been mostly in fisheries that lie solely within the jurisdictions of single nations, because resolving ownership problems in such fisheries is much easier than in multinational fisheries. An example is that of New Zealand, which has allocated shares of certain fish stocks to users, thereby affording the opportunity for the management system to limit fishing capacity and maintain sustainability in the fisheries (Dewees, 1989). There are many other examples such as the Alaskan groundfish fishery, one of the most important fisheries of the USA, Canadian Atlantic herring, surf clams and quahogs in the United States, and the Pacific Halibut fishery of Canada and the US. In these fisheries, rights to catch fish have been allocated to

both groups and individuals, and as a result the management system has been able to control fishing capacity at levels commensurate with MSY (Holland, 2000).

These examples of the assignment of use or property rights in both national and international fisheries provides evidence of their utility in avoiding "the tragedy of the commons" and implementing effective management and conservation measures, including limiting fishing capacity. As pointed out by Joseph, et.al., (In Press) "the question is: is it likely that such a change in multinational tuna fisheries is possible**…** it would be difficult to reach agreement among the divergent interests in the tuna fisheries of the world to assign property rights and limit the number of vessels that can operate and to achieve consensus as to how this would be done. In any scheme to limit capacity or allocate shares of the available harvest the "have-nots" will be reluctant to agree to anything that they perceive as limiting their opportunity to enter the fishery or to increase their participation in it. Furthermore, most of the world catches of tunas are taken in the EEZs of the have-nots, which they perceive as a strong reason for allocating greater shares of the catches to them. Therefore, since the tunas (with the exception of skipjack in most areas) are fully exploited, increased participation by the have-nots must come at the expense of the haves. These reductions in fishing capacity of the haves must either be great enough to provide the opportunity for have-nots to bring vessels into the fishery, or some mechanism for transferring vessels to them will be necessary. Additionally, criteria for determining how capacity would be assigned to the new entrants would have to be developed."

5.1. Rights based options for controlling fishing capacity

Although limited in numbers and scope, there has been some experience in the TRFMOs with the assignments of property or user rights in tuna fisheries. Allen, *et. al*, (In Press) review such experiences and offer a detailed discussion on the requirements for implementing rights based management into tuna fisheries. They noted that these rights have been assigned mostly to nations and not individuals. ICCAT has for years assigned national quotas in the bluefin, swordfish, bigeye and albacore fisheries; all of which have been assigned to nations. The CCSBT has allocated southern bluefin catches among members; national allocations have been made by other TRFMOs as well. The RVR of IATTC has assigned a capacity quota to vessels, which is a weak form of user right; this weak right only provides for a right to fish, not a right to a fixed share of the fish. The Agreement on the International Dolphin Conservation Program (AIDCP), which applies in the area of the eastern Pacific Ocean, is the nearest example of an international allocation of quotas to individuals. The AIDCP allocates a dolphin mortality limit (DML) to each qualified vessel, which allows it to take dolphins up to the DML while fishing for tunas. It is a relatively weak right since there are national mortality limits, which, if reached, would curtail an individual vessel's right.

The number of rights assigned in tuna fisheries has been very limited; nevertheless there has been an extensive amount of literature on the topic. In a recent study Joseph, et.al. (In Press) have discussed a number of approaches for limiting fishing capacity that involve user rights, and they have grouped these into those that tend to remove the incentive for overcapacity and those that do not. These are repeated here.

5.1.1. Alternatives that do not remove the incentive for overcapacity

This category of measures seeks to limit the number and/or fishing capacity of vessels that are permitted to participate in a fishery. Because the quantity of fish each vessel may take is not limited, there remains an incentive on the part of vessel owners to take as large a portion of the total allowable catch as possible. Competition among the vessels remains high, and there is a strong incentive for each owner to improve the efficiency of his vessels so that they can take a greater portion of the total available catch. This capacity stuffing results in increased fishing capacity which makes it more difficult to maintain conservation controls.

5.1.1.1. Vessel registers

On the one hand, two of the regional tuna bodies (ICCAT and the IOTC) maintain "positive lists" of vessels that are authorized to fish in the waters under their charge; however, the lists do not limit the numbers of vessels. New vessels can be entered on the lists if they meet the qualifications prescribed by the regional tuna bodies. On the other hand, the register of the IATTC limits the vessels that can fish in the EPO, and therefore limits the fishing capacity.

5.1.1.2. Regional registers

The regional vessel register (RVR) discussed here would provide mechanisms for reducing overcapacity while allowing for the participation of have-not nations in the fishery. Because the implementation of an RVR would not address fully the overcapacity problem, other controls on the fishery would have to be established concurrently to prevent overexploitation.

The first action of an RVR would be to place a moratorium on fleet growth. Each state would be required to provide to the regional tuna body a list of vessels that it had authorized to fish under its flag. To prevent a state from "padding" the list with inactive or non-functional vessels, or to prevent a flood of vessels from entering the fishery from other areas as soon as the intention to establish the register became public knowledge, only vessels considered to be actively fishing in the area could be listed on the RVR. An actively-fishing vessel might be defined as one that had been fishing in the area for a predetermined period of time. To remain on the RVR, a vessel would have to remain active in accordance with whatever definition was chosen.

Purse-seine vessels come in all sizes, from small coastal vessels that can carry only a few tons to the largest ocean-going vessels capable of holding more than 3,000 tons of frozen tuna. Most of the world catch of tuna by purse-seine vessels is taken by vessels with carrying capacities greater than 800 tons. The smallest purse seiners fish only seasonally for tunas, spending most of their time fishing for other species, *e.g*. anchovies, sardines, mackerels, *etc*. Some criteria would have to be established regarding which vessels could be included in RVRs. A useful criterion for listing a vessel on the RVR might be to include any purse-seine vessel with a carrying capacity greater than some minimum tonnage and

for which the annual catch of the principal market species of tuna makes up some significant portion of its annual catch of all species combined.

In some fisheries, certain tuna fleets may fish throughout the entire area of a regional organization, while other fleets may be confined to more restricted areas. For example, in the western Pacific there are large fleets of vessels that confine their fishing to the area around the home Islands of Japan or to the EEZ of Papua New Guinea. It may therefore be necessary to consider the establishment of sub-regional registers to allow for these differences in the distributions of fleets. In such cases additional control measures, *e.g.* closed areas, would be needed.

To ensure that it is adaptive to changing conditions in the fishery, a key feature of any RVR system would be allowance for transfer of vessels among users. This means that the capacity quota assigned to a vessel should remain with the vessel, rather than with the flag state. This has been one of the obstacles confronting the smooth functioning of the IATTC system. Although the original intent of the IATTC system was that the capacity quota would stay with the vessel, rather than the flag state, some states have removed vessels from the register when those vessels transferred to another flag. In cases when the receiving flag has no unused capacity, the transferred vessel, which would have been removed from the register by the state from which it was transferred, could not be entered on the register, and therefore would be declared IUU. The reasons why a state might chose to act this way are obvious. States with fleets would not want to lose those fleets to others, so they would keep a "captive" capacity quota to use later.

A market for vessel capacity would be created if the capacity quota followed the vessel to wherever it transferred to within the region. Without the transfer provision the value of a vessel could decrease, since it would be bound to a flag state, and that state could impose on the vessel whatever constraints or monetary requirements it chose. The vessel owner would have no options except to subscribe to the requirements, sell the vessel outside the region (although similar RVRs could be in effect in other regions), sell the vessel to someone within the same flag state, most likely at a reduced price, transferring it to some other use or abandoning or scrapping it. Maintaining transferability, that is the capacity quota belongs to the vessel and not the flag state, within the RVR system would also provide the opportunity for the have-nots to acquire vessels; they could compete in the market place for capacity allocations.

Another important feature that should be considered for an RVR program would be the inclusion of measures to allow for vessel replacement. As vessels age, they are replaced with new ones to ensure an economically viable and efficient fishery. However, the carrying capacity of the replacement vessel must not exceed that of the vessel being replaced, and that the replaced vessel must not be allowed to continue to fish for tunas in the area to which the RVR applied. It is likely that the replacement vessel would be more efficient than the one that was replaced, so some means of measuring the change in efficiency would have to be available, and mechanisms would have to be developed within the RVR system to adjust for these changes. In addition to capacity growth from changing efficiency, there is also the need to reduce fleet capacity because there is too much capacity in the world fleet of tuna purse-seine vessels. When an RVR system is initiated there

would be more vessels on the register than needed to harvest the tunas at the MSY level. A buy-back scheme could be used to reduce the fleet size to levels closer to the optimum. At the outset it is likely that government or international monetary funding would be needed to make the buy-backs, due to the large capital expenditures that would have to be made, but once the fleet reached the optimum level the program could be maintained by industry. Of course, a government program to fund buy-backs would be a subsidy to the fishery because it would increase the profitability of the vessels that were not bought back. However, such a subsidy might be considered acceptable, since it would mitigate problems of overfishing and place the industry in a position to fund its own programs.

Buy-back schemes have been used in a number of fisheries; some have been government programs and others industry programs. Many have been successful, but there are several problems. These have been discussed by Holland, Gudmundsson and Gates (1999), Clark and Munro (2003) and Curtis and Squires (2007), and reviewed by Joseph (2005) with respect to tuna fisheries. Among the problems are ensuring that bought-back vessels do not reenter the fishery, the lack of motivation for the fishermen to sell back their vessels and replace them with more efficient ones and ensuring that most of buy-backs are not the least efficient vessels.

5.1.1.3. A global register

If each of the regional tuna bodies establishes an RVR they could work together to establish a global register. Such a list would be useful from several points of view. First, it would provide governments with a list of vessels that are authorized to fish for tunas in the world's oceans, and, by default, identify any vessels without such authorization, which would be deemed IUU vessels; second, it would identify vessels being carried on more than one register; third, it would facilitate legitimate transfers among regions; fourth it would facilitate monitoring and surveillance; and, fifth, it would be relatively easy to monitor changes in the capacity or characteristics of the world's purse-seine fleet.

The most logical place to assign responsibility for creating and maintaining the global register would be within the regional tuna bodies themselves. Responsibility could be delegated to a single regional tuna body by agreement of the other bodies, or they could be jointly responsible and work through a committee made up of representatives from each of the bodies. Alternatively, responsibility for maintaining the global register could be given to an organization outside of the regional tuna bodies.

5.1.1.4. Licensing

Possession of a license would seem to be the same as being on an RVR, but there are things that could be done with a licensing scheme that could not easily be done with RVR schemes in their present form. Licensing schemes have been used in many fisheries to limit the numbers of vessels authorized to fish. Like an RVR scheme, licensing vessels to fish even if the numbers of licenses are limited and other constraints such as catch quotas are implemented, does not take away the competition by the license holders to catch fish. The tendency of fishermen to race to catch fish and to improve the efficiency of their vessels will remain as long as the amount of fish each vessel can take is not fixed.

Notwithstanding this shortcoming, licensing has been used by several states to control entry into their fisheries (Sinclair, 1983; Wilen, 1988; Townsend, 1990, Hallman et al. In Press), but has not been used by regional tuna bodies to control international tuna fisheries. Tuna fisheries are multinational, and developing a licensing scheme that is acceptable to all states involved in the fishery is complicated by issues of sovereignty. If each state in an international tuna fishery undertakes its own licensing scheme, such as the VDS for the WCPO, it becomes more difficult to create an effective program for limiting capacity, but, if the authority to license was vested in the regional tuna bodies more versatile and effective systems could be developed.

A simple approach to limiting capacity through licensing would be for each state with vessels fishing in the region to license each vessel in its fishery and to issue new licenses only for replacement purposes. If all states did this it would basically result in prevention of increases in capacity as a result of the entry of additional vessels into the fishery. The same problems of excess capacity and making room for have-nots exist for this licensing approach as for the RVR approach. If transferability of licenses was included, have-nots could buy into the fishery; the marketplace would determine the value of a license and any nation, group or individual would be able to compete in that marketplace for a license.

Townsend (1992), Townsend and Pooley (1995) and Cunningham and Gréboval (2001) have discussed fractional licensing, and Joseph (2005) has suggested that it be considered for use in fisheries for tunas. Fractional licensing includes a reduction in fishing capacity at the outset of the program, and could include transferability of licenses.

If properly applied, the fractional licensing would eliminate the need for buy-backs; its success would depend on the transferability of the fractional licenses. The regional tuna body would determine the target size for the fleet, which for all fisheries would be less than the current fleet size. The total number of licenses to be issued would be the fraction that the target fleet size is of the current fleet size. For example, if the current fleet size were 150 vessels, or 150 thousand tons of carrying capacity, and the target fleet size were set at 100 vessels, or 100 thousand tons of carrying capacity, each vessel would be issued two-thirds of a license. A vessel would not be authorized to fish without a full license, so the owner of one vessel who wishes to fish would have to acquire an additional one-third of a license[3]. Since the licenses originally issued by the regional tuna body would be transferable, and since no vessel would be able to fish with less than a full license, a market for fractional licenses would develop. In reality, tuna vessels are not all alike; in general, the larger, newer, better-equipped ones have greater fishing capacities than the others. In the above example, some of the largest vessels might be issued licenses with a "value" of 1 or more than 1, and the smallest ones might be granted licenses with values of less than one half. This raises several problems. First, decisions as to the values of licenses to be granted to each vessel would have to be made. This task could be assigned to the regional tuna bodies, which would use the characteristics of the vessels and their catches per day of fishing during the previous few years to make their decisions. The problem of balancing

[3] Fractional licensing has some similarities to the IATTC RVR in which cubic meters of well volume can effectively be traded. If all the IATTC well volumes were devalued to a fraction of their current value so the new total equaled the target, the system would be the same.

capacities among buyers and sellers would be complicated, so some sort of brokerage house at which fractions of licenses could be bought and sold would probably be needed. Because the conventions establishing the regional tuna bodies do not include provisions for the kinds of monetary transactions contemplated in a rational licensing scheme, they would have to be modified, or institutions would have to be created outside the framework of the organizations. If the proper number of licenses were set at the initiation of the program there would be no need for buy-backs at that time. However, fishing capacity would probably increase due to improvements in equipment and fishing methods, so either some provision for buy-backs would be needed to compensate for these efficiency changes, or the licenses would have to be for a fixed term, at the end of which their values would be reduced to compensate for increases in efficiency. Since there would be a market for the licenses, have-nots would be able to enter the fishery on the same basis as the haves.

A fractional licensing scheme has the advantage of equitability among the participants in a fishery. At the outset the value of each license would be reduced by the same percentage for every vessel, and the cost of bringing a license to unity would be proportionately the same for all vessels.

The owner of a vessel with less than a full license for the area in which it has historically fished might wish to transfer that vessel to another area that does not have a fractional licensing scheme. This would not be possible, however, if the regional tuna bodies in the other areas have management schemes that prevent additions to fishing capacity in those areas (which they hopefully would have).

Joseph (2005) has examined the possibility that auctions be used to sell predetermined numbers of fishing licenses in order to manage tuna fleet capacity. An auction system could reduce fleet capacity and provide an opportunity for have-nots to enter a fishery. If the licenses were issued for a limited term, the number of licenses auctioned at the beginning of the next term could be reduced to compensate for increases in vessel efficiency during the previous term.

Ideally the regional tuna body would recommend a level of licensing less than the current fleet level, which would eliminate the overcapacity problem. Some of the vessels owned by unsuccessful bidders would be sold to successful bidders who did not own vessels and others would be converted to other uses or scrapped. Revenues from the auction could be used to compensate unsuccessful bidders whose boats were converted to other uses or scrapped. This would, in essence, be an industry-funded buy-back program. Have-nots would be able to enter the fishery by successfully bidding for licenses.

Because of the many different sizes of purse-seine vessels, some system of setting the number of licenses by size categories would have to be developed. This could be accomplished by setting the numbers of licenses to be auctioned in proportion to the current size distribution of vessels, *i.e*. the numbers of licenses in each size category would be a constant percentage of the numbers of vessels in each category in the current fleet.

There are several ways that an auction could be structured. One way would be for the regional tuna body to determine the numbers of licenses to be auctioned, conduct the

auctions, carry out the buy-backs and monitor the overall program. Another way would be for the TRFMO to determine the numbers of licenses, but delegate the conduct of the auctions and buy-backs to an independent organization. Still another way would be for the regional tuna body to set the numbers of licenses, but leave the auction and the buy-back program to the industry, as is done in the OPRT.

Like the other licensing schemes discussed here, this approach would need additional control mechanisms such as catch quotas or effort limitations to prevent overfishing; also it would not remove the incentive of fishermen to race to catch their share of the quota and to increase the efficiency of their vessels, but it would eliminate the need for government subsidies to fund buy-backs.

5.1.2. Alternatives that tend to remove the incentive for overcapacity

For this category of management measures, the management system implements controls that tend to remove the incentive for vessel owners to increase fishing capacity by allocating the allowable catch among users or user groups.

5.1.2.1. Allocating the allowable effort

Total Allowable Effort (TAE) corresponding to the TACs for individual species can be calculated and then allocated to individual operators as Individual Transferable Effort (ITE) in a form of rights-based management. ITEs can be specified as days fished, as in the Forum Fisheries Agency (FFA) vessel day program: "Palau Arrangement for the Management of the Western Pacific Purse Seine Fishery Management Scheme (Vessel day scheme)." ITEs represent a major step forward from open access and limited entry and are a better-structured right than either, due in particular to the stronger exclusive use by individual vessels. Transferability of days at sea can reduce overcapacity and restructure industry to more closely align with a profitable fishery. ITEs may also be useful when the infrastructure necessary to enforce use rights over catches is insufficient or nonexistent, such as monitoring of catches and landings. Vessel monitoring systems facilitate the use of ITEs.

ITEs face a number of limits, so that programs that allocate the catch to individual operators, such as ITQs, are almost always favored over ITEs. ITEs suffer in that they are defined in terms of an ill-defined input, fishing effort, rather than catch. Fishing effort is a composite of all economic inputs, and measurement by a proxy variable, days at sea, can give an incomplete and biased measure. There is not a unique relationship between a unit of effort measured as a day and the resulting fishing capacity and catch; a day at sea gives fishers an incentive to increase the use of economic inputs not specified by the unit of effort, the same problem when only the vessel is limited. A day held by a smaller and older vessel can differ markedly from a day held by a larger and newer vessel that embodies more advanced technology. Continued technical progress also means that each day of fishing, although denominated in nominal days or units of gear, is more productive each year. Because the relationship between effort and catch is both nonlinear and stochastic, ITEs are subject to random events, such as luck and environmental changes that were not

necessarily considered when calculating the overall ITE. Also, ITEs do not limit the catches of different species, such as catch limits on bigeye.

5.1.2.2. Allocating the allowable catch

The assignment of catch quotas to individual operators can result in a self-regulating mechanism to control capacity. In such cases the incentive to build excess capacity is virtually eliminated because the holder of a quota would have a good estimate of how much fish he could harvest, and would know how much capacity would be needed to take that harvest. (Actually, the holder might elect to have capacity somewhat in excess of the amount needed to harvest his quota, in case the quotas were increased due to increased abundance of fish or in case of loss of one or more of his vessels.) If the quota were assigned to a nation, or to a group of vessels not all belonging to the same owner, there would be little or no incentive to limit fishing capacity, as the vessel owners could increase their shares of the overall catch by increasing the fishing capacities of their vessels.

Decisions on how to allocate a limited resource are difficult achieve. To reach agreement on allocation, each party must believe that it is or will be better off as a result of allocation than it was before the allocation. For have-nots, this often means that they must perceive an opportunity to enter the fishery through direct allocation when they are ready, or to enter by buying someone out. There has been a great deal of attention paid in international tuna fisheries to defining criteria that can be used in assigning allocations. Although long lists of possible criteria have been developed, most of the limited allocations that have been made in tuna fisheries have been based on short-term historical participation in the fishery, and how much of the resource is caught or occurs in the EEZs of the participating nations, or those wishing to participate. It appears from the limited experience and success so far in allocating tuna resources that a set of well-defined criteria for making allocations will be needed before management controls based on partitioning the catch among fishing interests can be implemented, particularly since many coastal and developing states have either entered or expressed interest in entering tuna fisheries. Among the many criteria that are being discussed, in addition to the two mentioned above, is a "genuine and/or legitimate interest" in the fishery in question. Though these terms are often used, their definition is "fuzzy."

Additional complications are that the tuna fisheries employ several types of gear and several modes of fishing to catch several species of tunas. In the EPO, for example, purse-seine vessels fishing for tunas set their nets on tunas associated with floating objects (particularly FADs), on tunas associated with dolphins and on tunas in free-swimming schools. Yellowfin, skipjack, bigeye and a wide array of non-target species are often caught in a single set. Fortunately, the less abundant temperate albacore and bluefin tuna are taken less frequently in mixed-species sets of purse-seine vessels. Matters are further complicated by the fact that the vessels of some nations tend to employ different types of sets, and may be geographically isolated from other fleets employing other set types. For example in the EPO fishery, some national fleets fish mostly for tunas associated with dolphins (almost all medium to large yellowfin), while other national fleets fish mostly on tunas associated with FADs (mostly skipjack, but with significant amounts of small to medium bigeye and yellowfin). Yellowfin and bigeye are mostly fully exploited, and in need of limits on their

catches, while skipjack can support increased fishing effort and catch. Formulation of regulations that would protect bigeye and yellowfin without severely reducing the catches of skipjack will probably require some sort of stratification of catch quotas by area, species and mode of fishing. Squires *et al.* (1998) and Sanchirico et al. (2006) have discussed the problems associated with the management of multi-species fisheries when individually-allocated quotas are used, which include complex species interactions, substantial mingling of stocks and limited ability of fishermen to target specific species. Accordingly, attempts to regulate tuna fisheries have met with limited success. Nevertheless, development of allocation schemes that can lead to resolution of the overcapacity problem in the world's purse-seine fisheries is possible.

In any program to assign allocations all nations with "genuine and/or legitimate interests" in a fishery should be included. Most or all of the principal market species of tuna could be included in the total allowable catches (TACs), or separate TACs could be established for each species, except probably for skipjack in most or all areas. In most tropical purse-seine fisheries TACs would be needed for yellowfin and bigeye because these species are fully exploited or over-exploited. If there were no TACs for skipjack, vessels would probably continue to fish for skipjack after the TACs for yellowfin and bigeye quotas were filled, and discard the yellowfin and bigeye at sea, which would, of course, result in exceeding the target catches for those two species. A solution to this might be to (1) set the quotas for yellowfin and bigeye at levels somewhat less than those corresponding to what the stock can support and (2) permit fishermen to fish for skipjack after the yellowfin and bigeye quotas were reached. However, they would be obliged to retain all of the yellowfin and skipjack that they caught, and the amounts of yellowfin and skipjack that they retained would have to be less than, say, 5 or 10 percent of the total landings for each trip of each vessel. Observers on the vessels would report any discards of yellowfin or bigeye. Vessels that exceeded the 5 or 10 percent limits would be penalized. An alternative would be to set a TAC for skipjack. If the TAC for skipjack were set on the basis of catch history of the three species in the fishery the discarding problem might be minimized, but would result in lost revenues from potential catches of skipjack, especially during years of above-average abundance of that species. Because of the problems associated with the stratification of the fishery that were mentioned above, the TAC for each of the species would have to be based on the catch histories of the nations participating in the fishery. The result might be a series of allocations to nations that were based on areas of fishing, species taken, and modes of fishing (set types). Using once again the example of the EPO fishery, certain nations would require greater portions of the skipjack and bigeye TACs, while others would require a greater portion of the yellowfin TAC (See Joseph and Greenough, 1978, for a discussion of allocations based on resource adjacency and catch history).

In allocating catches to nations, if there are no limits placed on the numbers of vessels that could participate in the fishery, there would be a tendency for capacity to increase, through either the addition of more vessels or increases in efficiency. This could be overcome if the nations limited fishing capacities of their fleets. However, the objectives of nations might differ; some might choose to maximize profits by limiting the number of vessels authorized to fish to the number that would be needed to take that nation's quota over the course of the fishing year, but others might choose to increase employment of fishermen and shipyard workers by having more vessels than necessary to harvest that nation's quota. If there were

any nations in the latter category the problem of overcapacity would not be adequately resolved. Allocation of quotas to individual vessels might resolve this problem.

In the process of assigning individual quotas (IQs) the management system would be confronted with the problems of a multi-species and multi-modes of fishing described above for country allocations. In setting the overall TAC it would have to be determined whether it would include skipjack, or only fully-exploited yellowfin and overexploited bigeye. An overall catch limit including all three species might not work because fishermen might direct their effort mostly towards yellowfin and bigeye, for which they receive higher prices, which would result in overfishing of those two species. Furthermore, the abundance of the various species of tunas vary due to natural factors, as well as to fishing, so the TACS would have to be adjusted, probably on an annual basis, to best manage the fishery. One solution to this might be to set the quotas for the three species as percentages of the variable TAC. Once the TAC was selected it might be partitioned by areas and allocated to individual vessels or operators. There are two advantages to partitioning the quotas by area. First, fishing conditions vary from area to area. Second, vessels of different nations fish in different areas and employ different modes of purse seining. All of the regional tuna bodies have adequate catch and effort statistics by area, season, and mode of fishing to ensure that the assignment of IQs by areas would be consistent with the total TAC. The wide range of characteristics of purse-seine vessels operating in the fishery must be considered in setting the IQs. The statistical data bases could be used to determine how these assignments would be made. For example, personnel of the regional tuna bodies could determine how many vessels there were in each of several categories and the annual average catches per vessel of each of the categories, and this information would be used as the basis for assignment of the allocations.

The major problems facing the assignment of IQs would be determining the basis for assigning them and the numbers that would be assigned. The simplest and most straightforward approach would be to assign an IQ to each purse-seine vessel in the fishery. As there is already overcapacity in all of the tuna purse-seine fisheries, this would not bring the fishing capacity to optimum levels, but it would at least prevent further increase in fishing capacity. An alternative approach would be for the management body to reduce the number of IQs to be allocated to less than the number of vessels in the fleet, increase the amounts of the IQs in proportion to the decrease in vessel numbers, and then auction the IQs to the highest bidders. The fleet size would be reduced to appropriate levels, and the unsuccessful bidders, whose vessels would be converted to other uses or scrapped, would be compensated from the proceeds of the auction. As was the case for some of the other systems discussed previously, have-nots could enter the fishery by bidding successfully for IQs. Finally, if IQs were properly set they would provide a self-regulating mechanism to control fishing capacity, as the vessel owners would have no reason to acquire more fishing capacity than necessary to harvest their quotas.

5.1.2.3. Transferability of quotas

Economists, such as Boyce (1992), Grafton (1996), Squires and Kirkley (1996), Squires *et al*. (1998), Clark and Munro (2002) and Hanneson (2004) have long advocated that allocated quotas should be a true property right and be transferable if the "tragedy of the

commons" and overcapacity are to be avoided. They have argued that if the IQs were made transferable (ITQs), the more efficient vessel operators would tend to purchase them from the less efficient ones, and the fleet size would be reduced without a reduction in catch.

The ITQs would, in essence, be property rights that could be bought, sold or utilized. Before assigning the ITQs, the governments, working through the regional tuna bodies, would have to define the nature of the rights. Would the rights be held in perpetuity (Batstone and Sharp, 1999), or would they expire after a preset period of years? For many tuna vessels that are operated efficiently the loans for their purchase are paid off within a few years; so the duration of the ITQ might be set to expire when the loan for the vessel was paid, or at the end of the expected life of the vessel. After that period the ITQ could revert to the regional tuna body for sale to the same or other potential operators. Funds generated through such transactions could be used to offset the cost of management or to assist developing coastal states purchase IQs.

The establishment of ITQs would open several avenues for resolving some difficult issues in the management of tuna fisheries:

1) States that did not have tuna vessels, but would like to acquire them, would have opportunities to enter the fishery by purchasing ITQs.

2) Individuals or groups that are opposed to tuna fishing, that would like the catches of tunas reduced, or that would like the bycatches of endangered, threatened or icon species reduced by reducing the catches of target species, could purchase ITQs and retire them from the fishery.

3) The management agency would be able to purchase ITQs and retire them from the fishery in order to reduce capacity and increase average abundance of the resource. NGOs wishing to reduce fishing mortality on the target species as well as overall bycatch could purchase and retire quota.

6. A plan of action for controlling fishing capacity

More than 60% of the roughly 4.3 million tons of principal market species of tuna are taken by purse-seine vessels, 14% by longline, 11% by pole-and-line, and the remainder by a variety of other fishing methods. Studies have shown that there is overcapacity in the purse-seine and longline fleets. There have been no studies for the other gear types, but there needs to be. This overcapacity jeopardizes the efforts of the TRFMOs to implement and maintain measures to ensure the sustainability of the tuna resources for which they are responsible. There is wide agreement among industry, nations, and TRFMOs that capacity needs to be controlled. Differences between those that currently have fleets and those that don't make it difficult to arrive at solutions to limit fishing capacity that everyone can agree on; also, there have been no adequate quantitative, legal, or socio-economic studies to examine how various solutions might work in international tuna fisheries. Such studies need to examine things such as the legal issues surrounding the rights of nations and individuals to fish on the high seas, the allocation of shares of the catch to nations and/or individuals, the rights and responsibilities of haves and have nots and of coastal states and

DWFNs, and the socio-economic effects of implementing various options addressing these issues. Towards this end, there needs to be consideration given by the TRFMOs to the formulation of a plan of action for controlling fishing capacity and the possibility of establishing user or rights based management systems. This topic was touched on at the first joint meeting of the TRFMOs held in Kobe, Japan in January 2007, but little progress has been made on evaluating and developing options for addressing the problems of managing fishing capacity. The second meeting of the TRFMOs being held in San Sebastian, Spain provides an excellent opportunity to discuss this topic, and to set the wheels in motion to develop a joint TRFMO plan of action for the management of fishing capacity in the world tuna fisheries.

Considering the foregoing discussions, it seems that one of the more effective approaches to consider for managing fishing capacity and the resources this capacity relies on for raw material would be the assignment of property rights to individual participants in the fishery in the form of ITQs. This could bring fleet size into balance with the ability of the stocks, other than skipjack, to sustain current levels of catch, and into balance with the demand for skipjack; it could ensure that the fisheries were prosecuted on a sound economic basis, and would ease political tensions among nations operating vessels in the fishery. Allowing quota trading between gears would also help realign capacity among gear types and species orientations. For example, bigeye quota held by purse-seine vessels setting on FADs could be purchased by longline vessels if the latter are more profitable, and both gear groups would enjoy gains in economic benefits; also, potential growth and recruitment overfishing for bigeye could drop. Realistically, the problems associated with the implementation of such a scheme could not be resolved without adequate data and background studies, and sufficient time for nations to negotiate a mutually acceptable agreement. Considering the difficulties that nations have had in developing rights based schemes in fisheries lying totally within their jurisdiction, it would be unrealistic to believe that an effective system of rights based management including ITQs could be developed very quickly for the complicated multi-national tuna fisheries. However, we are at a pivotal point in history of tuna fisheries. Excluding bluefin tuna, most of the tuna stocks are in reasonably good health, sustaining high levels of catch. However, the available fishing capacity is far greater than that necessary to harvest the fish at levels corresponding to the MSY. This excess fishing capacity poses a threat to the sustainability of the tuna resource, represents a waste of capital, and decreases the economic returns to the fishery. Unless effective management measures are implemented in the near future, it is likely that the tuna stocks that are currently overfished will become further overfished and that those that are currently not overfished will become overfished. In addition, there will be further wastes of capital. Over the long run, it is unlikely current management measures such as catch quotas, effort restrictions, closed areas and seasons alone will be enough to conserve these valuable resources, nor will these measures be adequate for addressing any imbalances in fishing capacity among gear types for species such as bigeye. There is an urgent need to take action to keep this from happening; the growth in fishing capacity must be curtailed, and fleets reduced. This could be most effectively accomplished through the application of user or rights based management schemes.

All of the TRFMOs are faced with similar problems of overcapacity. Solutions for resolving the problems of too much fishing capacity and implementation of management

schemes that can ensure sustainability of the resources are similar in all oceans and all tuna fisheries. The tuna industry is global, and when an action takes place in one area, there is a reaction in another. Vessels move from ocean to ocean on a regular basis, and if controls are placed on them in one area they will look at options for moving to other areas where they may exacerbate already existing or developing management problems.

The FAO Plan of Action on Fishing Capacity calls on all states and regional fisheries organizations confronted with an overcapacity problem to limit and progressively reduce such fishing capacity, and to formulate a plan of action to achieve efficient, equitable and transparent management of fishing capacity worldwide. Such plans of action are in various stages of development within the TRFMOs. Because of the global nature of the tuna fisheries, and the commonality of problems associated with the management of tuna, particularly with respect to managing fishing capacity, it would be advantageous for the TRFMOs to exchange information on their experiences in the development of their respective plans of action. This could be facilitated through the establishment of an inter-agency committee or working group, comprised of representatives of each of the TRFMOs, and could lead to a global plan of action for managing tuna fishing capacity.

Several important points that might be considered in the steps along the way to formulating the plans of action respecting purse-seine and large longline vessels are:

1) All of the regional tuna bodies agree to moratoria on the building of purse-seine and large longline vessels for tuna fishing. The tuna industry itself has called for such moratoria, and governments should take advantage of this opportunity by following up the industry initiative. Implementing moratoria would provide the regional tuna bodies with time to develop more comprehensive programs for capacity limitation and reduction.

2) The development of closed RVRs for purse-seine and large longline vessels within each regional tuna body would provide a mechanism for limiting fishing capacity, and, if coupled with a buy-back provision, could provide the opportunity for reducing fleet capacity to more optimal levels. It would also set into motion the application of rights-based management, making it easier in the long run to develop more efficient means of controlling capacity. Once the RVRs are developed for each TRFMO, they could then work together to develop a global RVR, which would provide a means of monitoring global fishing capacity and preventing spill-over from one fishery to another. The RVRs may not be the most efficient means of managing fishing capacity, but they may be the most practical means of accomplishing something over the short term, and once they have been implemented, there will be time to develop more efficient systems, thereby avoiding the possibility of doing serious damage to the resources until those more efficient systems are established.

3) Once the closed RVR systems are in place, and capacity is under control, the regional tuna bodies would have time to examine the merits and possibilities for introducing more efficient rights-based systems, particularly ITQs. A well-designed ITQ system incorporates all of the attributes needed for efficient management: ITQ holders would utilize only enough fishing capacity to take their quotas, the incentive for capacity growth would be

minimized, the fishery would operate on an efficient economic basis, opportunity for have-nots to enter the fishery would be available and environmental groups could purchase quotas and set them aside to meet their objectives. However, because of the complexities in developing such systems, this will not happen soon, so it is imperative that the second option above be implemented as soon as possible.

4) A strong enforcement capability will be required to eliminate IUU fishing and ensure compliance with the systems developed. The experience of ICCAT with bluefin tuna provides guidance on how this could be accomplished (Barrett, 2003). The regional tuna bodies would want to work together to develop mechanisms to persuade the owners of IUU vessels and the nations in which they are registered to comply with the conservation programs. Such mechanisms could include the use of "diplomatic persuasion" by the members of the regional tuna bodies on the IUU nations, the use of "bad press" to convince the IUU nations that they should comply with the conservation programs, denial of access to port facilities to IUU vessels, or the use of trade and economic sanctions against the offending nations.

5) Purse-seine and large longline vessels take more than 70% the world catches of tuna. If the issues of fishing capacity and effective conservation are to be resolved, controls must be applied to much of the remaining 30 percent of the world's tuna fleet. As mentioned above, the construction of longline vessels that are less than 24 m in overall length, but capable of fishing on the high seas and super-freezing their catches so as to make them acceptable for the market for *sashimi*-grade tuna is contributing to the overcapacity. Pole-and-line vessels account for about 11% of the world catch of tunas. These vessels catch mostly skipjack, which are not overfished, but also take the more heavily fished albacore and yellowfin. Relatively little research on fishing capacity has been done on the pole-and-line and small longline fisheries for tunas. Nevertheless, rather than waiting for the results of such studies, the moratorium and RVR approaches suggested for purse-seine and large longline vessels should be applied to the small longline and pole-and-line vessels at the same time. In this way, 85-90% the excess capacity problem would be addressed. The remaining catch is taken in coastal waters by small vessels, using a variety of gear type (Gillett, 2005). It would probably be difficult to apply capacity controls to these small fleets that are similar to those applied to the other fleets. An alternative approach might to include special catch quotas that are assigned to these fleets and administered by the flag states. Regardless of how this is handled, it is imperative over the long run that controls be applied to all fleets, as otherwise efforts to control only large fleets would be placed in jeopardy.

Finally, more than 10 years have passed since the approval of the FAO action plan. For tuna, with few exceptions, little has been done to comply with the FAO International Plan of Action for Capacity. Over the past decade, fishing capacity of the world purse-seine fleet has increased by more than 40% as a result of new entries and improvements in technology and efficiency. This failure to implement the recommendations of the International Plan of Action places in jeopardy the tuna resources of the world. This current meeting of TRMOs in San Sebastian affords an excellent opportunity to formulate a concerted effort to address these problems. All of the executives and directors, plus key members of the plenary bodies of the organizations will be participating in the meeting. Since there is worldwide

agreement that overcapacity exists in the tuna fisheries and that these excesses, unless corrected, are likely to result in further overcapacity and overexploitation of these valuable resources along with downward pressures on profits and other economic benefits, priority should be given to outlining a plan of action to limit, and ultimately reduce, fishing capacity.

This outline of action may appear to be ambitious, and also presumptive on the part of the author, but the world's tuna fisheries are on the cusp of a production curve, and unless states and regional tuna bodies exercise their responsibilities in an enlightened, timely and effective manner our tuna fisheries and the resources upon which they are based will slide down the slippery slope of overfishing and further overcapitalization.

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