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Requirements and Alternatives for the Limitation of Fishing Capacity in Tuna Purse-Seine Fleets

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1. THE BACKGROUND

Harvests of fish from the world's oceans have been relatively stable at about 85 million tons per year for the last decade (FAO, 2005). These harvests represent catches from hundreds of stocks of fish. Many of these stocks have been overfished, resulting in declining catches. The decreases in catch have been replaced by the development of fisheries on previously unexploited or lightly exploited stocks. It has been estimated by Garcia *et al*. (2005) that about 25 percent of the fish stocks making up the world catch of marine fish are overexploited and about 50 percent are fully exploited. The primary cause of this overexploitation of the world's fisheries has been attributed to the existence of more fishing capacity than is needed to harvest the available catch (Mace 1997). In fact, during the last three decades the world's fleet of active fishing vessels increased at a rate several times greater than the rate of growth of world catches (Gréboval and Munro (1999).

Because of this situation, and the resulting concern of nations over the deteriorating state of world fisheries, the FAO adopted an International Plan of Action for the Management of Fishing Capacity (IPOA-CAPACITY). The objective of the IPOA was for states and regional fisheries organizations to achieve worldwide, efficient, equitable, and transparent management of fishing capacity, preferably by 2003, but not later than 2005. Though the target date of 2005 has passed and there is not worldwide management of fishing capacity, many nations and regional organizations have initiated programs to address the problems associated with excess fishing capacity. Nevertheless, world fishing fleets continue to grow, and overfishing continues to occur.

Although at the outset, tuna fisheries have not been the specific objective of these initiatives, there has nevertheless developed considerable concern over growing fishing capacity in world tuna fleets and the impact of this on the tuna stocks.

1.1 World Tuna Fisheries and Status of Stocks

The principal market species of tuna (skipjack, *Katsuwonus pelamis*; yellowfin, *Thunnus albacares*; bigeye, *T. obesus*; albacore, *T. alalunga*; and bluefins, *T. thynnus, T. orientalis, and T. macoyii*) make up about 5 percent of the world's commercial production of marine species (FAO, 2005). Though not a large component of the world catch of fish in terms of tonnage, in terms of value tuna are a much more significant component of the total value of all marine fish caught. For nations like the Maldives, Ecuador, and many of the Pacific Island States, tuna is one of the major components of their economy.

Prior to 1950 world catches of tuna were less than 350 thousand tons annually, but at that time they began to increase, and continued to grow until around 1998, at which time the catch reached nearly 4 million tons (Miyake, 2005a). Since 1998 catches have fluctuated around that level. Most of the catch, about 60 percent, is taken by purse-seine vessels, with about 15 percent being accounted for by pole-and-line vessels, 15 percent by longline vessels, and the remainder by a variety of other gear types.

With the exception of skipjack in some oceans, almost all of the principal market species of tunas are either fully exploited or overexploited (IATTC, 2003; ICCAT, 2003; Langley *et al.*, 2003; Joseph, 2004; de Leiva Moreno and Majkowski, 2005).

The bluefin tunas are the most heavily exploited of the principal market species. Catches of southern bluefin have declined from a high of 80 thousand tons in the early 1960s to current levels of about 15 thousand tons. The species is heavily overexploited, and increased fishing mortality will not result in sustained increases in catch; in fact, there is increasing concern over the possibility of recruitment failure for this species. The situation is similar for the Atlantic bluefin. In the western Atlantic the stock is considered to be heavily overexploited, and in the eastern Atlantic and Mediterranean the stock is below the level corresponding to the average maximum sustainable yield (AMSY). Bluefin in the North Pacific are probably fully exploited, but catches vary considerably due to natural fluctuations in abundance. Current harvests of the three species of bluefin have averaged about 60 thousand tons in recent years: 15 thousand for southern bluefin, 25 thousand for Atlantic bluefin, and 20 thousand for North Pacific bluefin.

There are six stocks of albacore in the world's oceans: two in the Pacific, two in the Atlantic, and one each in the Mediterranean Sea and Indian Ocean. Four of these stocks are fully exploited, one is not fully exploited and the status of one is unknown. In recent years catches have averaged about 225 thousand tons, 140 thousand of which is from the Pacific, 60 thousand from the Atlantic and Mediterranean, and the rest from the Indian Ocean.

Prior to 1980 most bigeye was captured by longline gear, which takes mostly large fish near the size that results in maximizing the yield per recruit. With the widespread use of fish-aggregating devices (FADs) by purse-seine vessels after the 1980s, large quantities of small bigeye have been caught. This reduced the overall yield per recruit and threatens growth overfishing of most of the bigeye stocks in the three oceans. World catches have averaged about 450 thousand tons in recent years: 230 thousand from the Pacific, 80 thousand tons from the Atlantic, and 140 thousand from the Indian Ocean.

All yellowfin stocks are considered to be fully exploited, and increased fishing effort would not be expected to result in sustained increases in catch. Recent world catches of this species have averaged about 1.3 million tons, of which about 800 thousand tons are from the Pacific, 400 thousand tons from the Indian Ocean, and 125 thousand tons from the Atlantic.

Skipjack comprise about 50 percent of the world catch of the principal market species of tuna. In recent years the average catch has been about 2 million tons per year. Of these 2 million tons about 1.5 million are from the Pacific, about 450 thousand from the Indian Ocean, and about 140 thousand from the Atlantic. The best scientific information suggests that skipjack in the eastern Atlantic Ocean may be fully exploited, but the stocks in other areas are probably not yet fully exploited, particularly in the western and central Pacific Ocean (WCPO).

In summary, with the exception of skipjack tuna, particularly in the Pacific, most stocks of tunas are fully exploited, and two stocks of bluefin are clearly overexploited. In general, increased fishing effort for most of these stocks will not result in sustained increases in catch, but would

probably lead to reduced catches over the long term. It is clear that controls on the amount of fishing mortality exerted on most of the stocks of tuna are needed.

1.2 Conservation Approaches

Tunas are a renewable resource, and the rate at which they are captured affects their abundance, and, therefore, their ability to sustain given levels of harvest. With increasing fishing pressure on the stocks of tuna it is necessary that conservation controls be initiated in order to keep exploitation at levels that will keep the populations at desired levels of abundance. Effective management of tunas is complicated, however, by the fact that they are great wanderers, and during the course of their travels they pass through waters under the jurisdictions of many different nations. This mobility sets the management of tunas apart from that of less nomadic species, and requires that nations cooperate with each other if management is to be effective. Early in the negotiations to draft a convention on the law of the sea the nations of the world recognized the highly-migratory nature of the tunas. Article 64 of the United Nations Convention on the Law of the Sea (LOSC) mandates that states co-operate directly or through appropriate international organizations to ensure the conservation of highly-migratory species. More recently, other international instruments have been drafted to ensure that nations comply with the dictates of LOSC. In 1995 the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Seas of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreement) was adopted by the United Nations. The objective of the UN Fish Stocks Agreement is to ensure that the relevant provisions of LOSC are applied with respect to the management of the highly-migratory stocks of fish of the world, particularly with respect to cooperation among nations as envisioned in Article 64 of LOSC. The UN Fish Stocks Agreement includes a number of new concepts, such as biodiversity and ecosystem management, transparency among stake-holders in developing conservation measures, and the application of the precautionary approach that should be included in any proposed management measures. The FAO Code of Conduct for Responsible Fisheries provides further support for the application of the provisions of LOSC and the UN Fish Stocks Agreement. These three international instruments have acted as catalysts for the implementation of measures to manage tunas.

Currently there are five international conventions for the establishment of Article 64-type tuna bodies in the world. Two of these tuna bodies, the Inter-American Tropical Tuna Commission (IATTC) and the International Commission for the Conservation of Atlantic Tunas (ICCAT), were created before Article 64 existed, and were used as case studies in formulating Article 64 and the subsequent instruments. The remaining three bodies, the Commission for the Conservation of Southern Bluefin Tuna (CCSBFT), the Indian Ocean Tuna Commission (IOTC), and the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Central and Western Pacific Ocean (WCPFC) were created more recently. All five of the regional tuna bodies have a similar objective of maintaining the stocks of fish for which they are responsible at or above levels of abundance that can support AMSYs. To achieve this objective, the bodies are empowered to coordinate and/or conduct research on the animals and fisheries for them, the results of which can be used to make recommendations to the high contracting parties for maintaining the populations at the desired levels of abundance. The degree to which the bodies have been successful in achieving their objectives has varied. The two oldest bodies,

IATTC and ICCAT, were created before there was enough fishing capacity to cause overfishing problems. However, as the fishing capacity increased, controls to prevent overfishing were needed. The two most recent bodies, IOTC and WCPFC, were created before overfishing occurred, but the capacity of the fleets in the Indian Ocean and WCPO are currently increasing rapidly enough to cause overfishing. The CCSBFT was created in response to severe overfishing of the southern bluefin stock, and its fundamental charge was to increase the population to a level of abundance that would support the AMSY.

1.2.1 The first attempts at international management

The first international conservation measures for tuna were implemented in the mid-1960s for yellowfin tuna in the eastern Pacific Ocean (EPO) by the IATTC (Joseph and Greenough, 1978). The prevailing policy at that time regarding fisheries for tuna was that access beyond 3 nautical miles of the coastline was open to the citizens of any nation who wished to fish. The resource was considered to be a common property of mankind, and to belong to whomever could first render it to his use. It was therefore "logical" that the form of conservation implemented by the IATTC was in the form of an output control, which entailed setting an overall quota on the catch. (A more detailed discussion of these programs is presented in **Section 3** below.) Any nation's vessels could fish under the quota, but once filled all would have to halt fishing for that species. This resulted in a race for the fish, and progressively shorter seasons as the fleet capacity grew. These facts caused increasingly greater confrontation among nations with large fleets capable of taking a large share of the catch before closure to unrestricted fishing (the "haves"), most of which were distant-water fishing nations (DWFNs), and nations with small fleets (the "have nots"), most of which were coastal, developing states. The have-not coastal states maintained that a share of the resource should be allocated to them by virtue of the fact that the tunas spent time in waters under their jurisdiction, and that the newly developing Law of the Sea was recognizing an exclusive economic zone (EEZ) to 200 nautical miles seaward of their coastlines. The haves maintained that the tunas were a common resource, and belonged to whomever could catch them.

This disagreement between the two factions as to how tuna should be managed made it progressively more difficult for the states to agree on conservation controls. Without a limit on the number of vessels that could enter the fishery, the purse-seine fleet operating in the EPO increased five-fold between the onset of the controls in 1966 and 1979, while the catch of tunas only doubled. Competition continued to increase, and the catches per vessel decreased. Because of economic pressures on vessels in general, and because the perceived "rights" of the coastal states were not being met to the satisfaction of those states, the concerned states could no longer agree to conservation controls. This resulted in the large fleet fishing without restriction and overfishing of the yellowfin stock. This was a clear example of where the failure to resolve the differing views of open access versus rights-based management approaches resulted in unrestricted fleet growth and overfishing of the tuna stocks.

During the 1970s a similar situation was developing in the Atlantic Ocean: tuna fleets were growing and fishing effort increasing. Bluefin in the western Atlantic was considered to be heavily overexploited, and in need of controls on catch and fishing effort. A significant portion of this increase in effort was the result of a "slop-over" effect from the closures in the EPO.

During the closure to unrestricted fishing in the EPO increasing numbers of vessels transferred operations to the Atlantic, where some of them concentrated effort off the eastern seaboard of the United States. Much of this effort targeted bluefin tuna. resulting in further overexploitation of the stock. In response to severe overfishing of bluefin, ICCAT set catch quotas and minimum size limits for that species in the western Atlantic. Meanwhile, in the eastern Atlantic and the Mediterranean Sea fishing effort was increasing, and bluefin in that region were being threatened with overexploitation. As fishing effort increased, bluefin was driven to below the AMSY level, and catch quotas were implemented. The increased fishing capacity resulted also in increased fishing mortality on yellowfin tuna in the eastern Atlantic. Competition for a limited supply of yellowfin resulted in increasingly greater catches of small fish. ICCAT instituted another output control in the form of minimum size limits for yellowfin tuna. This control proved to be ineffective, and the yellowfin stock continued to be subjected to excessive fishing pressure.

1.2.2 Changing philosophy of management

As the IATTC and the ICCAT struggled to manage their fisheries, using output controls such as catch quotas and size limits, they came to realize that such measures alone were not effective in preventing overfishing. Using catch limitations alone without limiting the fishing capacity that could partake in the catch limit resulted in increased competition for a limited supply of fish, a classic case of a regulated open-access fishery which was first defined by Homans and Wilen (1997) and reviewed more recently by Gréboval and Munro (1999). As competition increased, earnings declined, resulting in pressure from the vessel owners to relax conservation controls. In the face of increasing vessel numbers and efforts by producers to circumvent regulations, the immediate reaction from the management authority would be to introduce additional controls. For example, in the EPO fishery there were limits on the catch of yellowfin tuna and small bigeye, limits on the amount of fishing for tunas in association with floating objects, limits on mortalities of dolphins in the fishery for tunas associated with dolphins, restrictions on types of gear and fishing practices, requirements to carry observers, requirements to contribute monetarily to the observer program, and a host of other regulations. In such a situation there can be so many regulations that fishermen can become confused as to which ones apply in every case; the tendency would be to circumvent them. Such micromanagement also raises the costs of harvesting.

It was clear to both the IATTC and the ICCAT, and also to the more recently created IOTC and WCPFC, that such “micromanagement” of their fisheries would likely result in failure to sustain conservation programs and failure to fulfill the objective of maintaining the stocks at AMSY levels. They recognized that there was too much fishing capacity operating in their fisheries and that for management to be effective some limits would have to be placed on fishing capacity. However, to successfully limit fishing capacity there would have to be some quantitative measure of capacity relative to the productivity of the resource and a move away from open-access/common-property concepts to rights-based management concepts.

1.3 Too Much Fishing Capacity

At the 21st Session of the FAO Committee on Fisheries (COFI) held in Rome during 1995 it was concluded that the existence of too much fishing capacity was leading to overfishing, and was

threatening the sustainability of the world's marine fish stocks. Governments and regional fisheries bodies were called upon to review the amount of fishing capacity within their jurisdictions and, where appropriate, to reduce the capacity of those fleets. In an effort to facilitate the governments and fisheries bodies in carrying out the COFI recommendation, FAO convened a meeting in 1998 (FAO, 1998) to study and recommend how to define, measure, and control fishing capacity. A series of technical documents dealing with these issues resulted from the meeting, but no clear definition of fishing capacity was agreed to by the participants. A second meeting was called by FAO in 1999 (FAO, 2000) and charged with developing a simple and practical method for the measurement of fishing capacity. The definition of fishing capacity defined by this second FAO meeting, which is more of a reflection of economic theory than fisheries population dynamics, represents the maximum amount of fish that can be produced by a fully utilized fleet or vessel during a time period, given the size of the stock being fished and the level of fishing technology being employed. The vessel's fishing capacity represents some maximum level of fishing mortality that it can generate.

This FAO technical definition of fishing capacity has caused some confusion among fisheries scientists and fishing industry personnel in how they view fishing capacity. In his discussion of the definition of capacity, Joseph (2005) noted that when fisheries scientists are attempting to define capacity they frequently use some input indicator such as a vessel's size or its engine power, as they believe them to be related to the ability of a vessel to generate fishing mortality; the fishing industry often 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 mostly prefer some technological-economic approach using potential output to measure fishing capacity because such an approach can be used to compute optimal inputs (Morrison, 1985). The economists' approach is the one that is widely applied by governments throughout the world (largely administered through surveys of businesses) when measuring the amount of productive capacity that is utilized in different industries and in the economy at large (Corrado and Mattey, 1997), and is the approach taken by the FAO technical meeting of experts.

The most common indicators of carrying capacity for high-seas tuna vessels used by fisheries scientists are: 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 is expressed in tons. The NRT can also be easily altered by changing partitions; and 3) Fish-Carrying Capacity (FCC), which is how many tons of fish the vessel can carry when fully loaded. For most large tuna vessels there is a close linear relation between each of the measures, GRT, NRT, and FCC. The FCC has been one of the most commonly-used measures of carrying capacity for purse-seine and pole-and-line vessels. It is easily understood by the fishing industry, and generally easy to compute. However, like GRT and NRT, 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 (Gillett and Lewis, 2003). Because the measure is somewhat plastic, 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.

Although fisheries scientists may have some difficulty in applying these technological-economic definitions of fishing capacity to their studies to estimate fishing effort and fishing mortality, the definitions facilitate studies to determine whether excess capacity exists. In fact, the two definitions, fishing capacity and carrying capacity, can be equivalent when a fleet of vessels is fully utilized, but for most tuna fisheries, carrying capacity for a fleet of vessels is probably most often less than fishing capacity.

Using the FAO definition of fishing capacity, and applying a linear programming technique, Data Envelopment Analysis (DEA), to estimate the technical efficiency and potential catching capacity of purse-seine fleets operating in different ocean areas, Reid *et al.* (2005), concluded that there was more fishing capacity available in all of the major purse-seine tuna fisheries of the world than was needed to take the current levels of catch. In short, there are too many purse-seine vessels currently fishing for tunas.

For their analysis of the EPO, Reid *et al.* (2005) used individual vessel data for the 1998-2002 period to estimate capacity utilization by vessel size classes. They concluded that excess capacity existed for all size classes and for all modes of fishing, and that excess capacity increased by more than 50 percent during the period of the study. For the Class-6 vessels (>363 tons of carrying capacity), which represent the preponderance of the fleet, the catch of yellowfin and bigeye combined could have been taken with about 66 percent of the actual fleet that made the catch, and for skipjack the figure was 71 percent. Given these figures the EPO purse-seine fleet could theoretically be reduced from the current level of about 185 thousand tons to 126 thousand tons of carrying capacity without sacrificing catch. (It is interesting to note that the scientific staff of the IATTC had previously advised the Commission that the optimum carrying capacity for the EPO fleet was approximately 130 thousand tons.)

In their analysis of the WCPO, Reid *et al.* (2005) concluded excess fishing capacity existed for all major national fleets operating in the area, Japan, the Republic of Korea, the Philippines, Papua New Guinea, the Taiwan Province of China, and the United States, and for the other fleets as a group. It was estimated that, on average, the purse-seine skipjack fishing capacity was between 14 and 35 percent greater than needed to take the available catch. For yellowfin and bigeye the capacity was between 11 and 28 percent greater than necessary.

In contrast to the EPO and WCPO analyses, individual vessel data were not available for the Indian and Atlantic Oceans. Therefore Reid *et al*. (2005) cautioned that because of the limited degrees of freedom and the paucity of the data with respect to detailed activities of the various nations and the modes of fishing, their estimates represented extreme lower-bound estimates of capacity. With these constraints, their analyses indicated that there is excess capacity in the Atlantic and Indian Ocean purse-seine fisheries for tuna. For the Indian Ocean capacity could be reduced by about 23 percent without reducing catch, while for the Atlantic the reduction could be about 13 percent.

From the foregoing review of the work of Reid *et al.* (2005) it appears that if all vessels operated efficiently the carrying capacity of the world's purse-seine fleet fishing for yellowfin, bigeye, and skipjack tuna could be reduced significantly without a corresponding reduction in catch. Unfortunately, similar analyses have not been undertaken for the other major fishing fleets: longline and pole-and-line vessels. Each of these types of gear harvests about 15 percent of the total take of tunas, and if effective management and conservation of the tuna resources is to be achieved, controls would have to be placed on these fleets as well.

Miyake (2005b) provides estimates of the size of the world's large-scale tuna longline fleet and the tuna resources available to it. He defines large-scale longliners as vessels greater than 200 GRT or overall lengths greater than 35 meters, equipped with "air blast" freezers capable of preserving fish saleable as *sashimi*-grade tuna. He reports that there are currently about 1600 large scale longliners operating on the world's oceans, and that they harvest 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. In addition to the large-scale longliners, Miyake reports that there is a fleet of approximately 1400 small-scale longliners (vessels between 24 and 35 meters in length) which harvest about 195 thousand tons of tuna annually. In addition to the large and small-scale longliners reported on by Miyake, there is a growing number of longline vessels of less than 24 meters in overall length. These vessels in many cases are capable of fishing on the high seas and are equipped with air blast freezers for *sashimi*-quality product, but because their size excludes them from monitoring activities by the some of the regional tuna bodies, statistics on their numbers and catches are scarce. However, because they are a growing fleet they will have to be included in any management program if the conservation objectives of those programs to be achieved.

Even before the studies of Reid *et al* (2005), providing quantitative evidence of overcapacity in the tuna purse-seine fisheries, and Miyake (2005b) providing empirical evidence of overcapacity in the large-scale longline fisheries, the regional tuna bodies recognized that there was more capacity available in the fisheries under their jurisdiction 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 for their tuna fisheries. They all have come to realize 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 they must be coupled with limitations on fishing capacity. All of these bodies have begun efforts to study the problem of overcapacity, and some have initiated efforts to correct it. However, as already mentioned, there must be a change in the way nations view their responsibilities respecting the management of the highly-migratory tunas before the problem of overcapacity can be resolved: 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. The problems of too much fishing capacity can be resolved only if there is a willingness on the part of nations and individuals to make changes in how their rights and responsibilities on the high seas are perceived and exercised. The remainder of report will discuss these issues.

2. DEFINING THE PROBLEM

2.1 Tragedy of the Commons

The technical fisheries and economics literature is replete with examples of the failure of management systems to adequately conserve the stocks of fish that they are charged with protecting. It has already been pointed out that about 25 percent of the stocks of marine fish 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 later they 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 it, which eventually leads to overfishing and declining catches. However, the decline in catches often leads to higher prices, in which case the fishery continues to be profitable 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 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. Regretfully, this "tragedy of the commons" (Hardin, 1968) has been a popular replay in ocean fisheries. These experiences have led to the realization that the concept of common resource and open-access needed rethinking. The change that is underway in many fisheries is to move away from these concepts and to assign 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.

2.2 Rights-based Management

It is clear that some form of a use or property right is a fundamental prerequisite to the limitation of fishing capacity, *e.g.* in the simplest schemes, for which the number of vessels in a fishery is limited, but no other restrictions are imposed, the owners of the vessels included in the limit have a participatory right in the fishery, and those not included in that list are excluded from the fishery. There are other schemes for which use or property rights are better defined. These schemes generally consist of setting an overall quota on the allowable catch, and then allocating this quota among the participants in the fishery. In such schemes the incentive to race to catch fish is eliminated because each participant has a limit on the quantity of fish that he can harvest. In some schemes individual quotas are transferable (ITQ). These schemes would lead to the creation of a market for ITQs, which could, in turn, lead to a reduction in the number of vessels in the fishery: an efficient operator could buy a quota from a less efficient operator; the efficient operator could take the combined quota with the vessels that he already has, in which case the vessels of the inefficient operator would be removed from the fishery. As already mentioned under a strictly open-access/common-resource philosophy it would not be possible to limit the number of vessels that can operate in a fishery. Any nation or individual would be able to enter

the fishery and to participate within whatever conservation guidelines management might set. There have been some successful programs in which property rights have been assigned that resulted in limiting the capacity of fleets to levels required for there to be effective management and conservation. In most cases these successes have been for national fisheries. Clark and Munro (2002) pointed out that the most difficult problem in any rights-based fisheries management system is determining how fishing rights should be defined and to whom they should be assigned. They noted that because of the controversy surrounding this problem governments, particularly democratic ones, have been slow to adopt rights-based limited-access systems in fisheries.

Fortunately for the tunas, with the exception of Atlantic and southern bluefin, and perhaps bigeye in some areas, the major stocks have not been overexploited, and governments are in a position to take effective management action to prevent severe overfishing. This would require moving away from concepts of open access and common property to the concept of rights-based management. This is different for tunas however, due to their wide distributions and highly-migratory nature and to the fact that many and diverse nations are involved in catching them or controlling access to waters in which they occur.

The 1982 LOSC and the UN Fish Stocks Agreement provide some guidance (and some confusion) on how this move from common property to rights-based management concepts can be considered. Article 64 of LOSC defines the tunas as highly-migratory species, and calls on nations to cooperate in their management and conservation. Articles 56 and 61 recognize the rights of coastal states to control access to the waters under their jurisdictions, and therefore to decide who can fish for tunas in those waters, with the caveat (Article 62) that, if the resource is not fully utilized, access to fish must be provided to the vessels of other states. In the case of tunas however, nearly all species are fully utilized throughout their range, and therefore one might consider that the coastal state would not be bound by Article 62 to provide access. Confusing the issue is LOSC Article 116, which relates to the rights of states to exploit the resources of the high seas. Although Article 116 is qualified by Articles 117, 118, and 119, which refer to the obligations and responsibilities of states respecting the conservation and management of the resources, it is frequently interpreted to imply that a fishery cannot be closed to new entrants. This creates a fundamental problem in securing the cooperation of all concerned states in initiatives to limit access to tuna resources. The UN Fish Stocks Agreement provides a framework of support for the LOSC regarding tuna. Article 7 of the Agreement states the responsibility of coastal states and other states to cooperate to ensure conservation and optimum utilization of the tuna resources, and Article 24 addresses the issue of developing states and the responsibility of developed states to developing states regarding conservation of tuna stocks and the development of fisheries on them.

2.3 Achieving Consensus

Reid *et al*. (2005) have shown that there is more purse-seine fishing capacity available than needed to take current levels of catch and any reasonable increases in potential catch, and that there is no room for additional fishing capacity in these fisheries without threatening the resources with overexploitation. Therefore, if fishing capacity is to be limited, the problem is to develop some means of enlisting the cooperation of all concerned nations in programs to limit

fishing capacity, *i.e*. fishing nations, non-fishing coastal nations, and both coastal and non-coastal nations wishing to expand their tuna fleets. The problem is difficult to resolve because even the simplest form of restricting fishing capacity partitions the catch in some way. Currently, on a world basis, most of the tuna is taken by DWFNs, while the majority of the catch is taken inside the EEZs. In the Atlantic and Indian Oceans and the EPO nearly half of the catch of tuna is taken inside the EEZs, while in the largest tuna fishery in the world, that of the WCPO, more than 70 percent is taken inside the EEZs. Many of the coastal states do not have tuna fleets, or only small ones, but many of them are desirous of developing fleets. Therefore, they are reluctant to enter into any schemes to limit fishing capacity that would curtail their efforts to develop fleets. Before any schemes to limit capacity and allocate catch can become a reality there must be a consensus reached among the concerned players to do so. They must realize that the process of limiting capacity in itself is the process of assigning property rights, and that as soon as the numbers of vessels in a fishery are limited, the available catch is mostly allocated. The problems between the haves and the have-nots must be addressed and resolved before the matter of excess fishing capacity can be resolved and effective management becomes a reality.

There have been some initiatives undertaken by the regional tuna bodies to limit fishing capacity, but progress is slow. The most significant progress in developing a capacity limitation program has been by the IATTC. In this case a list of vessels authorized to fish in the EPO is maintained by that organization. New vessels are not supposed to enter the fishery unless they are to replace vessels on the list. Vessels on the list are supposed to be transferable among the nations participating in the program. Some capacity is held in reserve for coastal states without fleets, but desirous of developing them.

The remainder of this report will discuss the actions that have been taken by industry, governments, and regional tuna bodies (including more detailed comments on the IATTC program mentioned above) to manage tunas and limit fishing capacity, and some possible approaches that might be considered in the future.

3. TUNA FISHERY MANAGEMENT EXPERIENCES

Over the last half century there have been numerous efforts on the part of governments, regional tuna bodies, and industry to manage tuna fisheries. Japan, during the 1950s, was the first nation to control the number of longline vessels fishing for tunas under its flag. The first international effort to manage a fishery for tunas was made by the IATTC in 1966, when it established a quota on the catch of yellowfin tuna in the EPO. Since these early efforts there has been a continuing series of initiatives in different regions of the world to manage tunas. Joseph (2005) reviewed these programs through 2003; an updated version of this review is included below.

3.1 National Approaches

Following World War II, the Japanese government directed considerable effort toward developing its fisheries, and by the latter part of 1960 Japanese longline vessels were fishing throughout the tropical and temperate regions of the oceans of the world. Longline tuna fishing was profitable, and the fleet grew. The increasing number of vessels and the growing labor costs began to erode the profitability of the fishery, so the Japanese government introduced programs

to limit the number of Japanese vessels that could operate in the fishery. By limiting the number of longline vessels, catch rates and economic returns were kept relatively high. However, because the tuna species targeted by the Japanese longline fleet are found throughout the oceans of the world, and because at that time they were considered a common resource available to whomever could catch them, the action taken by the Japanese government was not successful in halting fleet growth. To escape the limitations placed on them by their government, Japanese boat owners invested in the construction and operation of longline vessels in nations that had not placed controls on fleet growth. It was this flow of capital that stimulated the development of large fleets of longline vessels in Taiwan and the Republic of Korea, and, more recently, the Peoples Republic of China and Indonesia.

Because the Japanese attempt to unilaterally resolve the problem of excess capacity was not successful, it was clear that any effective program to limit fleet size and growth would have to be much broader based and involve all states with vessels participating in the fishery, rather than just Japan.

3.2 Regional Intergovernmental Approaches

3.2.1 The Inter-American Tropical Tuna Commission (IATTC)

As mentioned in **Section 1.2.1**, the first time an international high-seas tuna fishery had come under conservation controls was in 1966, when the IATTC adopted a catch quota limiting the harvest of yellowfin tuna in order to prevent the near-shore portion of the stock in the EPO from being overfished. At the time the purse-seine fleet comprised about 40 thousand tons of carrying capacity, and nearly all of it was under a single flag, that of the United States. The quota was structured in a manner that allowed catches to be taken on a “first-come, first-served” basis. The season for unrestricted yellowfin fishing commenced on January 1, and would be closed on a date that would assure that the quota would not be exceeded.

The conservation program maintained high catch rates and profitability. This attracted new investment in vessels, and fishing capacity began to grow. As the fishing capacity grew, the season to unrestricted fishing decreased from about 10 months to less than 4 months as more and more vessels raced to catch as much fish as they could before the season for unrestricted fishing was ended. Pressure to increase catch quotas beyond the recommendations of the scientists mounted. Most of the catch was still taken by vessels of the United States, and the coastal states of the region complained that the first-come, first-served basis of the conservation program discriminated against them because they had fewer and smaller boats, and could not compete. This resulted in intense negotiations among the nations with an interest in the fishery to allocate shares of the quota to the coastal states, small vessels, *etc*. (Bayliff, 2003: Table 4). In some cases the shares assigned to the coastal states were sufficient to allow their vessels to continue fishing throughout the year. This marked a significant change in the way management of tuna resources was viewed, and, in fact, was a small step toward rights-based management, even though the allocations were termed economic-need quotas rather than rights-based quotas.

During the mid and late1970s most of the world had moved to or was moving toward an extended jurisdiction of 200 nautical miles. Because coastal states under this regime of extended

jurisdiction controlled access to a significant, if not a majority, share of the world's tuna resources, their position regarding special recognition in sharing of the resources was strengthened. By 1978 the carrying capacity of the purse-seine fleet in the EPO had increased to about 170 thousand tons. As discussed in **Section 1.2.1**, pressure from all sides for increased catch limits and increased allocations was so great that agreement could not be reached to implement a catch quota; this resulted in overfishing the stock of yellowfin. As yellowfin abundance declined, much of the fleet left the EPO to fish in other ocean areas or remained in port because the catch rates were so low that vessels could not meet operating expenses. This situation continued, and fishing effort in the EPO remained low until the mid-1980s, by which time yellowfin abundance had increased to above levels corresponding to the AMSY, and vessels began to return to the fishery. In 1985 purse-seine carrying capacity was 115 thousand tons, and catch rates and profits were high. The size of the fleet was more or less in balance with the current levels of catch, and there was no need to place restrictions on the harvest. This situation attracted more vessels, and the fleet has continued to grow (IATTC, 1988).

Because of the rapid resurgence of the fleet and the fear that the earlier experience of overfishing would be repeated, the Commission began to consider the implementation of measures to limit the number of vessels entering the fishery, but such efforts were mostly unsuccessful. The purse-seine fleet continued to grow, and this larger fleet exerted increased fishing effort on yellowfin and bigeye tuna. To prevent overfishing, conservation controls were implemented for these two species. Until 1999 none of the conservation measures that were implemented resulted in limiting or halting the growth in the fleet. In fact, it seemed that the mere introduction of the idea of limiting fishing capacity stimulated fleet growth. Those without fleets or with small fleets wanted to establish a larger presence in the fishery before they were constrained from doing so by the introduction of capacity limitation measures.

After extensive international negotiation, the first measures to limit purse-seine fleet capacity in the EPO fishery were implemented in 1999. Purse-seine carrying capacity limits were assigned to each of the 13 nations involved in the fishery. (Not all of the 13 nations were members of the IATTC, but all participated in the negotiations to assign limits.)

During the negotiations several factors were taken into account in assigning vessel limits. The most important was the level of catches taken during 1985-1998 by each of the 13 nations. Other factors that were considered were catches taken within the EEZs of the nations bordering the EPO, the landings of tuna from the EPO in each of the 13 countries, and the contribution of each of these nations to the conservation programs of the IATTC. For countries that were participating in the fishery during 1985-1998, the allocations of fleet capacity were approximately equal to the capacities of the actual fleets operating during 1998. One coastal state that did not have a fleet, but which had a longstanding and significant interest in the tuna fishery of the EPO, was assigned a capacity limit that would allow that nation to acquire a tuna fleet. There were several other coastal states participating in the negotiations that did not have tuna fleets at the time, but they insisted that the agreement provide the opportunity for them to acquire fleets. A capacity limit for each of these coastal states to grow into was negotiated by the governments, thereby assuring that they could acquire vessels within the framework of the program. The total limit set by the resolution 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 scientific staff of the IATTC noted that a fleet carrying capacity of purse-seine vessels of about 130 thousand tons was adequate to harvest the current catches of tunas. The actual carrying capacity operating at the end of 1998 was 138 thousand tons. By the end of 1999 carrying capacity reached 158 thousand tons. It was clear that there was a rush to bring new capacity into the fishery before regulations prohibiting new entries could be enacted. Unfortunately, it was not possible for the nations to agree 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.

With growing concern over the large increases in capacity, the IATTC intensified its efforts to limit fleet growth. The governments (1) agreed to established a definitive list of purse-seine vessels authorized by the participants to fish for tunas in the EPO (the Regional Vessel Register, RVR), (2) noted that any purse-seine vessels fishing for tunas in the EPO that are not on the RVR would be considered to be undermining IATTC management measures, (3) indicated that only vessels flying the flags of participating nations could be entered on the RVR, (4) instructed that carrying capacity would be measured as the volume of the fish wells, (5) prohibited the entry of vessels not included in the RVR to the purse-seine fleet operating in the EPO, except to replace vessels removed from the RVR, (6) made provisions for five coastal states bordering the EPO to add vessels to the RVR with a total combined carrying capacity not to exceed 20 thousand tons, (7) defined a participant as a member of the IATTC, and states and regional economic integration organizations, and fishing entities that have applied for membership or that cooperate in the conservation programs of the Commission .

The central principle encompassed in the RVR is that the capacity quotas are assigned to vessels, rather than to governments. The clear intent of this capacity limitation program is to fix the number of vessels that are authorized to fish in the EPO at current levels, although the special provisions for certain coastal states would allow it to grow by about 17 thousand tons. It is also the intent of the program to allow vessels in the RVR to transfer to any of the other 12 nations, thereby allowing the nation to which the vessels transfers to increase its capacity by the amount of the transferred vessel, but requiring the nation from which the vessel transferred to reduce its capacity by that amount. If a vessel on the RVR is replaced, or its capacity increased, then a vessel of equal capacity, or an amount of capacity equal to the increase in capacity, must be removed from the RVR. In a manner of speaking, the RVR creates a market for trading capacity. A vessel owner or a nation desirous of increasing its capacity can offer to purchase vessels listed on the RVR. When purchased, the vessel, which would remain on the RVR, along with its capacity quota, would go to the purchaser. Once the RVR was established through political negotiation, theoretically, any transfers of vessels among nations would result from market forces.

Since the inception of the RVR system there has been disagreement among some of the participants as to whether transferability was agreed to in the original resolution establishing the program. Although this provision for transfer is not clear in the resolution, it was clarified in a document (IATTC, 2003b) presented by the Director of the IATTC: “The Secretariat’s understanding of how the Resolution was intended to work with respect to transfers was to allow vessels on the Register to simply transfer flag from one participant to another. The participant

the vessel was transferring from would not be able to replace the vessel, and there would be no restrictions on any participant being able to receive the transferring vessel."

Because of the confusion over whether there is transferability, as defined above, among the participants, several vessels were dropped from the RVR by their flag states. When they are dropped from the RVR by the flag state they are leaving the owners are informed that the vessels could not be authorized to fish by the flag they are transferring to unless that flag had unused capacity. Unless some arrangement by the participants was made to increase capacity the vessel would be declared to be illegal, unregulated and unreported (IUU) fishing—there are vessels that have fallen into this situation. The participating governments agreed to increase the capacity limits for the states to which the vessels were transferring, and to allow the states from which they transferred to retain the capacity quotas for the departed vessels. This, of course, has resulted in the total capacity limits being increased and exacerbating an already serious overcapacity problem.

The IATTC has made a considerable progress in limiting fishing capacity in the EPO, but unless the issue of transferability is resolved along the lines it was intended to follow, the problems associated with too much fishing capacity will not be resolved.

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

The first management measures implemented by ICCAT are discussed in **Section 1.2.1**. These included measures to protect small tunas and limits on the catches of bluefin, but not limits on fishing capacity.

One of the first measures to limit the size of fishing fleets in the Atlantic was adopted in 1998 for northern albacore and bigeye. In that year the member governments of ICCAT 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 meters 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. Subsequently, a total allowable catch (TAC) of 34.5 thousand tons was set for northern albacore, which was allocated among the nations participating in the program. For bigeye, additional recommendations were made, calling on the participants to limit their catches in 2004 to the levels of 2001. 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 was assigned a catch allocation of 5 thousand tons and a fleet limit of 60 vessels, Taiwan 16.5 thousand tons and 125 vessels, and the Philippines 2.1 thousand tons and 5 vessels. In order to have available information with which to monitor and ensure compliance with the resolutions, each participant was required to provide a list of vessels that operated under its flag in the northern albacore fishery in 1993-1995, and each year thereafter, and in the bigeye fishery in 1991-1992, and each year thereafter. In 2005, in response to the fact that the catches of bigeye by Taiwan exceeded its assigned quota, ICCAT reduced its catch allocation to 4.6 thousand tons and the number of vessels that could target bigeye to 15.

These actions by ICCAT to address the problem of unsustainable exploitation of northern albacore and bigeye provide the basis for the nations participating in the fishery to manage these resources in an effective manner. By setting a TAC for each of these species, and allocating that TAC among the participants in the fishery, there is an opportunity for each nation to regulate the number of vessels authorized to fish under its country allocation. Unfortunately, hardly any of the participating nations with assigned country allocations have chosen to limit fleet capacity. The result is that fleets can continue to grow, and as they grow their owners will tend to apply pressure to their governments to negotiate for increasingly greater TACs and country allocations. Past experience has shown that this kind of behavior results in the failure of conservation measures.

Although these initiatives are a step in the right direction, they fall short of their objectives. Because information to compare current fleet capacities with baseline fleet capacities has not been fully available, it is difficult to know if participating parties are indeed limiting their fleet sizes to recommended levels.

3.2.3 The Indian Ocean Tuna Commission

Although the IOTC has a much shorter history than the IATTC or the ICCAT, it has undertaken several measures that have had an impact on the problem of fishing capacity. The earliest efforts were recognition by its members 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. Accordingly, the Scientific Committee of IOTC was asked to make recommendations on the best estimate of the optimum capacity of the fishing fleet that would permit the sustainable exploitation of the tropical tunas. Due to a lack of information, however, the Committee was unable to make such recommendations.

In an effort to initiate the preliminary steps of limiting fishing capacity, in 2002 the IOTC approved measures to establish and maintain a Record of Authorized Vessels (RAV) of greater than 24 meters 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 authorized to fish. However, any vessel not on the RAV would be considered to be engaged in IUU fishing. Measures were also approved requesting that nations participating in the agreement undertake certain actions, such as closing ports to and prohibiting imports from vessels involved in IUU fishing and not granting the use of their flag to vessels that had been involved in IUU fishing unless the ownership of the vessel had changed. In 2005 the cooperating parties agreed that vessels of less than 24 meters in overall length that fish outside the EEZ must be on an IOTC list of vessels authorized to fish in the Indian Ocean, or they would be considered to be IUU vessels. The measures for vessels greater than 24 meters in overall length, and for vessels less than 24 meters in overall length that fish outside the EEZs, taken together 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.

In addition to the vessel lists, the IOTC in 2003 approved a resolution requiring each nation with more than 50 vessels on the RAV to limit the number of their fishing vessels greater than 24 meters in overall length to the number registered on the RAV in 2003. 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 capacity up to the 50-vessel guideline, resulting in an increase in capacity.

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

The CCSBT is different from the other regional tuna bodies in that it is concerned primarily with southern bluefin tuna, and in that its area of concern is wherever this species is found. When CCSBT was formed, its three members, Australia, Japan, and New Zealand, were the only nations fishing for southern bluefin on a significant scale. A TAC of 12 thousand tons was implemented, and allocated among the three members. This provided the opportunity for the three nations 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 kind of ITQ system in which its share of the overall quota was partitioned among various Australian fishing companies, most of which were involved in aquaculture 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 that can operate. Over the last few years, however, 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 of 14 thousand tons. 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 meters in overall length authorized to fish for southern bluefin tuna. The CCSBT considers any vessel that is not on the record and 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 excess capacity in the southern bluefin fishery, but, it is difficult to determine precisely how effective these measures are.

3.2.5 The Western and Central Pacific Ocean

The tuna fishery of the WCPO is the largest in the world, accounting for nearly 50 percent of the world catches of the principal market species, and the single largest purse-seine fishery is prosecuted there. Less than 20 percent of the catch in the WCPO is taken on the high seas, so the

coastal and island states control access to most of the catch in the region. This potentially has a large impact on how management arrangements will be formulated. Nevertheless, the tunas are highly migratory, and the principles defined in Article 64 of the LOSC and the UN Fish Stocks Agreement apply with respect to cooperation among nations and management requirements that apply throughout the range of the species. In response to the mandates of these international instruments, the WCPFC was created by the nations with interest in the tuna resources of the region and entered into effect on June 19, 2004; its inaugural session was held in December 2004. The convention is responsive to the need for controlling fishing capacity when necessary. Article 5(a) of the convention notes that the WCPFC shall "take measures to prevent or eliminate…excess fishing capacity," Article 10(g) states that the Commission shall develop "criteria for the allocation of the total allowable catch or the total level of fishing effort," and Article 10, 2(c) states that the Commission may adopt measures for "limitations of fishing capacity". During one of the planning sessions for the establishment of the WCPFC the governments represented at the meeting agreed that "all States and other entities concerned to exercise reasonable restraint in respect of any regional expansion of fishing effort and capacity." It is clear that the WCPFC provides the legal authority for the organization to deal with the problem of excess fishing capacity. Because of the newness of the WCPFC, it will have to build on what other institutions in the region, notably the Forum Fisheries Agency (FFA) and the Palau Arrangement, are doing and have done.

The oldest body with an interest in the tuna resources of the region is the Forum Fisheries Agency (FFA), which was created in 1979 by the 16 member countries of the South Pacific Forum to help them manage and develop their living marine resources, particularly the stocks of tuna inhabiting the WCPO. The FFA maintains a register of vessels that are eligible to apply for an access license for fishing in the EEZs of FFA members. Any vessel that has been found to be IUU fishing with respect to the EEZ of any FFA member country is blacklisted, and cannot obtain an access agreement. This move has tended to reduce IUU fishing and associated excess capacity.

The Palau Arrangement for the WCPO purse-seine fishery, which was concluded in 1992, has the objective of limiting the level of purse-seine fishing in the region. The arrangement provides for an overall limit of 205 purse-seine vessels that will be licensed by the parties for fishing in their waters. Of the 16 FFA members, 8 are members of the Palau Arrangement. The majority of the catch of tuna from the area is taken in the waters of these eight members.

The countries that are members of the Palau Arrangement are in the process of examining a long-term management system based on national limits on the number of allowable purse-seine days fished. The Ocean Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC), along with the WCPFC and the FFA, will provide technical information and advice to the Palau Arrangement countries in order to assist them in developing the management system. The system being discussed would set a total number of allowable fishing days for the combined EEZs of the parties to the Palau Arrangement. It appears that this level of allowable effort will be set to ensure sustainable harvests of the stocks of tunas inhabiting the area. It also appears that the total allowable number of fishing days will be allocated among the coastal states that are party to the Palau Arrangement, and that these allocations will be made in proportion to the abundance of the resource in the respective EEZs and/or the levels of harvest made in those

zones. Each country would then be able to license vessels to utilize the fishing days allocated to its EEZ. It is not contemplated that the number of vessels that can purchase licenses to fish in the respective EEZs will be limited. However, the Palau Arrangement members have agreed to a combined limit of 205 vessels for all of the Palau Arrangement members. The licensing scheme being contemplated apparently will not include United States purse-seine vessels, which are licensed under a special arrangement with 16 of the Pacific Island nations. There are about 40 vessels in this arrangement. It should be kept in mind that the limit is expressed in numbers of vessels, rather than in carrying capacity. It is possible that a tendency toward more efficient vessels will develop, resulting in an increase in fishing capacity. As had been made abundantly clear by the scientists of OFP, the efficiency of fishing vessels can vary a great deal, so some means of standardizing the allowable number of fishing days to a particular class of effort will be necessary. It will also be necessary to monitor efficiency changes over time because of "capital stuffing," since once days are limited fishermen will try to compensate by increasing their efficiency by investment and adopting technological innovations. If the parties to the Palau Arrangement balance the number of vessels, taking into account fishing capacities of the vessels that they license, with the number of fishing days each of them has been allocated, this could serve to ameliorate any excess fishing capacity problems. However, there would have to be close cooperation among the countries in establishing this balance, as vessels may seek to purchase licenses for more than a single EEZ, since tunas are highly migratory, and aren't always available in the same EEZs. The matter of subsidized vessels would also have to be considered in any system that might be developed if that system is to be most effective. A vessel with subsidies would be able to fish at lesser levels of catch and still make a profit, whereas an unsubsidized vessel would not. This would result in more vessels seeking licenses than if there were no subsidies. Also, the area of the WCPO that lies beyond the EEZ of any nation will have to be considered in any scheme for controlling fishing effort and capacity. Once the WCPFC is fully operational, it will deal with the issue of controls in the high-seas area, but there will have to be coordination with what the coastal states are doing by way of licensing within their EEZs.

Although the effort limit scheme discussed above can potentially relieve the problem of too much capacity, it could be dealt with more directly and effectively if vessel limits were included in the allocations of total allowable fishing days. Also, in the WCPO, as in other areas, the problem of too many longline vessels must be dealt with, as those vessels take about 30 percent of the total catch of the region.

3.3 Industry Arrangements

In response to decreasing catch rates in the world longline fishery and declining ex-vessel price in the global purse-seine fishery there have been two industry organizations, one for large longline vessels and the other for purse-seine vessels, created over the last few years that deal with the issue of fishing capacity.

3.3.1 The world longline fleet and the Organization for the Promotion of Responsible Tuna Fishing (OPRT)

Two major factors have impacted the profitability of the longline industry. One is the high demand and high value placed on tunas for the *sashimi* market, which has caused longline

fishing effort to increase more than the demand, resulting in declines in vessel profits. The other is the development of FADs, which increase the efficiency of capturing small tunas, including bigeye. Increased catches of small bigeye have reduced the recruitment of large bigeye to the longline fishery, resulting in reduced abundance and declining catches of these large fish, which are the primary target of the longline fishery. This situation has caused a great deal of concern for the longline industry. Because of this concern, and in keeping with the FAO International Plan of Action for the Management of Fishing Capacity (IPOA-CAPACITY), the Japanese longline industry has undertaken action to reduce the size of its large-scale, air blast-freezing, tuna longline fleet by approximately 20 percent. Because there are large longline fleets fishing under the flags of several other nations, the Japanese industry has undertaken measures to enlist the cooperation of many of those fleets in an overall program to reduce fishing capacity of the world's longline fleet. Japan has targeted 130 vessels for removal from its fleet, and Taiwan has agreed to limit its fleet to 600 vessels. Taiwan will require that Taiwanese-owned vessels under flags of convenience be transferred to its registry. To stay within its 600-vessel limit, some of the recalled vessels will be "bought back" and scrapped, as will the 130 Japanese vessels. The Japanese government has prohibited the importation of tuna from vessels that might, by their actions, diminish the effectiveness of programs to conserve and manage tuna resources, including efforts to control fishing capacity. The scheme has a chance to succeed because Japan is the primary market for *sashimi*-grade fish, and if that market were denied to a longline vessel, it would find it difficult to fish profitably.

The OPRT was originally established between an industry association that represents all Japanese high-seas longline vessels, and a similar association represents 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 People's Republic of China, and the Philippines have joined OPRT. Some Japanese and Taiwanese longline vessels have been bought back by the Japanese and Taiwanese longline industries and scrapped. 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.

This Japanese initiative to reduce the number of large-scale tuna longline vessels can be a useful means of controlling excess fishing capacity and contributing to better conservation of the tuna resources important to the longline fishery. However, to be effective, there are two other factors that must be considered. First, there must be effective measures to resolve the excess capacity problem in the surface fisheries, which, because of increasingly greater catches of small bigeye, are having a serious impact on the abundance of large bigeye available to the longline fleets. Second, there are growing fleets of longline vessels less than 24 meters in overall length that are not included in the vessel lists and management programs of various organizations. Many of these vessels are registered in developing coastal states. These fleets of small vessels are fishing progressively greater distances from shore and taking increasingly greater quantities of tunas, and as the infrastructure in the coastal states processing and shipping *sashimi*-grade tuna to Japan develops, there will be an increasing need to include these fleets in any programs to limit capacity in the world longline fleet. Until these problems are dealt with, there cannot be effective tuna management.

3.3.2 The World Tuna Purse Seine Organization (WTPO)

The number of large purse-seine vessels has been steadily increasing over the last several decades, and now comprises about 570 vessels with a total carrying capacity of nearly 600 thousand tons. Additionally, this growing fleet has increased its efficiency in catching tuna. This increase in productivity has been the result of many factors, including better vessel design, the use of sophisticated electronic equipment, and the development of the use of FADs. With this tremendous potential to catch fish, when the supplies of tunas, particularly skipjack, are abundant, 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. For most of the years since 1998 there have been abundant supplies of skipjack and catches in excess of demand, and prices have reached the lowest levels of the last several decades. 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. In 1999 several industry organizations representing purse-seine vessels came together to form an organization, the WTPO, to address this problem. The organization has attempted to treat the problem of overproduction by requiring vessels to spend more time in port between trips and by calling for a limit on fleet growth.

Although many boats followed the recommendations of the organization regarding the length of time between trips, many others did not; so it is difficult to tell whether this has had an impact on price. It has had little or no impact on excess capacity, because new purse-seine vessels continue to enter the fishery. Regarding limiting capacity, the organization has called 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 replacement vessels of an equal size removed from the register. So far, such a world register has not been implemented. The idea of an industry initiative to address the problems created by excess capacity in the world tuna fleet provides a number of possibilities, some which are discussed by Joseph (2003), for helping to resolve these problems.

4. MOVING FORWARD

There is almost universal agreement among governments, regional tuna bodies, and industry that there is more than enough tuna fishing capacity to harvest the tunas, with the possible exception of skipjack, at the AMSY levels, and more than enough fishing capacity to satisfy the market demand for skipjack. Squires *et al*. (1998 and 2000) have pointed out that excess fishing capacity 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. There is also agreement among governments, regional tuna bodies, and industry that limits should be placed on the numbers of vessels allowed to fish. It is also recognized that these situations of 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 due to 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 excess capacity.

As discussed earlier sections of this report, a solution to this problem would be to limit the number 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. All of the major purse-seine fleets are well above this level (Reid *et al*., 2005) and so are the fleets of medium and large longline vessels (Miyake (2005b). Before effective programs to limit capacity can be implemented there are some issues that must be considered. These have been discussed in **Section 1.3**, and more extensively by Joseph (2005). Some of them are reiterated and expanded upon in the following paragraphs.

4.1 The Need for Change

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 open access to a common resource prevails, overfishing, or the threat of overfishing, will continue. The vesting of some sort of 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, which is reasonable, since resolving ownership problems in such fisheries is much easier than in multinational fisheries. In many of its fisheries New Zealand has allocated shares of the resource to users, which has allowed the management system to limit fishing capacity and maintain sustainability in the fisheries (Dewees, 1989). Another example is that of the Alaskan groundfish fishery, one of the most important fisheries of the United States. In this fishery, rights to catch fish have been allocated to both groups and individuals, and as a result management has been able to control fishing capacity at levels commensurate with AMSY (Holland, 2000).

Pacific halibut provides an example of an international fishery for which property rights have been assigned to fishermen, which has led to the maintenance of both economic viability and keeping the stocks at AMSY levels. Vessels of two nations, Canada and the United States, harvest Pacific halibut. The International Pacific Halibut Commission (IPHC), of which the two nations are members, is responsible for the management of halibut. To protect the resource from overexploitation the IPHC set overall limits on the amount of catch that could be taken. Initially, the fishery was managed by opening the season to unrestricted fishing on January 1 of each years, and closing it when the quota was reached. Under that scheme, competition for the available catch increased, fishing capacity increased, and the length of the open season decreased from a year-long fishery to one that lasted only a few weeks. Eventually, the IPHC allocated shares of the catch to the two nations. Within the fleets of each nation, the same pattern of "a

race for the resource" continued. Open seasons were shortened to a matter of days in some areas. To resolve this problem, each country assigned property rights to its fleet. Canada assigned ITQs, and the length of the fishing season became a superfluous control to regulate the total catch; the fishing season increased from just 6 days per vessel in 1990 to 245 days in 2000, while during that period the number of vessels dropped from 435 to 281; the corresponding catches went from 3.9 to 4.3 thousand tons. A similar pattern was experienced in the U.S. fishery. (Squires *et al*., 2000) stated "Under open access, and prior to the transferable private production right or ITQ, production under the shortened production period—under the "derby fishery"—required relatively large crew sizes, longer working days, and longer trips to catch as much halibut as possible. After the ITQ was introduced, the rivalrous consumption and competition over the resource stock found under open access was curtailed and the fishery could extend over a longer period. Consequently, both labor requirements and the duration of the working day or fishing trip declined. In short, full utilization of variable inputs under normal operating conditions depends upon the duration and intensity of operations. In turn, these are determined by institutions, customary practices, and social norms, and in the broadest sense, these factors differ according to the type of property right regime."

These examples of the assignment of use or property rights in both national and international fisheries provides clear evidence of their utility in avoiding "the tragedy of the commons" and implementing effective management and conservation measures, including limiting fishing capacity. The question is: is it likely that such a change in multinational tuna fisheries is possible? In **Section 2.3** it was pointed out that 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 have to be developed.

4.2 Making Room with Buy Backs

Perhaps the simplest and quickest approach to take with respect to providing for the entry of have-nots into a limited fishery might be to set the initial capacity limitation level in excess of target or current capacity in the fishery and to use this excess to partition, according to certain agreed-to criteria, to have-not entrants. The next step would be to reduce overall capacity to the target level through attrition, or through some mechanism for buying vessels out of the fishery. If the former, the rate of attrition would likely be very low and excess capacity would remain in the fishery for many years. If the latter, it would most likely be necessary for governments to be involved in financing the buy backs, since in this scheme catches would not have been allocated to individuals, and there would not be much incentive for industry to fund the buy backs.

An alternative approach would be for governments to buy back some vessels immediately after the capacity limits were implemented, and attempt to sell them to new have-not entrants. The rate at which vessels of the haves would be bought back would be determined by the rate at which have-not buyers could be found for them.

Based on the experiences in other fisheries, the assignment of transferable individual property rights in one form or another might be the most efficient and effective means of handling the problem of new entrants. Under such schemes a market would develop for shares of the potential harvest, thereby allowing any individual, group, or nation to enter the fishery by buying a catch quota and/or a share of the total fishing capacity. Many of the have-not nations are coastal developing states and some consideration should be given to mechanisms for assisting them in the purchase of rights into the fishery in question if their cooperation in instituting effective management is to be assured.

4.3 Criteria for Determining Participation

The first allocations of catch in an international tuna fishery were made in the EPO in 1969 (Bayliff, 2001). At that time most of the catch was taken by U.S. flag vessels. The coastal states had only a few small vessels, and contended they could not compete with the U.S. fleet during the season of unrestricted fishing. They therefore negotiated for special allocations based on the fact that the tunas occurred in their coastal waters. At that time the United States did not recognize coastal states' jurisdiction over tunas. After extensive debate and negotiation the agreed upon criterion used to determine the allocations was based on "economic need." Vessels determined to be at an "economic disadvantage" to other vessels were provided special allocations that could be taken after the fishery to unrestricted fishing was closed. The allocations were assigned to all states, but specified for the economically disadvantaged vessels within that state. The economically disadvantaged vessels were generally the smaller purse seiners, pole-and-line vessels, and vessels fishing under the flags of states with only a few purse-seine vessels. Allocations were progressively increased and applied to vessels of all sizes of coastal developing states (Bayliff, 2001: Table 4). During the 1970s many nations extended their jurisdiction over fisheries to 200 nautical miles. On the basis of this extended jurisdiction the coastal states of the EPO negotiated to allocate the available catch in accordance with this criterion. The negotiations failed, and the fishery was unregulated from 1980 through 2003.

During the 1970s catch quotas were placed on bluefin tuna in the western Atlantic Ocean. The quota was allocated among the nations currently involved in the fishery (Canada, Japan, and the United States), no other criteria were considered. Countries, such as Cuba and Brazil, with very limited fisheries were exempt from the regulations. Since that time ICCAT has allocated catches of swordfish, bigeye tuna, and northern albacore among participating states. No firm criteria for making these allocations were defined; rather they were negotiated mostly on the basis of current levels of catches being taken by the nations. However, the member governments have held special meetings to develop criteria upon which allocations could be based, but so far there has been no agreement on which criteria should be used.

Because of the heavily overfished state of southern bluefin tuna during the 1980s, Australia, Japan, and New Zealand agreed to voluntarily restrict their catches of southern bluefin tuna to near their then current levels of harvest. When the Convention for the Conservation of Southern Bluefin Tuna entered into force these voluntary catch levels were formalized as allocated quotas.

More recently the IATTC has allocated carrying capacities among the fishing nations. These allocations were made primarily on the basis of current levels of catch, but also considered historical catches taken within the EEZs of coastal states of the EPO, landings of tuna from the EPO at ports of each state, and the contributions of the states to the IATTC.

In practice, allocations in international tuna fisheries have been mostly the result of intense negotiations among the involved parties, and as seen above, have most often reflected the historic and current distribution of catch. Many of the regional tuna bodies have recognized that there is an urgent need to develop a set of criteria that can be used as a basis for making allocations of catch and/or capacity and have established working groups and committees to identify such criteria. A working group of ICCAT has listed a series of criteria that can be considered for making allocations, and the Convention on the UN Fish Stocks Agreement [Article 10 (3)] lists 10 points to be considered in developing criteria for allocation. Joseph (2003) also provides a list of some of the most important criteria that might be considered in making allocations. Although identifying criteria to be used in allocating will never replace negotiations among countries, such criteria will ease the burden of intense negotiations, particularly if a weighting mechanism is developed for the use of the identified criteria.

4.4 Capacity Growth

Another important problem that must be considered in any program to limit fishing capacity is the effect of the limitations on the ability of the vessels remaining in the fishery to catch fish. There are many examples that show that when limits such as closed seasons, restricted areas, the number of days fished, and the types of gear that can be used, are applied, fishermen are able to increase the fishing mortality that their vessel are able to generate. Such capital stuffing (Wilen 1985 and 1989) must be monitored and quantified, and the capacity limits adjusted for, if management measures are to remain effective in conserving the resource. Productivity growth, especially through technological change, is another critical source of growth in fishing capacity (Squires, 1992).

4.5 A Multi-species Fisheries

The different tuna species frequently associate with each other in the same aggregations. Not only do these tunas aggregate together, but many other species associate in these aggregations. Most vessels capture more than one species of tuna during a single trip, and they frequently do that during a single set. They may also capture a variety of other non-tuna, non-target species. For example, longline vessels frequently catch billfishes and sharks, and purse-seine vessels frequently catch sharks, mahi-mahi (*Coryphaena* spp.), wahoo (*Acanthocybium solandri*), and rainbow runners (*Elagatis bipinnulatis*). The application of management measures may be complicated because some of the stocks of fish these vessels may be capturing during the same fishing operation are over- or fully exploited, while others are not fully exploited. In situations

where capacity limitations are being considered for a target fishery that may include over- and underexploited species of tuna, the process of setting the levels of fleet size will be complicated. On the one hand, if capacity was targeted to underfished skipjack, then there would be a danger to fully-exploited yellowfin or overexploited bigeye, unless other constraints on levels of harvest were considered. On the other hand, if overfished bigeye were the target for setting capacity limits, the result might be that skipjack would be underfished. Any schemes to limit fishing capacity must consider these characteristics of tuna fishing, and also the effects on the bycatches species, some of which are the objects of other fisheries.

5. THE ALTERNATIVES

Joseph (2005) presented a series of options to be considered for limiting fishing capacity. These options included input controls, such as licensing, limits on the numbers and sizes of vessels, and effort restrictions, and also output controls such as quotas on allowable catches, including country quotas, individual quotas, and transferable quotas. All of the options reflect a move away from open-access systems of management to rights-based systems. The simplest approach, the vessel register, does not provide a specific right to a quantity of fish, but provides a right of access to the resource. At the other end of the spectrum, quotas for specific quantities of fish are assigned to users, and the users can transfer that right to other entities for some consideration. The options fall into two categories: 1) those that do not remove the incentive to increase capacity through increased efficiency, and 2) those that tend to remove that incentive. These are briefly reviewed below, and, when appropriate, expanded upon; however, the reader is referred to Joseph (2005) for a more detailed discussion of the various options. For the purposes of the discussion which follows, it is assumed on the basis of the information presented in this report that maintaining the *status quo* regarding the management of tunas is not a viable option, and that some means of limiting fishing capacity is necessary if the tunas are to be effectively managed.

5.1 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 much 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 makes it more difficult to maintain conservation controls.

5.1.1 Vessel registers

The initiatives taken by the various regional tuna bodies to limit fishing capacity through the establishment of vessel registers are described in **Section 3.2** of this report. On the one hand, two of the regional tuna bodies (ICCAT and IOTC) maintain “positive lists” of vessels that are authorized to fish in the waters under their responsibility; vessels not on those lists would not be authorized to fish in the Atlantic or Indian Oceans. However, the lists do not limit the numbers of vessels that can be on them. 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.

The approach taken by the IATTC is the only one that addresses the problem of overcapacity. Although, as discussed earlier, the IATTC model has several shortcoming, which result in failure to control the expansion of fishing capacity as much as hoped, it nevertheless provides useful experience for the development of more effective capacity limitation.

5.1.1.1 Regional registers

There is an Article 64-type regional tuna body in every area of the world in which commercial quantities of tuna are harvested. Each of these bodies has expressed a need to limit and/or reduce the capacities of vessels operating within waters under its jurisdiction. Some have made first-cut attempts at limiting capacity by establishing a register of vessels authorized to fish in their region of competence. These attempts provide the basis for formulating a simple and straightforward model for limiting capacity—the Regional Vessel Register (RVR). The RVR discussed here envisions a model that provides mechanisms for reducing excess capacity 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 to prevent overexploitation would have to be established concurrently.

The first thing that the establishment of an RVR would do 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 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 at least 6 of the previous 18 months. To remain on the RVR, a vessel would have to remain active in accordance with the definition.

Purse-seine vessels come in all sizes, from small coastal vessels that have a capacity to carry only a few tons of fish to the largest ocean-going vessels capable of holding more than 3000 tons of frozen tuna. Most of the world catch of tuna by purse-seine vessels is taken by vessels with carrying capacities greater than 400 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 25 tons for which the annual catch of the principal market species of tuna makes up more than 50 percent of its annual catch of all species combined.

In some fisheries tuna vessels may fish throughout the entire area of a regional organization, while in other areas fleets may be geographically isolated from other fleets. For example, in the western Pacific there are large fleets of vessels that confine their fishing to the area around the Philippines or Indonesia. It may therefore be necessary to consider the establishment of sub-

regional registers to allow for these differences in the distribution of fleets. In such cases additional control measures applied, *e.g.* closed areas, would be needed.

The RVR, which would be maintained by the appropriate regional tuna body, would include information on each vessel, which would be provided and verified by the flag states. The information should *inter alia* include:

- Name of vessel
- Registration number
- Type of fishing method
- Previous names and previous flags
- Port of registry
- Registered owners, managers, and/or operators
- Location and year of construction
- Length, beam, and molded depth
- GRT and carrying capacity in tons
- Carrying capacity in cubic meters
- Number and power of main engine(s)

To ensure that it is adaptive to changing conditions in the fishery, a key feature of any RVR system would be allowance for vessels to be transferred 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 intent of the IATTC system is that the capacity quota stays 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 would drop substantially, 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 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 must be 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 changing efficiency, there is also the need to reduce fleet capacity in all of the fisheries because there is currently more capacity available than is needed to harvest all the species of tunas except skipjack at AMSY levels. At the outset, any RVR list instituted will provide for more capacity than needed for the fishery. An obvious means of achieving these reductions would be to remove vessels from the register, and the most commonly considered approaches would be through attrition or a buy-back program. Tuna vessels have a long operational life, so reduction of fleet capacity by attrition is not practical. This leaves buy-backs as the most likely option.

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 *et al*. (1999), Clark and Munro (2003), anf Curtis and Squires (in press), 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.

When an RVR system is initiated there would be more vessels on the register than needed to harvest the tunas at the AMSY level. A buy-back scheme could be used to reduce the fleet size to more optimum levels. 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. For example, the current fleet limit for the EPO is for 243 vessels with a total carrying capacity of approximately 185 thousand tons. The target carrying capacity for the area is about 135 thousand tons. Since the modal vessel capacity is about 1,000 tons, the fleet should be reduced by approximately 50 vessels (or more if there was a disproportionate number of small vessels in the buy-back group). At current vessel prices this represents a buy-back valued at approximately 200-300 million U.S. dollars. It would be unrealistic to think that the industry would be willing or able to make such payments at the outset of the program. However, after the removal of 50 vessels through buy-backs, the catch per vessel and corresponding profitability per vessel would increase and the industry would probably be a willing to fund further buy-backs to compensate for increases in fishing capacity. 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.

If each regional tuna body established an RVR along the lines outlined above there would be a global limit on purse-seine fishing capacity. However there would need to be some coordination among the regional tuna bodies to prevent problems from arising such as having the same vessel on more than one register.

5.1.1.2 A global register

If each of the regional tuna bodies establishes an RVR these bodies 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 on the world's oceans, and, by default, identify any vessels without such authorization, which would be deemed IUU vessels; second, it would prevent vessels from 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 all the 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, such as FAO or the World FishCenter.

5.1.2 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 number of vessels authorized to fish. Like an RVR scheme, licensing vessels to fish even if the number 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 their share (or, preferably, more than their share) of the harvest and to improve the efficiency of their vessels will remain as long as the amount of fish each fisherman 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), 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 it would be 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 the entry of additional vessels into the fishery of the region. The results would be essentially equivalent to an RVR without a buy-back provision. 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 in the program 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. 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 would probably 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 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 should have).

Joseph (2005) has suggested that auctions be used to sell predetermined numbers of fishing licenses in order to manage tuna fleet capacity, but this approach has not yet been applied. 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 fishing 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 need 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 regional tuna body 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 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.

5.2 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.

5.2.1 Allocating the allowable catch

The assignment of catch quotas, as shares of the TAC, can result in a self-regulating mechanism to control capacity, particularly when the quotas are assigned to individual operators. 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 permanent or temporary loss of one or more of his vessels.) If the quota were assigned to a nation, or 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 capacity of their vessels.

Who gets what share of a limited resource has always been a problem for humankind and has been the reason for major conflict among individuals, bands, tribes, nations, and various other enclaves of peoples over the history of civilization; in some cases these differences have led to armed conflict. Disputes over fisheries resources have not escaped such conflicts. Some nations have been able to resolve problems of allocation within their national fisheries, but in multinational tuna fisheries that has been much more difficult to do. If governments are to reach agreement on allocation, each of them 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. These have been discussed in **Section 4.3** of this report and in more detail by Joseph (2003). 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 in question and how much of the resource is caught or occurs in the EEZs of the nations participating, or wishing to participate, in the fishery. 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. This concept has been written into a number of studies of allocation criteria and into international instruments dealing with fisheries, but a clear definition of what constitutes a genuine and/or legitimate interest is lacking.

In addition to the difficulties discussed above, the issue is complicated by the fact 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 seldom taken in mixed-species sets of purse-seine vessels. Matters are further complicated by the fact that the vessels of same 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, Colombian, Mexican, and Venezuelan and Colombian vessels fish mostly for

tunas associated with dolphins (almost all medium to large yellowfin), while Ecuadorian and Spanish vessels fish mostly on tunas associated with FADs (mostly skipjack, but with significant amounts of small to medium bigeye and yellowfin). Yellowfin and bigeye are 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 strata of area, species, and mode of fishing. Squires *et al.* (1998) 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.

Assigning allocations to nations has frequently been discussed. All nations with genuine and/or legitimate interests in a fishery would be included in the program. Most or all of the principal market species of tuna would 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 TACs 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 the AMSYs 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, Ecuador would require a greater portions of the skipjack and bigeye TACs, while Mexico would require a greater portion of the yellowfin TAC.

In allocating to catches to nations, if there are no limits placed on the numbers of vessels that can participate in the fishery, there might be a tendency for capacity to increase, through either the addition of more vessels or increases in efficiency. This could be overcome in the nations that limited the 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 the fully-exploited yellowfin and. An overall catch limit including all three species might not work because fishermen might direct their effort mostly toward yellowfin and bigeye, for which they receive higher prices, which would result in overfishing of those two species. Furthermore, the abundances 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. In the EPO, for example, yellowfin are caught in association with dolphins over a wide area of the EPO, but bigeye and skipjack, particularly the former are caught mostly between about 5°N and 5°S. Second, as stated previously, vessel 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 result in a total TAC for the region that would equal the overall 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 (say, six) 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 determing 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.

5.2.2 Transferability of quotas

Economists, *e.g.* 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 to 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.

6. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

It is abundantly clear that the world's fleet of tuna purse-seine vessels has grown well beyond the level needed to harvest the principal market species of tunas, with the exception of skipjack, at levels corresponding to their AMSYs, and skipjack at levels necessary to meet the demand for that species. This overcapacity has caused severe economic problems in many of the tuna fisheries, and has made it difficult for the regional tuna bodies to implement effective measures to manage the tuna stocks, which has resulted in levels of exploitation exceeding those corresponding to maintenance of the stocks at AMSY levels. Most of the stocks of bluefin tuna are overexploited. All of the stocks of yellowfin are fully exploited, and cannot sustain increased levels of fishing mortality. It appears that bigeye tuna in the Atlantic and Pacific Oceans, and probably in the Indian Ocean as well, are being harvested at unsustainable levels. In addition to the overcapacity in the purse-seine fisheries, it is apparent that there is too much capacity in the longline fisheries as well. As a result, longline fishing is barely profitable (Miyake, 2005b).

The problem of overcapacity has become so severe in the tuna fisheries that the industry itself has taken measures to address the issue. The WTPO has called for a moratorium on the construction of tuna purse-seine vessels, and the Organization for Promotion of Responsible Tuna Fisheries, an industry organization, has moved to reduce the number of large-scale longline vessels by 20 percent. Although these initiatives have fallen short of their objectives, they nevertheless demonstrate the seriousness of the overcapacity problems in tuna fisheries.

In efforts to correct the problem all of the regional tuna bodies have initiated programs to limit fishing capacities. In 1998 the IATTC began negotiations to limit the number of purse-seine vessels operating in the EPO to then current levels, and in each year since then has attempted to strengthen the programs to limit capacity. The RVR developed by the IATTC is a move in the right direction, but it has not yet to resolved the problem. Between 1998 and 2006 the carrying capacity of the purse-seine fleet in the EPO has increased by about 35 percent. The problem of transferability of individual capacity quotas has not yet been fully resolved, is limiting the success of the program. For example, when the owner of a vessel flying the flag of Nation A participating in the RVR program sells that vessel to a buyer in Nation B that participates in the program, Nation A has often retained that vessels quota , rather than transferring it to Nation B. If the vessel continued to fish, it would be classified as an IUU vessel. If Nation A replaced that vessel, it would add to the already excess capacity. The efforts of ICCAT to limit fishing capacity have been mostly in the form of recommendations to member and participating parties that they not increase their fleet capacities beyond certain designated levels. These designated levels were often chosen as those of the years with greatest capacity and/or greatest catches. The methods employed for monitoring changes in capacity have not been effective, and controls on fleet growth have met with limited success. The situation for the IOTC is developing in a manner similar to that of ICCAT. In the WCPO, where the largest single purse-seine tuna fishery in the world takes place, an initiative to limit fishing effort, but not fleet size, is underway. It is still too early to know whether this program will preventing overfishing, but it is certain that it does not directly address the problem of overcapacity, which represents a waste of capital that could be better directed at some of enterprise.

The construction of longline vessels that are less than 24 meters in overall length, but capable of fishing on the high seas and air blast-freezing their catches so as to make them acceptable for the market for *sashimi*-grade fish is contributing to the overcapacity problem, as these vessels, unlike those more than 24 meters in overall length, are not subject to limitations directed at reducing longline fishing capacity. This has resulted in an increase in the construction of these smaller longline vessel. Unless addressed, this situation can reduce the effectiveness of attempts to control longline fishing capacity.

It is generally agreed that the concept of open or unlimited access to tuna resources has led to too much fishing capacity, resulting in overfishing of some species and waste of capital. To resolve this tragedy of the common, nations must move away from this open-access practice and develop systems that assign use or property rights to the participants in international tuna fisheries. The assignment of these rights is a formidable task because of the difficulty in determining what the rights should entail, how they should be assigned, and how those with a genuine and/or legitimate interests in the fishery, but not assigned property rights, should be treated. Several approaches to limiting fishing capacity in a fishery in which use or property rights have been

assigned are presented in this report. Some of these approaches include incentives for limiting fishing capacity, and, as such, are self–regulating, while others do not include such incentives. The difference is whether the right provides an opportunity to fish, or whether it provides a limit on the quantity of fish that can be taken. In the former case, there would be a race to take as great a share of the catch as possible before the season ended, resulting in a tendency to increase the fishing capacity. In the latter case, a vessel owner would have no incentive to increase the fishing capacity of his vessel(s) beyond that necessary to harvest his quota. On the one hand, the non-self regulating approaches include systems that provide authority or licenses to fish through some sort of assignment or through competitive bidding. On the other hand, the self-regulating approaches allocate shares of the catch to nations, enterprises, or individuals. The key to the success of either of these approaches is the inclusion of ITQs. An ITQ, when coupled with the allocation of catch quotas, would eliminate the incentive to increase capacity and would provide for the entry of have-not into the fishery by allowing them to purchase ITQs. It would also provide the opportunity for groups that are opposed to fishing to purchase ITQs and set them aside in order to reduce fishery-induced mortality of target, bycatch, and/or icon species.

Based on the information presented in this report, it appears that the most efficient means of controlling fishing capacity and managing the tuna resources of the world would be to institute a system of ITQs. This would 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. This would ensure that the fisheries were prosecuted on a sound economic basis, and would ease political tensions among nations operating vessels in the fishery. However, judging from the extended time it has taken for individual nations to develop licensing schemes with buy-back provisions and/or ITQ systems of management, it would be optimistic to think that similar systems could be developed quickly for the complicated multi-national tuna fisheries. However, we are at a pivotal point in history of tuna fisheries. 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 AMSYs. 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 tha t the tuna stocks that are currently overfished will become further overfished and that those that are currently maintained at sustainable levels will become overfished. In addition, there will further waste of capital. Catch and effort restrictions will be inadequate to conserve these resources. We must act now to halt the growth in fleet capacity, and establish measures to reduce that capacity over the longer term. To achieve these goals, the following actions respecting purse-seine vessels might be considered:

First, all of the regional tuna bodies should agree to moratoria on the building of new purse-seine vessels for tuna fishing. The tuna industry itself has called for a moratorium, 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.

Second, the development of RVRs within each regional tuna body, as outlined in **Section 5.1.1**, 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 the regional tuna bodies, they could work together to develop a global RVR, which would provide a means of monitoring global fishing capacity and preventing slop-overs 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, without doing serious damage to the resources until those more efficient systems are established.

Third, once the 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, as outlined in **Section 5.2**. 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, there would be no incentive for capacity growth, 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 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.

Fourth, 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 should 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.

Fifth, purse-seine vessels take about 60 percent the world catches of tuna. The alternatives discussed above for limiting fishing capacity have been presented in the light of application to purse-seine fleets. If the issues of fishing capacity and effective conservation are to be resolved controls must be applied to much of the remaining 40 percent of the world's tuna fleet. It has already been mentioned that the fishing capacity of the large-scale longline fleet should be reduced by about 20 percent. The industry has been attempting to address this problem, but its efforts have not been completely successful. Also, as mentioned above, the construction of longline vessels that are less than 24 meters in overall length, but capable of fishing on the high seas and air blast-freezing their catches so as to make them acceptable for the market for *sashimi*-grade fish is contributing to the overcapacity. Pole-and-line vessels account for about 15 percent of the world catch of tunas. These vessels catch mostly skipjack, which are not overfished, but, in addition, they catch substantial portions of the world catches of albacore, and also yellowfin and bluefin. Relatively little research has been done on the pole-and-line fisheries for tunas. Nevertheless, rather than waiting for the results of such studies, the moratorium and RVR approaches suggested for purse-seine vessels should be applied to longline and pole-and-line vessels at the same time. In this way, 90 percent of the excess capacity problem would be

addressed. The remaining 10 percent of the 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 large 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, at the beginning of 2007 an excellent opportunity will exist to initiate an action plan to control fishing capacity in the world's purse-seine fleet. In 1999 the Food and Agriculture Organization (FAO) of the United Nations approved an International Plan of Action for the Management of Fishing Capacity (IPOA-CAPACITY), which called on states and regional fishery bodies to achieve efficient, equitable, and transparent management of fishing capacity worldwide, preferably by 2003, but no later than 2005. More than five years have passed since the approval of this action plan. For tuna, with the exception of some limited success by the IATTC, little has been done to comply with the IPOA-CAPACITY. Purse-seine fleets have continued to grow, and, in the EPO, notwithstanding the fact that a program to limit capacity has been in effect since 1998, carrying capacity increased by 35 percent between 1998 and 2006. This failure to implement the recommendations of the IPOA-CAPACITY agreement places in jeopardy the tuna resources of the world. An excellent opportunity to correct this situation will be at the forthcoming meeting of regional tuna bodies to be held in January 2007 in Tokyo, Japan. At that time all of the executives and directors, plus key members of the plenary bodies of these organizations will meet to discuss a variety of issues related to the operation of these organizations. Since there is worldwide agreement that overcapacity exists in the tuna fisheries and that these excesses, unless corrected, are likely to result in overexploitation or further overexploitation of these valuable resources and in further overcapacity, priority should be given to outlining a plan of action to limit, and ultimately reduce, fishing capacity. Such a plan of action should include, as a first step, an agreement to set a moratorium on the entry of purse-seine and longline vessels into tuna fisheries, with implementation of the moratorium no later than January 2008. As a second step, the meeting should agree to implement a global RVR with transferability for purse-seine, longline, and pole-and-line fleets, or an equivalent program, within two years of implementation of the moratorium. Buy-back programs should be considered as part of this process. A third step would be to agree to undertake studies to examine the possibility of developing an ITQ system for tunas, including a provision for handling small coastal fisheries.

This outline of action may appear to be ambitious, and also presumptive on the part of the authors, 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 a 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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