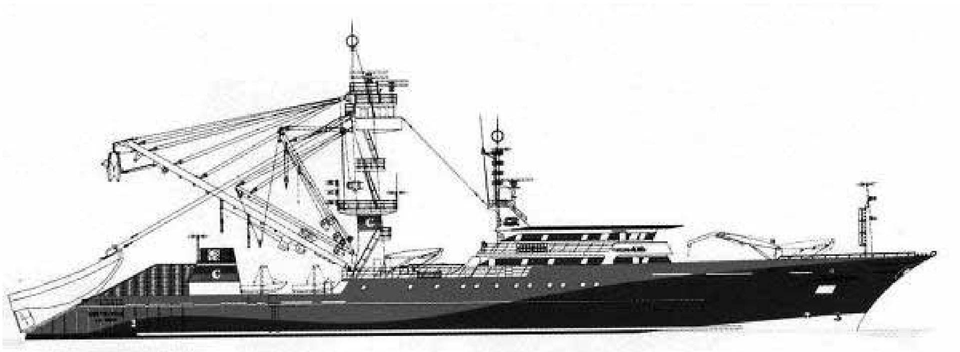
Western and Central Pacific Fisheries Commission

1st Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission
WCPFC–SC1
Noumea, New Caledonia
8–19 August 2005

WCPFC–SC1 **FT IP–5**

Past developments and future options for managing tuna fishing capacity, with special emphasis on tuna purse seine fleets



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FAO, Rome, Italy

August 2005

Past developments and future options for managing tuna fishing capacity, with special emphasis on purse-seine fleets

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ABSTRACT

There has recently been a great deal of concern expressed by regional tuna fisheries management organizations, governments and the tuna fishing industry that there is excess fishing capacity in the world's tuna fleets, which could lead to overfishing of some populations, such as yellowfin and bigeye, and to harvests of skipjack in excess of demand, resulting in reduced ex-vessel prices.

Analyses have shown for the world's purse-seine fleet that fishing capacity, measured as the ability of vessels or fleets to catch fish, is greater than that needed to sustain current levels of harvest. Although similar analyses have not been conducted for other gear types, the longline industry has initiated measures to reduce capacity of large-scale longline fleets by 20 percent.

There have been several efforts by regional tuna bodies to implement measures to limit the capacity of some tuna fleets operating in their respective regions. The most comprehensive of these has been the Regional Vessel Register (RVR) of the Inter-American Tropical Tuna Commission (IATTC).

In the present study, two categories of options for managing fishing capacity, particularly for purse-seine fleets, are presented: 1) open-access and common property-based options, and 2) limited-entry and rights-based options. The first category includes the options of *i*) maintaining the status quo and *ii*) reducing capacity by closing off part of a vessel's fish-storage space, but not its fishing power, or requiring vessels to remain in port at the end of each trip for periods longer than necessary for unloading the catch and re-supplying the vessel. Neither of these options is considered to be an effective means of addressing the capacity problem. The second category includes *i*) an RVR similar to that of the IATTC, but with a vessel buy-back option, *ii*) a self-regulating measure that assigns individual quotas and *iii*) licensing schemes, including fractional licences and the use of auctions for the sale and transfer of licences.

It is concluded that the common-property and open-access nature of tuna fisheries has been a major cause of excess capacity in these fisheries, and that moving away from these concepts toward rights-based management schemes might resolve the problems of excess capacity.

Because the process of developing acceptable measures to reduce capacity will be slow and difficult to achieve, it is recommended that the regional tuna bodies strengthen and/or implement as soon as possible moratoria on the growth of capacity in all industrial-scale tuna fisheries. It is also recommended that the regional tuna bodies work together

to establish a list of all medium- and large-scale tuna vessels, including the vessel characteristics and specifications needed to monitor world tuna fishing capacity.

1. INTRODUCTION

Over the last several years there has been a great deal of attention given to the problem of excess capacity[1] in fisheries (Gréboval and Munro, 1999). This has led to the development of an International Plan of Action for the management of fishing capacity (IPOA-CAPACITY), which was approved in 1999 by the Food and Agriculture Organization (FAO) of the United Nations (Cunningham and Gréboval, 2001). The IPOA-CAPACITY 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. Although the IPOA-CAPACITY did not specifically or uniquely address the issue of tuna fishing capacity, tuna fisheries are apparently suffering the same woes of excess capacity as are most other fisheries. This general concern over excess capacity in the world's tuna fisheries has been expressed by all of the regional tuna bodies. For the most part, these regional tuna bodies have initiated measures to address the problem of excess capacity. In addition, the tuna industry itself has expressed concern, and, indeed, has initiated, in some cases, measures to mitigate the problem.

The problem of excess capacity in the world's tuna fleets was the object of a study by Joseph (2003), who attempted to show for the eastern Pacific Ocean (EPO), and, by inference, for other areas, that there was more purse-seine tuna fishing capacity than needed to harvest the available resources. In that study, he presented a series of ideas that might be considered in the search for effective mechanisms for managing capacity.

In response to this growing concern over excess capacity in the world's tuna fisheries, during the latter half of 2002 FAO started a project on management of tuna fishing capacity. The objectives of the project are to provide technical information necessary for addressing problems associated with the world-wide management of tuna fishing capacity, taking into account conservation of the tuna stocks and socio-economic issues. Majkowski (2003) defined the project's activities to consist of 1) technical work preparatory to an Expert Consultation on Management of Tuna Fishing Capacity, 2) a consultation to review and integrate the results of the preparatory work and to formulate conclusions and recommendations, and 3) dissemination of these findings. To assist FAO in achieving its objectives regarding the project, a Technical Advisory Committee on capacity (TAC) was established to provide technical advice on the best way of implementing the project. The motivation for the present paper is to provide background information to the TAC, which, in turn, will provide advice to FAO and the Expert Consultation on Management of Tuna Fishing Capacity on measures for limiting fishing capacity in the world's tuna fisheries.

Since the preliminary work of Joseph (2003), several more comprehensive studies have been completed, many as a result of the work of the TAC, dealing with trends in the capacity of tuna fishing fleets and with the measurement of fishing capacity in the world's purse-seine and longline fleets (Gillett; Reid *et al.*; and Miyake, this collection). The studies, which are reviewed in Section 2 of this report, conclude that there is more capacity in the world's purse-seine and longline fleets than is needed to take the current levels of catch. In other words, the levels of catch being made in these fisheries today could be taken with significantly less capacity. For the purposes of this paper the

[1] In terms of an input indicator such as potential fishing days, excess capacity exists when the actual days fished by a fleet are less than the potential days fishing that that same fleet is capable of generating if fully utilized.

conclusions of Reid *et al.* (this collection), will be considered accurate, and it will be assumed that there is excess capacity in the world's purse-seine fisheries.

As stated in Joseph's (2003) review, there have been several initiatives taken by regional tuna bodies, and by the tuna industry, to address the problem of excess capacity. Notable among these is the program of the Inter-American Tropical Tuna Commission (IATTC) to limit purse-seine capacity in the EPO, the efforts of the International Commission for the Conservation of Atlantic Tunas (ICCAT) to limit the number of vessels fishing for northern albacore and bigeye in the Atlantic Ocean, the Organization for the Promotion of Responsible Tuna Fisheries (OPRT) to reduce world longline fleets by 20 percent and the efforts of the World Tuna Purse-seine Organization (WTPO) to place a moratorium on the entry of new purse-seine vessels into the world's tuna fisheries. Based on the initiatives of the OPRT, it will be assumed that there is excess capacity in the world's longline fisheries. These topics will be reviewed and updated in Section 3 of this report.

Considering the assumption made above, that there is more fishing capacity in the world's purse-seine and longline fleets than is needed to take current levels of harvest, this paper will examine a series of options that might be considered for managing tuna-fishing capacity. These options, which will be presented in Section 4 of this report, will deal primarily with possible measures for controlling the capacity of purse-seine vessels that normally fish beyond the near-coastal zone and that were included in the analysis of Reid *et al.* (this collection). The current size of the world fleet of large purse-seiners is about 570 vessels, which capture slightly more than 60 percent of all of the principal market species[2] of tunas taken from the world's oceans. By moving quickly to address the capacity problem in the purse-seine fleet, the potential impact of too much fishing mortality could be averted. However, in any lasting and equitable solution to the capacity problem, all fleets that harvest tunas must be incorporated into capacity-limitation programs. Therefore, although it is not the intention of the author to address the issue of capacity in non-purse-seine fisheries, some attention will be given to these other fleets, particularly the distant-water longline fleets.

In the final sections of this report the author will summarize his findings with respect to possible options for managing fishing capacity, and, as appropriate, address recommendations to the TAC, regional tuna bodies, national fishery administrations and the private sector.

2. A REVIEW OF ESTIMATES OF TUNA-FISHING CAPACITY

In this section of the report available information on the current numbers and capacities of tuna-fishing vessels and data on past trends, and also published reports on whether there is excess capacity in the tuna fisheries, will be reviewed. The amount and quality of the information available varies greatly. The most complete and current data are for purse-seine fleets, particularly those that operate primarily in the Pacific Ocean, followed by information on large-scale longline vessels. There is limited information available on capacity in the pole-and-line fleets, trolling fleets and miscellaneous other types of fishing fleets. The only detailed and readily-available information on long-term trends in the capacity of tuna fleets is for purse-seine and pole-and-line vessels in the EPO.

2.1 Defining capacity

Before going further with this discussion, it is necessary to discuss what is meant by the term capacity in this report, since it is defined and used in so many different ways. The

[2] The principal market species of tuna are: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*T. obesus*), albacore (*T. alalunga*), Atlantic bluefin (*T. thynnus*), Pacific bluefin (*T. orientalis*) and southern bluefin (*T. maccoyii*).

term capacity is generally used to reflect what a vessel can catch, or how much fishing mortality a vessel is capable of generating. Most fisheries scientists use some input indicator such as the size of a vessel or its engine power to define capacity because they believe them to be related to the ability of a vessel to generate fishing mortality. The fishing industry most often uses size as a measure of capacity because it is related to how much fish a vessel can catch in a single trip. Economists generally prefer some technological-economic approach, using potential output to measure fishing capacity, because such an approach can be used to compute optimal inputs (Morrison, 1985). The economists' approach 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).

The most common indicators of 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. The GRT of a vessel can be easily changed by changing bulkheads and walls; 2) Net Registered Tonnage (NRT), which is the total of all enclosed space within a vessel available for cargo and expressed in tons. The NRT can also be easily altered by changing partitions; and 3) Fish-Carrying Capacity (FCC), which generally relates to how many tonnes 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 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 (Gillette 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 metres of refrigerated fish storage space, a less pliable measure of how much fish a vessel can carry, is being used more frequently as a measure of capacity.

The FAO Fisheries Department convened technical meetings of experts to address the issues of how to define, measure and control fishing capacity in 1988 and 1999. The primary result of these meetings was to define fishing capacity in terms of potential output. The definition arrived at was that fishing capacity is the maximum amount of fish or fishing effort that can be produced over a period of time by a fishing fleet if fully utilized, given the biomass and age structure of the fish stock and the present state of technology; in other words, it is the ability of a vessel or vessels to catch fish. To facilitate the measurement of excess capacity, which the meetings concluded was the difference between capacity output and a target level of capacity output, target fishing capacity was defined. Target fishing capacity is the maximum amount of fish that can be produced over a period of time by a fishing fleet if fully utilized, while satisfying fishery management objectives designed to ensure sustainable fisheries.

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. A series of such analysis for tuna fisheries have been commissioned by FAO for evaluation by the TAC; the results of these analyses will be discussed later in this section.

2.2 Estimates of capacity

2.2.1 Purse-seine

As noted above, the most detailed information available on the numbers and capacities of vessels is for the tuna purse-seine fleets.

2.2.1.1 Eastern Pacific Ocean (EPO)

Joseph (2003) showed trends in Fish-Carrying Capacity (FCC), measured in tonnes, for the purse-seine fleet of the EPO for 1960-2001. These statistics have been updated for 1961-2002 and expressed in cubic metres of well volume (IATTC, 2004). In 1961 there were 125 purse-seine vessels with an average capacity of 256 cubic metres, and a combined FCC of 32 thousand cubic metres. By 1980 the average capacity of the purse-seine vessels had increased to 726 cubic metres, and the combined FCC to 196 thousand cubic metres. During this period of fleet expansion the catches of tuna, after reaching the highest levels then recorded, began to decline as a result of the excess fishing mortality generated by this very large fleet. Because of reduced stock abundance and poor catches, much of the fleet left the fishery during 1980-1984. After the stock of tuna recovered, many, but not all, of the vessels returned to the fishery in 1985-1986. Between 1984 and 1996 FCC averaged about 130 thousand cubic metres. During this period catch rates per vessel were high, which attracted new investment in vessels. Capacity began to increase, and by the end of 2002 it reached about 200 thousand cubic metres, the greatest in the history of the fishery. There has been concern that these increases in capacity will result in a repeat of the situation during the 1970s, when there was more fishing capacity than needed to harvest the available resources, which caused the catch rates to decline.

To look at the problem of excess capacity, Joseph (2003) applied a linear programming technique, Data Envelopment Analysis (DEA), which was first applied to problems of fishing capacity by Kirkley and Squires (1999) to estimate the technical efficiency and potential catching capacity of the EPO purse-seine fleet. The estimates of fishing capacity from the analysis were based on the greatest observed catches in a year, and took into account yearly changes in stock biomass and sea-surface temperatures. Two analyses were conducted, one for yellowfin alone and one for skipjack, yellowfin and bigeye combined. In both cases the estimated fishing capacity, that is the maximum potential output of the fleet, was greater than the observed catch. For the 1970-2000 period, the ratio of the combined annual catch of skipjack, yellowfin and bigeye to the DEA-estimated fishing capacity, which is a measure of capacity utilization, was between 0.5 and 0.7, indicating that there was excess capacity in the EPO purse-seine fleet. In other words, if all the vessels in the fleet operated as well as the most efficient vessels, the observed catches could have been taken with fewer vessels than operated in the fishery. It was concluded in the study that, even though substantial excess capacity existed in the fishery, it was probably overestimated because individual vessel data were not used and yield curves, including estimates of average maximum sustainable yield (AMSY) were not incorporated into the analyses. In addition to these estimates of excess capacity in the fishery, the IATTC has estimated that the fleet is probably about 25 percent greater than that needed to take current levels of catch.

In a more recent DEA study for the EPO, Reid *et al.* (this collection), estimated capacity output and technical efficiency for the purse-seine fleet during 1998-2002. They found that excess capacity for combined catches of skipjack, yellowfin and bigeye, defined as capacity output minus observed landings, exists for all vessel size classes. Between 1998 and 2002, excess capacity, purged of technical efficiency, increased by about 60 percent. In terms of capacity utilization (CU), the ratio of landings to capacity output, current levels of catch in the EPO could be taken with a fleet that is between 60 and 75 percent of its current size.

2.2.1.2 Western and central Pacific Ocean (WCPO)

Gillett and Lewis (2003) estimated the numbers and carrying capacities of purse-seine vessels participating in the tuna fishery of the WCPO during 1988, 1995 and 2003. They considered any vessel with a capacity greater than 400 cubic metres that fished during the year to be participating in the fishery in that year, and excluded vessels that fished only in the Exclusive Economic Zones (EEZs) of Indonesia, the Philippines, Australia, New Zealand and other countries of the WCPO. For 1988, they estimated that there were 136 purse-seine vessels with a combined capacity of 140 thousand cubic metres (average capacity equal to 1073 cubic metres). For 1995, they estimated that there were 175 vessels, with a combined capacity of 200 thousand cubic metres (average capacity equal to 1143 cubic metres). By 2003 the number of vessels had increased to 191, with a combined carrying capacity of 233 thousand cubic metres. This represents a growth of 66 percent between 1988 and 2003 in the capacity of the purse-seine fleet in the WCPO.

Joseph (2003) also estimated the numbers and capacities of purse-seine vessels operating in the western Pacific Ocean, but his estimate for 2000 was greater than that of Gillett and Lewis (2003). This is particularly evident if the figures expressed in the Joseph study are converted to cubic metres, to make them comparable to those of Gillett and Lewis figures; the conversion would increase the estimate by about seven percent. This was probably due to several factors. First, vessels over 250 tonnes of carrying capacity were counted in the Joseph study, whereas only vessels over 400 cubic metres were counted in the Gillett and Lewis study. Second, some vessels that fished only in domestic waters were included in the Joseph study, whereas these were not included in the Gillett and Lewis study. Third, Gillett and Lewis considered they may have underestimated capacity by about ten percent.

Similar to the situation in the EPO, the growing fleet size and increased catches in the WCPO, and the recent extremely low ex-vessel prices paid for canning-grade tuna worldwide, have led to concern on the part of many of the nations involved in the WCPO fishery as to whether there is a potential problem concerning the size of the purse-seine fleet in the fishery. Reid *et al.* (2003), provide some insight into this problem. They used catch data by set type (sets on floating objects, payaos and schools) within categories of vessel size and DEA to estimate potential catches under observed levels of fishing effort. They used two approaches regarding the number of sets per day and the types of sets made by an average vessel. In one analysis, technical efficiency, or skipper skill, was purged, and in the other it wasn't. Analyses were run for each national fleet and for all fleets combined. For all fleets combined the "non-purged" analysis estimated that if all vessels worked at the full-capacity level the annual catches taken during 1997-2000 could have been taken with 77 percent of the actual effort expended. Alternatively, if all vessels worked at their fleet's best-practice production frontier by using the appropriate level of variable inputs and were fully technically efficient, the observed number of fishing days during the same period would have produced 25 percent more catch. When the number of sets per day was fixed and technical efficiency or skipper skill purged, the excess capacity is estimated to be much less. In this case, if effort days were reduced by seven percent the same catches during 1997-2000 could be made. Alternatively if all vessels operated at the production frontier level, the same number of days generated during 1997-2000 would have harvested eight percent more fish. These results suggest that the recent levels of catch observed in the fishery could have been taken with a smaller fleet, or that the current fishery has a capacity in excess of what is needed to take current levels of harvest.

In a more recent study, Reid *et al.* (this collection), confirmed the results presented in the earlier study mentioned above, and concluded that if WCPO vessels operated efficiently, fully utilizing their variable inputs, and harvesting the average annual reported levels of landings, fleet sizes could be reduced by around 12 percent.

2.2.1.3 Atlantic Ocean

Joseph (2003) estimated that there were approximately 53 purse-seine vessels with a carrying capacity of about 48 thousand tonnes that were available to fish in the Atlantic Ocean during 2000. Most of these vessels were in the 800- to 1200-tonne class. Data on long-term trends in fleet carrying capacity have not been generally available for the

Atlantic. However, Reid *et al.* (this collection) were able to obtain some data on purse-seine fleets with which they could extend their DEA studies to the Atlantic Ocean. They found excess capacity to exist, but that it was not as severe as those for some of the other oceans. They concluded that if vessels operated efficiently, fully utilized their variable inputs, and harvested the average annual reported level of landings, fleet size could be reduced by about 13 percent.

2.2.1.4 Indian Ocean

The purse-seine fishery in the Indian Ocean did not develop significantly until the early 1980s, when French and Spanish vessels began to fish for part of the year in the Indian Ocean. Detailed estimates of the number of vessels that operated in the Indian Ocean are not readily available, but Joseph (2003) estimated that in 2000 there were approximately 67 purse-seine vessels with a carrying capacity of nearly 130 thousand tonnes available to fish in the Indian Ocean. Most of these vessels had capacities of more than 1800 tonnes. Using aggregated data for 1981-2002, Reid *et al.* (this collection), estimated that the current fleet size for the Atlantic could be reduced by about 23 percent without reducing the recent average levels of catches of skipjack, yellowfin, bigeye and albacore. They stressed that for both the Atlantic and Indian Ocean the estimates of capacity output are extreme lower-bound estimates.

2.2.2 Longline

Longline vessels operate wherever tunas are found throughout the oceans of the world. The large-scale longliners fish primarily for the *sashimi* market; their catches are frozen at ultra-low temperatures, and fishing voyages may last up to a year. Although most of the regional tuna organizations attempt to maintain lists of large-scale longline vessels that operate in their areas, the lists are not adequate for examining trends in fleet capacity.

Miyake (this collection) has estimated the numbers of longline vessels currently fishing for tunas throughout the oceans of the world. He broke his estimates into two groups, small longliners greater than 24 metres, but equal to or less than 35 metres in overall length, and large-scale longliners that are greater than 35 metres in overall length. He estimated that there are currently 1622 large-scale longliners and 1421 small longliners that fish for tunas. In addition, there are 106 large-scale longliners and 503 small longliners that fish primarily for swordfish, but may occasionally fish for tunas.

Miyake also estimated the amounts of tuna taken by these longline fleets. The large-scale longliners annually capture about 390 thousand tonnes of all species of tunas combined, and the small longliners take about 200 thousand tonnes annually. He notes that the economic break-even point for a large longliner is about 240 tonnes of tuna per year, which is very close to the actual per-vessel production per year, and that, because the species of tuna longliners exploit are fully exploited, increased catches cannot be expected. (Longliners also catch billfishes in addition to tunas and, depending on the quantities taken, this could affect the economic break-even point). He concluded that there is excess capacity in the longline fleets of the world, and if capacity could be reduced, catch and earnings per vessel would increase. The fact that the longline fishing industry is undertaking measures to reduce the number of longline vessels by 20 percent is cited by Miyake as clear evidence of excess capacity. As further evidence of the problems of capacity in the longline fleets, Miyake showed that the number of longliners in the Japanese fleet is declining. In 1980 there were 864 large-scale longliners in the Japanese fleet, but this number declined to 503 in 2000. Similarly, the corresponding numbers for small longliners in the Japanese fleet are 554 and 134. Finally, he notes that data on artisanal longline vessels that fish mostly for subsistence purposes are not available, but that the numbers are significant.

2.2.3 Other gear

Purse-seine and longline vessels account for about 75 percent of the world catch of the principal market species of tuna. Of the remaining 25 percent, pole-and-line vessels account for about 18 percent and miscellaneous other gear for the rest. Obviously, for any management schemes to be effective, all significant gear types must be considered. However, there have been few analyses of the impact of these other gear types on the problems of excess capacity. There are few data available on trends or current levels of capacity for these gear types.

In studies on the control and management of fishing capacity in the world's tuna fisheries, the TAC was interested in evaluating the impact of small-scale and artisanal type fisheries on measures to control fishing capacity. After considering this matter, it was decided that it would be virtually impossible to estimate the capacity of small-scale and artisanal fleets, given the complexity of such fisheries and the time and cost needed to complete such a study. Therefore, it was concluded that an estimate should be made of how much tuna these small-scale and artisanal type fisheries harvest annually, so that information could be used to evaluate their importance to any efforts to manage fishing capacity. Consequently the FAO commissioned a study to look at this problem (Gillett, this collection). In his report, Gillett notes "Rather than attempting to formulate a clever definition of small-scale/artisanal tuna fishing and then apply it globally to tuna fisheries, it may be more appropriate to establish a boundary for information to be collected by this study in accordance with objectives of the FAO tuna fishing capacity work. That is, the boundary should be established in view of the aim of knowing the level of catches of all tuna fisheries for which capacity estimation is not possible". He divided tuna fisheries into industrial and non-industrial categories. Non-industrial fisheries were subdivided into small-scale and medium-scale components. Industrial and small-scale fisheries were defined by gear and/or vessel attributes. The small-scale category included handlines, trolling from open vessels, rod and reel, recreational fishing, and the use of undecked, unpowered or sail vessels, or vessels powered by outboard engines. Medium-scale fisheries were considered to be those that fell between industrial fisheries and small-scale fisheries. Gillett estimated that about 320 thousand tonnes of the principal market species of tuna are harvested by the small-scale fisheries, but he was unable to estimate the proportion of the catch taken by the medium-scale component. The eight percent of the world catch of the small-scale fisheries is significant enough to require that any effective plan to manage tuna fisheries include this component of the fishery.

3. CURRENT MANAGEMENT MEASURES THAT IMPACT THE CAPACITY OF TUNA FISHING FLEETS

Owing to a number of unique characteristics of tunas and the fisheries for them, their effective management offers several challenges. Tunas are widespread throughout the oceans of the world. Most of the species of tuna undertake extensive migrations that carry them through the jurisdictional waters of many coastal states and onto the high seas, which are beyond the jurisdiction of any single state. If they are to be properly managed any management measure must apply to wherever the tuna are found. It would do no good to provide protection for them when they are in one area if they do not receive equal protection when in another. The fleets that fish for tunas are also very specialized, and very mobile. An entire fleet of vessels can move from a fishery in one region of the world to one in another region with great ease. A single vessel may fish in two or three oceans in a single year. Likewise, the market for tunas is international, the product moving throughout the markets of the world. A small change in production in one area can have an almost instant effect on price world wide. The nations framing the 1982 United Nations Convention on the Law of the Sea (LOSC) recognized the migratory characteristics of tunas, and the uniqueness of the fisheries for them, and called on states with an interest in tunas, including fishing and coastal states, to work jointly through international regional bodies to manage tunas. This concept is included in Article 64 of the Convention, which mandates that nations work cooperatively through regional fishery bodies in managing highly-migratory species, and, where such organizations do not exist, to create them. Highly-migratory species, which include the principal market species of tunas discussed in this report, are listed in an annex to the LOSC. In keeping with the objectives of the LOSC, there are presently Article 64-type tuna bodies in all the oceans of the world (although one of these is not yet operational). These organizations are responsible for managing the tunas.

Until recently, there have been few attempts to manage tuna fisheries by the implementation of input controls, such as limits on the number of days that can be fished or the number of vessels authorized to fish. Most efforts to manage tuna have involved output controls, particularly catch quotas and minimum size limits. The success of output controls in conserving tuna stocks has been limited because they have not controlled the number of vessels that can participate in harvesting the allowable catch. In fact, in the few examples in which catch quotas have been applied to tunas, they have frequently stimulated fleet growth rather than limiting it. So long as there is open access to the resource being managed there is an incentive for fishers to increase their opportunity to take a greater share of the allowable harvest by adding to their fishing capacity, either through the addition of new vessels, by increasing the efficiency of the vessels already operating in the fishery, or both. This tendency of input substitution or "capital stuffing", as it is referred to by Cunningham and Gréboval (2001), has been a major problem in fisheries management in general, and the tuna fisheries have not been immune to it. In the following paragraphs the various efforts of nations, international organizations and the private sector to manage tuna fisheries are discussed.

3.1 Governmental and intergovernmental arrangements

3.1.1 Early efforts by Japan to limit the number of longline vessels in its fleet

In an effort to stimulate economic growth after World War II, the Japanese government directed considerable effort toward developing its fisheries. High-seas tuna fleets were one of the primary targets for growth, and by the latter part of 1960 Japanese longline vessels fished throughout the oceans of the world. The fishery was profitable, and attracted increasing investment in vessel construction. The increasing number of vessels and the growing labor costs eventually 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 high. However, because the tuna species targeted by the Japanese longline fleet are found throughout the oceans of the world, and because they constituted at that time a common property resource available to whomever could catch them, the action taken by the Japanese government was not successful in halting fleet growth. Japanese expertise and capital was invested in the construction and operation of longline vessels in nations that had placed no controls on fleet growth. This flow of capital stimulated the development of large fleets of longline vessels in the Taiwan Province of China and the Republic of Korea, and, more recently, China and Indonesia.

It became abundantly clear from the failure of the Japanese attempt to unilaterally resolve the problem of excess capacity that any effective program to limit fleet size and growth would have to involve all states with vessels participating in the fishery.

3.1.2 The Inter-American Tropical Tuna Commission (IATTC)

In 1966 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 driven to below the level of abundance at which it could support the AMSY. This event marked the first time that an international high-seas fishery had come under conservation controls. At the time the purse-seine fleet consisted of about 40 thousand tonnes of carrying capacity, and nearly all of it was under a single flag. 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 at which the current catch, plus the expected catch to be taken by vessels that were at sea at closure, plus catches taken under special allocations, plus the expected catch to be taken incidentally when fishing for other species, equaled the catch quota.

The conservation program stimulated vessel owners to add capacity, rather than to reduce it. Because yellowfin abundance remained high as a result of the conservation quotas, catch rates remained high as well. Processors, faced with a limited supply of raw material, raised prices. Profitability for the vessel operators was high. This attracted new investment in vessels, and capacity continued to grow. As a result of the growth in capacity, the season for unrestricted fishing decreased from 10 months to less than 4 months as more and more vessels raced to catch as much as they could before the season for unrestricted fishing was closed. Pressure to increase catch quotas beyond the recommendations of the scientists mounted. Most of the catch was taken by a single nation, 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 smaller fleets of smaller boats and could not compete. This resulted in intense negotiations among the nations with interests in the fishery to allocate shares of the quota to coastal states. 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.

Because of their highly-migratory nature, and the fact that at that time most nations subscribed to a narrow coastal jurisdiction, tuna were considered to belong to whomever could catch them. However, in the mid- and late-1970s most of the world had moved to or was moving toward extended jurisdictions. Because coastal states under this regime of extended jurisdiction controlled access to a significant, if not a major, share of the world’s tuna resources, their position regarding special recognition in sharing of the resources was strengthened. By 1978 the purse-seine fleet in the EPO increased to about 192 thousand cubic metres of carrying capacity, an increase of 500 percent over that of 1961. Pressure from all sides for increased catch limits and increased allocations was so great that agreement could not be reached on implementation of a catch quota, which 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 catch rates were so low that vessels could not meet operating expenses. (This transfer of the fleet to other regions had a serendipitous affect on tuna production, because at that time tuna stocks in other ocean areas were mostly underexploited, and the developments by this transferred fleet led to new tuna supplies. However, the situation has now changed; there are no new frontiers for tuna production). This situation continued, and fishing effort in the EPO remained low until the mid-1980s, by which time yellowfin abundance had increased to above AMSY levels and vessels began to return to the fishery. In 1985 purse-seine carrying capacity was 138 thousand cubic metres, and catch rates and profits were high. The size of the fleet was in balance with the ability of the yellowfin stock to sustain 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.

Recognizing that the pattern of fleet growth was repeating that of the 1970s, in 1987 the Director of the IATTC began calling for 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 resulted in increased fishing effort on yellowfin, requiring conservation limitations to be implemented so the stock would not be overfished. It also resulted in substantial increases in the catch of small bigeye tuna, resulting in measures to limit the fishing effort on small bigeye taken by the surface fishery. Until 1999 none of the conservation measures that were implemented resulted in limiting or halting the growth of the fleet. In fact, it seemed that the mere introduction of the idea of limiting capacity stimulated fleet growth. Those without fleets or with small fleets wanted to establish a larger presence in the fishery before they were prevented from doing so by the introduction of capacity-limitation measures.

By the end of 1998 the purse-seine fishery for tunas in the EPO was probably the most regulated tuna fishery in the world, and possibly one of the most regulated of any 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, quotas on how many dolphins could be taken in the fishery for tuna 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. It was clear that such "micromanagement" of the fishery would likely result in failure to sustain a conservation program and failure to fulfill the objective of maintaining the populations at AMSY levels. Consequently the governments with an interest in the fishery decided to work through the IATTC to implement measures to put a halt to the growth in fleet, and eventually reduce it to more manageable levels. After a year of negotiations among the members of the IATTC and other interested governments, the first measures to limit purse-seine fleet capacity in the EPO fishery were implemented in 1999. The resolution defining the capacity-limitation program assigned purse-seine carrying capacity limits 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 limits. The most important was the level of catches taken by each of the 13 nations during 1985-1998. Other factors that were considered were the levels of catch taken within the EEZs of the nations bordering the EPO, the landings of tunas from the EPO in each of the participating countries, and the contribution of each country to the conservation program of the IATTC. For those countries that were participating in the fishery during 1985-1998, the allocations of fleet capacity were approximately identical to the actual fleets operating during 1998. In the case of one coastal state that did not have a fleet, but which had a longstanding and significant interest in the tuna fishery of the EPO, a capacity limit that would allow that nation to acquire a tuna fleet was assigned. There were several other coastal states participating in the negotiations that did not have tuna fleets at the time, but insisted that the agreement provide the opportunity for them to acquire fleets; such provision was made, thereby assuring that capacity limits could be assigned to those coastal states. The total limit set by the resolution for purse-seine vessels in the EPO for 1999 was 158 thousand tonnes of carrying capacity. The staff of the IATTC noted that a carrying capacity of purse-seine vessels of about 130 thousand tonnes was adequate to harvest the current catches of tuna. The actual carrying capacity operating at the end of 1998 was 138 thousand tonnes. By the end of 1999 carrying capacity reached 158 thousand tonnes. 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, and the result was continued fleet growth.

Negotiations to seek a solution to the excess capacity problem continued. Nearly all nations with tuna purse-seine vessels under their flags, and nearly all tuna boat operators, agreed that there was excess capacity in the tuna fishery of the EPO, and that measures were needed to halt the growth in capacity, and to even reduce it. However, agreement to limit capacity could not be reached among the member governments of

IATTC, and capacity continued to grow. By the end of 2002, carrying capacity of the purse-seine fleet in the EPO reached 200 thousand cubic metres, the greatest in the history of the fishery.

In an effort to seek a solution to the problem, the IATTC established a working group to examine alternative means of limiting fishing capacity. Inspired by the FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, and on recommendation of the working group, the Commission approved a resolution in 2000 to establish and maintain a record of vessels authorized by their governments to fish in the IATTC convention area for species under the purview of the Commission. The resolution also called for the IATTC to maintain an inventory of the pertinent characteristics, and features for vessel identification, for each vessel on the Regional Vessel Register (RVR), as called for in the FAO compliance agreement. Once the RVR was established the working group recommended that fleet capacity be restricted to those vessels on the RVR. In June 2002 the Commission approved the Resolution on the Capacity of the Tuna Fleet Operating in the Eastern Pacific Ocean. The Resolution 1) established the RVR as the definitive list of purse-seine vessels authorized by the participants to fish for tunas in the EPO, 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 participants could be entered on the RVR, 4) instructed that 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 provision for five coastal states bordering the EPO to add vessels to the RVR with a total combined capacity not to exceed 20 thousand tonnes and 7) defined a participant as a member of the IATTC, and states, economic integration organizations and fishing entities that have applied for membership or that cooperate in the conservation programs of the Commission.

The concept encompassed in the RVR is that the capacity quotas are assigned to vessels, rather than to governments. The 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 will allow it to grow by about 17 thousand tonnes. It is also the intent of the program to allow vessels on the list to be transferred to other flags, thereby allowing the flag to which the vessels transfers to increase its capacity by that of the transferred vessel, while requiring the flag from which the vessel was transferred to reduce its capacity by that amount. Although this provision for transfer is not abundantly 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".

With the implementation of the RVR, the IATTC has again taken the lead in attempting to introduce innovative and effective management measures for tunas. The RVR provides a mechanism for fixing the fleet of purse-seine vessels operating in the EPO at its current size, with an allowance for minimal expansion to fulfill the needs of several coastal states. An important feature of the arrangement is the provision for allowing vessels to transfer among the participants. Once a vessel is listed on the RVR it is authorized to fish in the convention waters. If a vessel is removed from the RVR by its flag state it can no longer fish in the area. As long as a vessel is on the RVR it can move from flag to flag. When a vessel transfers from the flag of one participant to that of another it stays on the RVR and its capacity "quota" is transferred with the vessel.

Similarly, if a vessel on the RVR is replaced, or its well capacity is increased, a vessel of equivalent size, or an amount of capacity equivalent to the increase in size, 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 changes would result from market forces.

Since implementation of the RVR, the ownership of three vessels have transferred among participants. In each case the states from which the vessels had transferred expressed concern that they would not be able to replace the vessels that had been transferred. Obviously, if this feature of transferability were not retained in the RVR system, it would weaken considerably the effectiveness of the system. The result would be a limit on fleet size that was fixed among nations and could be not changed without difficult and time-consuming negotiations. The IATTC Permanent Working Group on Fleet Capacity will meet in the near future to discuss this issue, and hopefully it will be successful in convincing the participants to retain the transferability feature of the RVR.

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

ICCAT is responsible for the conservation and management of tunas, billfishes and tuna-like fishes in the Atlantic Ocean and adjacent seas. Its first management measures were in the form of output controls, which were a minimum-size limit of 3.2 kg for yellowfin tuna in 1974, and a similar minimum-size limit for bigeye in 1980. The rationale for establishing the minimum size limit on yellowfin was to increase the yield per recruit, while the rationale for bigeye was primarily the fact that bigeye and yellowfin of less 3.2 kg are difficult to distinguish from one another.

Much of the concern over the status of the tuna stocks in the early years of ICCAT'S history was centered on bluefin tuna, which had been heavily exploited in the western Atlantic Ocean, resulting in declining catches. The first conservation measures adopted for bluefin were set in 1974, when a minimum size limit of 6.4 kg was established, and fleets were urged to reduce fishing mortality. Since that time more restrictions have been placed on bluefin, including closed areas and seasons and limits on catches. The catch in the western Atlantic has been set at less than 2.5 thousand tonnes over the last several years, and has been allocated to participants in the fishery. These bluefin regulations have had a potential impact on fishing capacity, in that allocating the catch among nations participating in the conservation program has provided an opportunity for those nations with allocations to limit the number of vessels authorized to fish under their flags. Not many participants have taken action to limit fleets, but the opportunity to do so exists.

Though swordfish is not one of the principal market species of tuna, the management measures taken by ICCAT for that species are pertinent to the discussions on managing tuna fishing capacity. In 1990 ICCAT expressed concern over the status of the swordfish stocks in the Atlantic, and recommended that fishing mortality should not exceed the levels of 1988. Management measures on swordfish were continued, and in 2003 quotas were set for both the northern and southern stocks and allocated among nations participating in the conservation program. Although no measures were taken for limiting capacity in the fishery, the fact that the allowable catches were allocated among participants provides an opportunity for the individual nations with allocations to limit the number and capacity of vessels operating under their allocations.

The first direct attempts to limit fishing capacity grew out of concern over the status of the northern albacore stock, which scientists estimated was being fished at unsustainable levels, and the stock of bigeye tuna, which was being harvested at increasingly earlier ages and in increasing amounts. In 1998 ICCAT approved a resolution calling on fishing nations to limit the sizes of their fleets fishing for northern albacore to 1993-1995 levels. During the same year ICCAT approved another resolution calling on nations to limit the numbers of their vessels greater than 24 metres in length fishing for bigeye tuna to 1991-1992 levels. Even though the limitations called for in the resolutions apply to the number of vessels, the numbers were to be coupled with a limitation on GRT so as to not increase total capacity. Subsequently a total allowable catch (TAC) of 34.5 thousand tonnes, allocated among the nations participating in the program, was set for northern albacore. Additional recommendations were made for bigeye, calling on participants to limit the catches made by their fleets in 2004 to the levels of their catches in 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. China was assigned a catch allocation of 5 thousand tonnes and a fleet limit of 60 vessels, the Taiwan Province of China 16.5 thousand tonnes and 125 vessels and the Philippines 2.1 thousand tonnes 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.

Both of the initiatives by ICCAT to address the problem of unsustainable exploitation of northern albacore and bigeye provided 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 limited their fleets. The fleets can continue to grow, and as they grow their owners will tend to put pressure on 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 controls.

The requirement for nations to limit the number of vessels operating in the fishery to prior levels will work only if the nations are willing to implement the controls necessary to limit the sizes of their fleets. In the reports of the ICCAT Conservation and Management Measures Compliance Committee (ICCAT, 2001) most of the participating nations did not provide the baseline data to establish fleet size in 1991-1992 and 1993-1995, nor did they subsequently provide annual vessel lists for those fleets. Thus, even though mechanisms are in place to limit fleet size, it is impossible to know if the requirements are being complied with currently, or how effective they will be in the future.

3.1.4 The Indian Ocean Tuna Commission (IOTC)

Although IOTC has a much shorter history than the IATTC or ICCAT, it has undertaken several measures that have had an impact on the problem of fishing capacity. The earliest efforts were a recognition by its members that fleet capacity in the Indian Ocean was likely to be 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 tropical tunas. Due to a lack of technical information at the time, the Committee was not able to make such recommendations. However, measures are being instituted to acquire the information necessary for the Scientific Committee to estimate the optimum capacity of the fishing fleet for the Indian Ocean tuna fishery.

In response to the FAO International Plan of Action to prevent, deter and eliminate illegal, unreported and unregulated fishing (IPOA-IUU), and in an effort to initiate the preliminary steps of limiting fishing capacity, the IOTC approved measures to establish and maintain a Record of Authorized Vessels (RAV) of greater than 24 metres in overall length authorized to fish in the Indian Ocean. Nations participating in the agreement can 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 list would be considered to be engaged in illegal, unregulated and unreported (IUU) fishing. Measures were also approved requesting the nations participating in the agreement to undertake certain actions, such as closing ports to and limiting imports from vessels involved in IUU fishing and not granting registration to vessels that had been involved in IUU fishing unless the ownership of the vessel had changed. These measures taken together would tend to reduce the number of vessels operating in the fishery because it would make it more difficult for an IUU vessel to operate profitably. However, the methods do not, in themselves, result in a reduction of the number of vessels authorized to fish in the Indian Ocean.

The IOTC took more direct action during its meetings in 2003 to initiate the process of limiting capacity. A resolution was approved that requires each nation with more than 50 vessels on the RAV to limit the number of its fishing vessels more than 24 metres in overall length to the number registered in the RAV in 2003. Although the resolution makes exceptions for some nations with fleets under development, and cautions that the measures taken could cause some nations to strive to bring their fleet capacities up to the 50-vessel guideline, resulting in an increase in capacity, approval of the resolution is a significant move in the right direction.

3.1.5 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 with only one species, southern bluefin tuna, and in that its area of concern is wherever this species occurs. When the 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 tonnes 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. Japan placed restrictions on the number of longline vessels that could participate in harvesting the allocation. Australia implemented an individual transferable quota (ITQ) system in which its share of the overall quota was partitioned among various Australian fishing companies, mostly those involved in bluefin ranching. 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 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 tonnes. An additional quota of 900 tonnes 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 IPOA-IUU, the CCSBT has taken action to create a record of vessels greater than 24 metres in 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 such approaches fail, then 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. However, it is difficult to determine precisely how effective these measures are.

3.1.6 The western and central Pacific Ocean

The largest tuna fishery in the world takes place in the western Pacific Ocean. Nearly 50 percent of the world catches of the principal market species of tunas come from that area, and the single largest purse-seine fishery is prosecuted there. Not only is the fishery the largest in the world, but the characteristics of the fishery are quite different from tuna fisheries in most other ocean areas. Most notably, in the EPO slightly more than half the catch is made on the high seas. In the western and central Pacific less than 20 percent of the catch is made on the high seas, so the coastal and island states control access to almost all of the catch in the region. This potentially has a large impact on how management arrangements can and will be formulated. Nevertheless, the tuna resources are highly migratory, and the principles defined in Article 64 of LOSC and the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks ("the UN Fish Stock Agreement") apply with respect to cooperation among nations and management requirements that apply throughout the migratory range of the species. An Article 64-type regional tuna body for the western and central Pacific Ocean, the Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean (Western and Central Pacific Fisheries Convention, WCPFC), has recently been established. This convention, which mandates the establishment of an Article 64-type regional tuna body for the western and central Pacific, has been signed and ratified; it entered into effect on 19 June 2004, and an inaugural session of the commission will be held on 6 December 2004. Although the new organization has not yet begun its formal work, the convention is responsive to the need for controlling fleet size when necessary. Article 5(a) of the convention states that the new Commission 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 new commission 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 new convention provides the legal authority for the organization to deal with the problem of excess fishing capacity, but how that will be dealt with is not yet formulated. However, there are currently several organizations and political arrangements that are working to develop measures to address the problem of fishing capacity in the western and central Pacific region.

The Forum Fisheries Agency (FFA) 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 tunas inhabiting the western and central Pacific Ocean. Much of the activity of the FFA was directed toward assisting the 16 countries to develop access arrangements with distant-water fishing nations (DWFNs), and developing monitoring and enforcement capabilities. The FFA maintains a register of vessels that are eligible to apply for access licences for fishing in the EEZs of FFA members. Any vessel that has been found to be engaged in 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 western and central Pacific 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, eight are members of the Palau Arrangement. The majority of the catch of tunas 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 numbers of allowable purse-seine days fished. The Ocean Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC), along with 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 contemplates setting a total number of allowable fishing days for the combined EEZs of the parties to the 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 parties to the Arrangement. It is likely 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 will then be able to license vessels to utilize the fishing days allocated to its EEZ. At this juncture in the discussions of the proposed system there is no information available as to whether the number of vessels that can purchase licences 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. It should be kept in mind that the limit is expressed in numbers of vessels, rather than in capacity. It is possible that smaller vessels would be replaced with larger ones, resulting in an increase in fishing capacity. As scientists of the OFP have made abundantly clear, the efficiencies of various sizes and types of fishing vessels can vary considerably, so some means of standardizing the fishing effort, possibly in number of “standard” days, will be necessary. It will also be necessary to monitor efficiency changes over time because of “capital stuffing”, since as soon as restrictions are adopted vessels owners will try to compensate for these by increasing the efficiencies of their vessels. If the parties to the Arrangement balance the number of vessels, taking into account the efficiencies of the vessels that they license and the number of fishing days allocated to each, any excess capacity problems would be ameliorated. However, there would have to be close cooperation among the countries in establishing this balance, as vessels may seek to purchase licences for more than one EEZ since tunas are 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 effective. A vessel with subsidies would be able to fish at lower levels of catch and economic return than an unsubsidized vessel, which would tend to result in more vessels seeking licences than if there were no subsidies. Also, the area of the western and central Pacific that lies outside of any EEZ would have to be considered in any scheme for controlling fishing effort and capacity. Once the new commission is operating it will deal with the issue of controls on the high seas, but there will have to be coordination with what the coastal states are doing by way of licensing within their EEZs.

This system being considered by the Palau Arrangement countries is unique and innovative, and it holds great potential for ameliorating the capacity problem. However, the problem of excess capacity could be dealt with more directly and effectively if vessel limits were included in the allocations of total allowable fishing days. Additionally, there must be limitation of vessels other than purse seiners, particularly longline and pole-and-line vessels, which account for about 30 percent of the catch of tunas from the region. Although there are far more longline vessels than purse seiners operating in the western and central Pacific (Miyake, this collection), the same mechanisms for controlling the capacity of purse seiners can be applied to longliners.

3.2 Industry arrangements

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

3.2.1 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 and billfishes in the *sashimi* market, which has caused the number of longline vessels to increase and the catch per vessel to decline. The other is the development of fish-aggregating devices (FADs), which have increased the catches of small bigeye and yellowfin. The increased catches of small bigeye have decreased the recruitment of large bigeye to the longline fishery, resulting in declining catches of this species. As bigeye are the primary target of the longline fishery, this situation has caused a great deal of concern for the industry. Because of this concern, and in keeping with the IPOA-CAPACITY, the Japanese longline industry has undertaken action to reduce the size of its large-scale, ultra-deep-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 the Taiwan Province of China has agreed to limit its fleet to 600 vessels. The Taiwan Province of China will require that Taiwainese-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 scheme has a good chance to succeed because Japan is the primary market for *sashimi* fish, and the Japanese government has undertaken to prohibit the importation of tuna from vessels that might, by their actions, diminish the effectiveness of programs to conserve and manage tuna resources, including the efforts to control fishing capacity. Thus a vessel that ignored these restrictions would find it difficult to fish profitably.

The OPRT was originally established between the Federation of Japan Tuna Fisheries Cooperative Association, which represents all Japanese high-seas longline vessels, and a similar industry organization representing the Taiwanese longline fleet. Its objectives are to track tuna coming into the Japanese market to ensure that it is from cooperating nations, to monitor the removal and scrapping of vessels, and to assist in the reimbursement of Japanese and Taiwanese fishermen for the costs of removing their vessels from the fleet. Since the founding of OPRT, longline fleets of Indonesia, the Republic of Korea, the People's Republic of China and the Philippines have joined it. So far about 43 Japanese and Taiwanese flag of convenience (FOC) longline vessels have been bought back and scrapped 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, two other important factors 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 small and medium-sized longline vessels that fish mostly in inshore regions, particularly in many developing coastal states. These fleets are taking increasingly greater quantities of tunas, so 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.

3.2.2 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 tonnes. Additionally, the individual vessels have increased their efficiency in catching tunas. This increase in fishing power has been the result of many factors, including better vessel design, the use of sophisticated electronic equipment, and the development of FADs. With this tremendous potential to catch fish, particularly when skipjack are abundant, catches increase sharply. These increases in production tend to outstrip demand, causing ex-vessel prices to decline. Conversely, when skipjack abundance is average or below average, there is more purse-seine capacity than needed to take the available fish. Since 1998 there have been abundant supplies of skipjack, and the catches have exceeded the demand, resulting in prices at the lowest levels observed over the last several decades. This has caused serious economic problems in the purse-seine industry and stimulated efforts by the vessel owners to do something to bring supply into balance with demand. In 1999 several industry organizations representing purse-seine vessels formed the World Tuna Purse-seine Organization (WTPO) to address this problem. The WTPO has attempted to treat the problem of overproduction in two ways. First, the members have agreed to reduce the level of fishing effort by requiring vessels to spend more time in port between trips. The target scheduled was for vessels of less than 1300 tonnes, 1300 to 1700 tonnes and more than 1700 tonnes of carrying capacity to spend a minimum of eight, nine or ten days in port, respectively, between trips. Second, the members have called for a limit on fleet growth. Industry organizations representing purse-seine vessels from about ten countries now belong to the WTPO, but there are several large fleets that are not members.

Although many vessels have followed the recommendations of the WTPO regarding the length of time between trips, many others have not; so it is difficult to tell whether this has had an impact on price. It has not had an impact on excess capacity, as 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 include only vessels authorized by their governments. New vessels could enter the register only as replacements for vessels of an equal size removed from the register. So far, such a world register has not been implemented. Nevertheless, industry initiatives provide a number of possibilities for addressing the problems created by excess capacity in the world tuna fleet, some of which are discussed by Joseph (2003).

4. OPTIONS FOR MANAGING TUNA FISHING CAPACITY

Taken as a whole, the various methods and initiatives by governments, international organizations and the private sector, have failed to halt the growth of tuna fleets on a global scale. Some of the output controls that have been implemented, such as catch limits, have served to prevent further overfishing of the tuna stocks, but unless the growth in tuna fishing fleets is curtailed, and some fleets reduced, the management measures that have so far been instituted will be placed in jeopardy, and the possibility of further subsidies to compensate for reduced catches will increase.

As has been pointed out in the IPOA-CAPACITY, and corroborated by the regional tuna bodies, there is an urgent need to get on with the task of limiting tuna fishing capacity. There are numerous legal and economic constraints that must be addressed if effective capacity limitation is to become a reality. In the following section several options for dealing with the capacity problem, and some of the constraints that must be overcome, will be presented.

4.1 General considerations with respect to controlling capacity

Most of the major issues of a technical and policy nature have been extensively reviewed by Gréboval and Munro (1999), Kirkley and Squires (1999), Newton (1999) and Cunningham and Gréboval (2001), and in this section only the highlights of issues discussed by them will be mentioned; the reader is referred to these documents for more detail.

The concept of open access has been the major cause leading to excess capacity in most fisheries. Historically, every individual has considered it to be an inalienable right to fish. Most of the world's commercially-important fish stocks are either fully exploited or overfished. Increases in fishing mortality must be halted, and in many cases fishing mortality must be reduced. The idea of open access to fish stocks must be re-thought, and, in fact, a change is underway. The concept of common property and open access has been rapidly eroding with respect to species that spend their lives inside the EEZs of single states. The assignment of property rights to fishers is becoming more commonplace in many coastal states. There is a broad body of national experience dealing with non-fisheries issues that can be useful in supporting the concept of assigning property rights with respect to stocks of fish found in an EEZ. For example, in nearly every country there is a limit on the number of taxis that can be licensed to operate in a city. A person who wants to own and operate a taxi must be authorized to do so by his government, and most often must purchase a licence from someone already in the business who is willing to leave it. In the state of California one cannot open a liquor store or bar without a liquor licence, and the number of licences is controlled by the state. The cost of liquor licences in California is high, and climbing. Similar limited-entry concepts are being increasingly applied in a variety of forms to many fisheries. Notable among these is the assignment of Individual Transferable Quotas (ITQs) in a number of coastal fisheries. In such cases, the allowable catch from a resource is allocated to a defined group of users, individuals and/or companies, with the right to transfer their shares to others. In general, these schemes have met with success, but there are problems (Batstone and Sharp, 1999; Cunningham and Gréboval, 2001) that can arise, such as how many ITQs an individual or a company can hold and provisions for subsistence and recreational fisheries and the traditional rights of indigenous peoples.

With respect to high-seas fisheries, and exploitation of highly-migratory fishes, such as the tunas, which spend part of their lives on the high seas and part in the coastal zones of various countries, the assignment of property rights is more complicated and difficult to achieve because the resources of the high seas have traditionally been considered to belong to whomever can catch them. Nevertheless, solutions are not impossible.

Article 116 of the LOSC provides the right to nationals of all states to fish on the high seas. Even though Article 116 goes on to say that this right is subject to a state's treaty obligations and to the provisions of Article 64, it nevertheless connotes the "idea" that the option is open to a state to freely enter into tuna fisheries on the high seas and, if applicable, in their own EEZs. Again, because most of the world's stocks of tuna are fully exploited, and some even overexploited, it is unrealistic to think that every state can enjoy open access to tuna fisheries. It will be necessary for states to work together to develop systems for controlling fishing effort and the size of fleets that exert that effort. In fact, there is ample legal basis for the obligation of states to cooperate. Article 118 of the LOSC mandates that states cooperate with each other in the conservation and management of living resources on the high seas, and in other areas where states harvest the same resource, i.e. inside an EEZ in which a state harvests a resource that entered from the high seas. Additionally, the FAO Code of Conduct for Responsible Fisheries and the UN Fish Stock Agreement state that the right to fish carries with it the responsibility to do so in a responsible manner, and calls on states to prevent overfishing and excess fishing capacity, and, if excess capacity exists, to undertake measures to reduce capacity to levels in keeping with the sustainable use of the resource. To carry out their mandate to conserve and manage tuna resources, many states have cooperated toward this end by working within the regional tuna bodies. Most of the early efforts at management were the implementation of output controls, specifically catch quotas and minimum-size limits. In some cases, but not all, these output controls, especially catch quotas, have prevented overexploitation. Fleets have increased as they raced to take greater shares of the quotas, and conservation controls have weakened as a result of pressure to increase catches. The problems of overfishing are generally the result of too much fishing mortality being generated by too many vessels. Fleet capacity needs to be brought into balance with the ability of the stocks of tuna to sustain certain levels of catch. Some form of property rights must be established to accomplish effective capacity controls in tuna fisheries. How to establish property rights, and how to distribute them among users in an international fishery, is a major problem because every user believes that it has a right to an equal share, and each sovereign coastal state controls access to a share of the harvest. This problem was recognized 25 years ago by Joseph and Greenough (1978) when they noted that disputes over how to allocate among users could intensify to the point where they become so dominant in everyone's mind that finding solutions to other important problems becomes impossible. More recently Clark and Munro (2002) have concluded that, unless some method of resolving the common-property problem is applied, limited success in capacity reduction will be likely over the long run. Regardless of these dire warnings, there has been progress made in allocating catches among participants. As noted in Section 3.1.3, ICCAT has allocated catches of bluefin, bigeye and swordfish among the nations harvesting these species in the Atlantic Ocean. The IATTC has initiated a Vessel Register (Section 3.1.2), which, in a way, allocates the fleet authorized to fish in the EPO among the nations currently participating in the fishery. Once the fleet is allocated, the corresponding catches are *de facto* allocated in the same general proportions. The process of allocation is negotiated among the participants. A series of criteria that can be used in making the allocations must be established. The regional tuna bodies have attempted to define such criteria (Joseph, 2003), but the two most important ones that are integral to nearly all of the negotiations are the historical catches taken by the nations with vessels in the fishery, and the proportions of the catch or the abundance of the resource in the EEZs of the coastal states of the region.

It is apparent in Section 2 that for all of the major tuna fisheries there is more fishing capacity than is needed to take the current harvests. The resolution of this excess capacity problem is a two-step process: halting the growth in tuna fleet capacity, and reducing the sizes of the current tuna fleets. The regional tuna bodies have begun the process of halting fleet growth, but, with the exception of the work of the OPRT, there is little being done about reducing capacity. The IPOA-CAPACITY is very clear on the obligation of nations and international organizations to reduce excess fishing capacity. One approach to reducing capacity is the introduction of incentive-adjusting measures (Cunningham and Gréboval, 2001), which attempt to remove the incentive of fishers to expand harvesting capacity. Measures such as ITQs and the imposition of taxes or resource-rental fees on the opportunity to fish tend to take away the incentive to build more vessels. If the tax is set high enough, and in proportion to the price of fish, then, barring any subsidies, there would be no incentive to acquire excess capacity.

Alternatively, rather than using self-regulating measures to reduce capacity, a more direct approach, which has been used in other fisheries, would be a mechanism to remove vessels from the fishery and compensate the owners of those vessels for their removal. The success of "buy-back" schemes to reduce fishing capacity has been mixed. Holland, Gudmundsson and Gates (1999) and Clark and Munro (2003) have identified several potential problems that can occur with buy-back schemes: 1) Unless a vessel that is bought-back is scrapped or converted to some other use, such as a research vessel or a supply vessel for offshore oil rigs, it is possible that it could move to another fishery and create excess capacity problems in that fishery; theoretically a vessel could be bought-back several times as it moves from fishery to fishery. The OPRT has addressed this problem by requiring that any longline vessel removed from the fishery through a buy-back be scrapped. Such a policy is critical to the success of buy-back schemes. 2) There is generally a tendency for the owners of less efficient vessels to offer them up for buy-back. If most of the buy-backs are inefficient vessels, the reduction in vessel capacity may be ineffective in reducing fishing mortality. 3) The opportunity to have vessels bought-back could motivate the construction of new, more efficient vessels in anticipation of having the less efficient vessels bought back. A limit on vessel capacity in the fishery could block this motivation. 4) Capacity growth of those vessels remaining in the fishery could negate any reductions in capacity. Therefore, monitoring efficiency changes of the vessels remaining in the fishery would be essential to the success of the program, because increases in the fishing powers of the individual vessels could result in the reduced fleet size being capable of exerting the same level of fishing mortality as before the reduction.

A final consideration is that nearly all tuna fisheries, with the possible exception of the troll fishery for albacore, fish for more than one species at the same time. Multi-species fisheries can create problems if one species is overfished or fully exploited, while another is underfished. This is the case for many tuna fisheries. Yellowfin and bigeye are fully exploited, or, in some cases, overexploited, while in many areas skipjack could sustain greater catches (Joseph, 2003). If only skipjack were considered in management of the fishery, yellowfin and/or bigeye would probably be overfished. If only yellowfin and/or bigeye were considered in management of the fishery skipjack would probably be underfished.

4.2 Open-access and common-property approaches

4.2.1 Maintaining the status quo

Most of the management measures for tunas have been in the form of output controls, which are concerned with the results of fishing, such as catch quotas and minimum-size limits, or input controls, which are concerned with the manner in which fishing operates, such as closed areas and seasons. Some of these output controls call on nations to restrict the harvest of certain species to levels experienced in earlier years, or to not capture individuals of designated species less than a certain minimum size. In most cases, such controls have met with limited success, as the total catches and/or the numbers of undersized fish caught have not declined. Most of the input controls have involved the establishment of closed seasons, particularly to fishing with FADs during certain months, and closed areas, such as for bluefin tuna in the Gulf of Mexico.

Although these measures represent attempts to keep levels of catch in balance with the ability of the resource to sustain those levels, they do not remove the incentive for fishers to increase capacity. In fact, these measures often work in the opposite direction in that they stimulate a race to harvest the available catch, which tends to increase capacity. As fishing mortality increases through fleet growth and increasing efficiency, more regulations are needed to prevent overfishing. As more regulations are imposed the fleets continue to grow. If economic profitability decreases, the governments may subsidize their fleets, which exacerbates the problem. Under the current system used to manage tuna fisheries, the cycle is likely to continue until there is either an economic or biological collapse of the fishery.

The regional tuna bodies realize that catch quotas and closed seasons and areas alone will likely not result in long-term solutions to the threat of overfishing. These bodies also recognize the need to undertake measures to control the sizes of the fleets harvesting tuna so that micro-management of the resource by the introduction of progressively more controls on how a fleet can operate is not necessary; consequently they have all expressed the need to implement measures to limit fishing capacity. As pointed out previously, most of the measures that have been introduced to limit fleet sizes to earlier levels have apparently not worked. Based on experience to date, it seems unlikely that the tuna fisheries can be managed by the implementation of TACs, minimum size controls, and closed areas and seasons, without addressing the excess capacity problem, so maintaining the status quo does not appear to be a good option for the future.

4.2.2 The World Wildlife Fund approach for limiting full use of existing capacity

In a recent study for the World Wildlife Fund (WWF), several options for reducing excess fishing capacity in the tuna purse-seine fleets have been suggested (Oliver, 2002). The options involved implementation of measures to restrict full utilization of existing capacity.

One category of options proposes various ways of closing off a proportion of each vessel's fish storage wells in order to reduce the overall capacity to a desired level. The example given is for the purse-seine fleet of the EPO, which currently has a capacity of 208 thousand cubic metres of well space. The target 2005 capacity for the fleet is 158 thousand cubic metres of well space. The reasoning behind this option is that by reducing the capacity of the fleet by closing off well space, the target capacity of 158 thousand cubic metres could be reached, and, as a result, the amount of time spent fishing would be reduced because more time would be spent in traveling to and from port. The author points out several shortcomings to this approach, but considers that, coupled with catch quotas, it would serve to protect the fish from overexploitation. However, the vessel operators might spend less time in port in order to make up for the reduced fishing time. From an economic point of view, the capital costs would not change, variable costs would increase, and overall profitability would decrease. It is possible that if profitability decreased sufficiently it would force some vessels out of the fishery, resulting in decreases in "true" capacity. It is, however, equally likely that as profitability decreased the fishing industry would pressure their governments to relax the conservation controls, which might cancel out the benefits of reduced fishing capacity.

The other category of options presented in the WWF study would place limits on the number of days a vessel would be allowed to fish, or require vessels to remain in port for minimum periods of time (as stated previously, the WTPO has already adopted requirements that purse-seine vessels remain in port for minimum periods between trips). Neither of these methods would alter the composition of the fleet, but would merely restrict its full utilization. These approaches would reduce the fishing mortality, but would not address the problem of excess capacity. There would continue to be capital wasted, and there would be pressure on governments to ease conservation controls, thereby placing the resources at peril.

4.3 Limited-entry and rights-based approaches

4.3.1 The IATTC model for a Regional Vessel Register

The IATTC's Regional Vessel Register (RVR) is a list of purse-seine vessels authorized to fish for tunas in the EPO. Vessels on the list can be transferred among nations participating in the RVR program, and vessels that leave the fishery can be replaced by other vessels of equivalent size.

The IATTC model, with some modifications, offers a potentially effective option for managing tuna fleet capacity. This approach considers that the capacities representing different flags do not really imply “property rights” for those flags, but rather signify a right for the vessel to fish. Any vessel on the list would be able to transfer its flag to any other participating nation, and its capacity quota would follow it to that new flag, but be lost to the flag from which it transferred.

The establishment of such a register, in essence, creates a limited-entry program and the right of access. The access right would be incomplete, because exclusive rights to the catch are not established in comparison to an individual quota (Townsend, 1990).

4.3.1.1 Establishing the register

When the WCPFC becomes operational there will be a regional tuna body for every major ocean area: the Atlantic and adjacent seas, the Indian Ocean, the EPO, the WCPO, and the extent of the distribution of southern bluefin tuna. A single global register could be established, but mechanisms would have to be built into the system to control the movement of vessels from one region to another as seasonal abundance and fishing conditions change; otherwise excess capacity could develop in some areas. A more functional approach would be for each regional body to establish a register of vessels authorized to fish in the waters for which it has management responsibility, which would eliminate the possibility of excess capacity in any region (provided the register for that region does not authorize excess capacity). If a vessel wished to fish in two regions, it would need to be entered in the registers for both of the regions. The two regional tuna bodies maintaining the respective registers would need to coordinate their activities regarding the vessel(s) in question, and take into account, when calculating the overall capacity limit, the fact that the vessel(s) would be fishing only part of the time in each of the regions.

The first objective of establishing the register would be, essentially, to place a moratorium on fleet growth. Each nation with vessels whose owners would like to fish in the region would be required to submit a list of such vessels. To qualify to be entered on the register a vessel would have to be considered to be actively fishing. The term actively fishing would need to be defined, e.g. an active vessel might be one that has fished in the region during at least 6 out of the previous 18 months. To stay on the register a vessel would have to continue to be active, according to the same or a similar definition. Establishing such a requirement would prevent vessels that had not been fishing from unduly adding to excess capacity. Also, it would prevent a flood of vessels entering a region as soon as the intention to limit capacity became public knowledge.

There will be a tendency for states to want to negotiate among themselves to allocate the total capacity of the extant fleet among participants, with those nations with small fleets, particularly developing coastal states, wanting guaranteed shares that they can grow into, and states with large fleets wanting to keep what they have. An important feature of this vessel register scheme is that the capacities belong to vessels, rather than to nations. When a vessel changes its registry from Nation A to Nation B, the total capacity of the vessels of Nation A is reduced, and that of Nation B is increased. Under this scheme, there will be opportunity for states desiring fleets to acquire them. These possibilities will be discussed in the following sections.

4.3.1.2 Vessel transfers

Two types of vessel transfers are envisioned in this proposed option. A vessel owner can transfer to another flag while retaining ownership of the vessel, or an owner can sell the vessel to a different owner who will register the vessel under a different flag. In either case the capacity quota would go with the vessel to the new flag and be removed from the old flag. The concept that the capacity follows the vessels will likely be raised as a problem by states that may potentially lose capacity due to transfers. In fact, however, the capacity can be retained or even increased, depending on the states’ willingness to make it attractive for vessels to stay under their flag or to transfer from other flags. There would be an incentive for vessels to choose the flags of nations providing advantageous operating conditions, such as favorable port facilities, tax incentives, lower fuel costs, marketing advantages, etc. In essence, the market would determine which vessels stay under which flag. If a nation had a national policy to acquire a tuna fleet it could structure its conditions of flagging in such a way as to attract vessels.

As stated above, it is envisioned that each regional body would establish a vessel register. Since each regional body has indicated that there is sufficient or excess capacity in its region, and since this is corroborated by the DEA studies reviewed in Section 2 of this report, there would be little opportunity for vessels to transfer from region to region (the regional body for the WCPO is not yet operational, but a study by Reid *et al.* (this collection) indicates that there is already excess capacity in the WCPO, and during the preparatory conferences the nations agreed that increases in capacity should not be allowed). Transfers from one region to another could take place only if vessel capacity was removed from the region to which a vessel wished to transfer by sinking, scrapping or converting to some other use, or special arrangements were formulated among regional tuna bodies to allow designated vessels to move seasonally among areas.

4.3.1.3 Vessel replacement

The opportunity to replace old vessels with new ones is necessary to ensure an efficient fleet and a viable fishery. In the vessel register scheme to limit fishing capacity being discussed here, any replacement of a vessel would be permitted only if a vessel of equal or greater capacity was removed from the register. If a replacement vessel is of greater capacity than the vessel being removed, then additional capacity would have to be removed from the register; for example two 1000-tonne capacity vessels could be removed and replaced by a single 2000-tonne capacity vessel. It is likely, however, that any newly-entering replacement vessel would have a greater fishing power than the vessel being removed, so adjustments to the total fleet capacity would have to be made to account for increases in fishing power. This idea will be discussed further in the following paragraphs.

4.3.1.4 Reducing excess capacity through buy-backs

The information reviewed in Section 2 of this report shows clearly that there is more fishing capacity in the purse-seine and longline fleets operating in each major ocean region than is needed to take the current levels of harvest. If the fleets operated more efficiently, capacity could be reduced substantially without causing reductions in the catches. The problem is to identify a means of reducing capacity that is equitable, possible to administer and effective in reducing fishing mortality.

One means often suggested for reducing fishing capacity is to allow attrition to take its toll of vessels. When a vessel sank or became unserviceable it would not be replaced. There are many purse-seine vessels that are more than 40 years old, and still operating effectively. If owners were not allowed to replace their ageing vessels they would make whatever repairs were necessary to keep their vessels in service. They might even make extensive renovations that would increase the fishing powers of their vessels. Reduction of capacity through attrition would take decades to achieve, and would not be an effective means for addressing the current critical excess capacity problem.

Buy-backs offer a more direct approach to reducing fishing capacity. Tuna vessels are bought and sold on a regular basis. The market price depends on demand, which, in turn correlates closely with the price paid for fish, which affects vessel profitability. Under the vessel register scheme, which allows transfer of vessels among participants, there will be a continuing demand and an international market for tuna vessels. The respective management authorities could enter this market to purchase vessels to remove them from the fishery. There are several potential problems that have been identified in the paragraphs above that can influence this market and the success of any buy-back program. The problems however, are tractable, and solutions are available. As has been mentioned already, an essential requirement for the success of any buy-back program is that any vessel that is bought back is scrapped or converted to some other use, which would ensure that the vessel would not return to the fleet at a later date, or move to another fishery, creating an excess capacity problem there.

Funding these buy-backs can have a direct influence on the success of any buy-back program. If left entirely in the hands of governments, including the cost of the buy-back program, it would constitute a major subsidy to the fishing industry. The result would be that those vessels remaining in the fishery would be able to fish more profitably than if there had been no buybacks, because the TACs would be shared by fewer vessels. Also, the motivation of fishers to have the program succeed would diminish. If left entirely in the hands of fishers, the vessels would have to operate on an economically-efficient basis, and the interests of the fishers and their motivation to succeed would be greater. This has apparently been the experience with some buy-back programs in other fisheries. In fact, the government of Australia is leaving the issue of buy-backs in its fisheries in the hands of the fishing industry.

It is suggested that the vessel register scheme proposed here include a provision for buy-backs. To fund the buy-back program, an assessment or tax could be applied to each vessel on the register. Since the analyses presented earlier show that there should be reductions in the purse-seine and longline fleets for each of the major fishing regions, the assessment or tax would be applied to all purse-seine and longline vessels included in the register of each area. The assessments and development of a pool of buy-back funds would be region- and gear-specific. The amount of the assessment would be determined through economic analyses, which would be updated periodically as conditions in the fishery change. It would be expected that the catches of vessels that remained in the fishery would increase as other vessels were removed from it, so profitability would change. The tax or assessment could be based on the catches, so that the larger producers would pay more. Alternatively, all or part of the tax or assessment could be applied to the processed product, since the processors would reap the benefits of a well-managed fishery. These changes would have to be incorporated into the analyses used to determine the levels of contribution.

Determination of the level of assessments is beyond the scope of this report. In a recent study, the U.S. National Marine Fisheries Service (NMFS, 2002a and 2002b) suggested the use of a "rule-of-thumb" approach based on setting the price for a vessel equal to one year of gross revenue generated in the fishery. However, for international tuna fisheries in which abundances of the target species fluctuate widely from year to year, and the successes of the vessels vary widely, this rule of thumb may not be a good indicator of the true value of a vessel. Additionally, information on gross revenues is usually not available. There is more publicly-available information for the purse-seine fishery of the EPO than for any of the other fisheries, so data for this fishery are used to illustrate the magnitude of the costs that might be involved in a buy-back scheme. There are currently 227 purse-seine vessels listed on the IATTC register, with a total carrying capacity of approximately 208 thousand cubic metres. There is an option in the vessel register program for four coastal states to add an additional 20 thousand cubic metres of capacity. If the options were exercised, the total capacity would be 228 thousand cubic metres. The long-term target capacity for the program is 158 thousand cubic metres. To attain this target, assuming none of the options for the coastal states are exercised, there would have to be a reduction of 50 thousand cubic metres, or 24 percent of the current capacity. Since the average size of a vessel in the fleet is about 900 cubic metres, about 55 vessels would have to be bought-back in order to reach the target fleet size of 158 thousand cubic metres. At an assumed price for a used 900- cubic metres vessel of between \$3 000 000 and \$4 000 000, the total cost for the 55 vessels would be in the neighborhood of $200 000 000. If an objective was set to make the 55 buy-backs within a 10-year period, the annual cost would be about $20 000 000. If financed entirely by the industry, each vessel would have to contribute about $100 000 per year. Whether the vessels could afford that amount, given the current overcapacity, prices of tuna and operating costs, would have to be determined by the suggested economic studies. At the outset it might be necessary to have joint contributions from industry and government, or at least to have low-interest government loans to the industry, for carrying forward the program. As the fleet was reduced toward the target size, the average catch per vessel would increase, thereby increasing earnings, so the industry would be better able to maintain the buy-back program needed to account for capacity growth resulting from increasing efficiency, without government help. The government contributions made during the early years of the buy-back program would be a subsidy. Though government subsidies can contribute to the excess capacity problem and lead to inefficiency Milazzo (1996 and 1998), in this case the subsidy could be considered a "good" subsidy, since it would be for a fixed term, and the end result would be a fleet capacity in balance with the ability of the resource to sustain catches at current levels (Clark, Munro and Sumaila, 2003).

Used in conjunction with a vessel register program to limit capacity, buy-backs offer an effective option for reducing capacity to target levels. In fact, this is the approach the OPRT has taken to reducing longline capacity. The organization has already removed a number of vessels from the world longline fleet. The longline industry has administered the program and provided the money for the buy-backs (with loans provided by the Japanese government). The experience in the longline fishery can provide useful information for the development of a program for the purse-seine industry.

4.3.1.5 Further considerations of vessel register programs to limit and reduce capacity

Vessel register programs, as outlined above, apply to high-seas longline and purse-seine fleets. These fleets account for about 75 percent of the world catch of the principal market species of tunas. Pole-and-line vessels take about 18 percent, and all other gears take the remaining 7 percent. DEA analyses have not been conducted for these other fleets, so there is no quantitative evidence with which to determine whether there is excess capacity in the smaller fleets, and, if so, to what extent. Nevertheless, there is qualitative evidence that indicates that there is excess capacity in nearly all tuna fisheries, and most of the regional tuna bodies indicate there is excess capacity for nearly all gear types. It would therefore seem prudent to place a moratorium on capacity in the high-seas pole-and-line fleets by instituting a register for those vessels. Failing controls on the pole-and-line fleets, there could be a flow of capital into the construction of additional pole-and-line capacity from owners of purse-seine and longline vessels who have been limited by the regional registers to current fleet sizes, and also other potential investors in the tuna industry. Similarly, the high-seas troll fleets, which target mainly albacore, could be handled in the same manner as the pole-and-line fleets, if it were concluded that there was excess capacity in those fleets.

For the smaller vessels such as handline, small longline and small gillnet vessels that fish exclusively in inshore regions, vessel register programs as similar to those for the larger vessels may not be necessary. The total catch of these smaller vessels has been estimated to constitute only a small percentage of the world catch of tunas (Gillett, this collection). A practical option for managing these fleets might be by the introduction of TACs that would be part of the general conservation programs implemented by the regional tuna bodies.

It is emphasized that the cooperation of coastal states in a regional vessel register should in no way derogate sovereignty with respect to providing licences to vessels to fish in their jurisdictional waters. However, to discourage IUU fishing, licence sales should be restricted to vessels in the regional registers. Along these same lines, and in order to facilitate the objective of the register program to limit and reduce capacity, the nations participating in the fishery should be willing to work together to take joint action to ensure that vessels not on the register do not get a "free ride" with respect to enjoying the benefits of a managed fishery. This joint action by the participants could include (but not be restricted to) restricted access to their waters, restrictions on the use of port facilities and trade sanctions. It is only through such cooperative efforts and sacrifices of the participants that a regional vessel register can be successful in maintaining optimal fleet sizes. There are several examples of successful employment of such measures (Barrett, 2003), particularly the action taken by ICCAT regarding bluefin tuna.

4.4 Allocating quotas

An alternative means of addressing the excess capacity problem is through the development of self-regulating mechanisms to control capacity. The assignment of catch quotas to participating nations in an international tuna fishery, or to individual vessels in that fishery, can be such a self-regulating mechanism. They involve determining what the TAC for a fishery should be and the allocation of that TAC among the nations or vessels participating in the fishery. If quotas are assigned properly, the incentive to build excess capacity is reduced, and the participating nation or vessel does not need to race to take its share of the catch. Theoretically, the participant would not use more capacity than is needed to take the allowable quota. However, the assignment of quotas does not guarantee that excess capacity will not be a problem. On one hand, if the quotas are assigned to individual operators the self-regulating or incentive-adjusting measure would be particularly effective, as there would be no advantage to the operator to race to take the quota; it could be taken more leisurely, and with minimal capital investment. On the other hand, if quotas are assigned to countries, and there are no limits on the number of vessels allowed to participate in a country's harvest, there would be a race within each national fleet to take maximum shares of that country's quota.

4.4.1 Allocating quotas to countries

For this option the idea would be that the TAC for a region would be allocated to the nations participating in the fishery. Knowing what their allowable catch would be, each nation could then limit its fleet to the number of vessels needed to take the harvest. This could be done independently by each nation, as is the case for the southern bluefin fishery and the Pacific halibut fishery, or it could be done in accordance with a set of standards developed by the regional tuna body responsible for the fishery.

Though the concept of allocating catches is simple, the tuna fisheries themselves are very complex, and it will be difficult to find a workable solution acceptable to all participants. The difficulties in assigning quotas in fisheries in which there are multiple species taken and market variability have been reviewed by Squires and Kirkley (1996) and Squires *et al.* (1998). Many of the problems discussed by these authors apply to the tuna fisheries. They all involve several participating nations. Some of these are coastal states, and others (DWFNs) are not. Some have well-developed economies, while others are developing. Each of the fisheries takes more than one species of tuna, some of which are overexploited, some fully exploited and others underexploited. A variety of gears harvest the different species. Longline vessels harvest relatively small amounts of large tunas (and billfishes) destined for specialty markets, while purse-seine vessels harvest large amounts of smaller tunas destined for the canned market. The vessels of some nations direct most of their effort toward one species, while others direct their effort toward several species. Finally, tunas on the high-seas have historically been considered an open-access resource, belonging to whomever catches them. All of these complex factors must be considered if a workable means of limiting capacity by means of country allocations is to be achieved.

Ideally, allocation should be determined by an algorithm that employs a series of agreed-to criteria, thereby removing the intense political and economic debate from the process each time an allocation is made. In practice, allocations in international tuna fisheries have been mostly the result of intense negotiations among the involved parties (Joseph, 2004). Although there has been a great deal of attention given to the identification of a series of criteria that can be used in the allocation process, historical and current involvement in the fishery has been the overriding criterion used. Nearly all allocations in tuna fisheries reflect the current distribution of catch among the participants, with some provision being made for developing coastal states. Precedent for moving away from the concept of open-access or common property to one of rights-based management has been set in several tuna fisheries. As already mentioned, national allocations have been made by ICCAT for albacore and bluefin tuna, and by the CCSBT for southern bluefin tuna, and in the past by the IATTC for yellowfin tuna (Bayliff, 2001). Capacity quotas were allocated in the tuna fishery of the EPO by the IATTC, but, after the first two years agreement could not be reached to continue them. Considering these experiences, there appears to be ample precedent for allocating catch and/or capacity quotas in other tuna fisheries.

In most cases, deciding on TACs to be allocated for yellowfin, bigeye or bluefin is straightforward because those species are fully exploited, and, in some instances, overexploited, so TACs can be readily agreed to. Skipjack, however, particularly in the Pacific Ocean, are not fully exploited, and the catches could be increased, so setting TACs might be done on an economic basis, rather than a biological one. Reaching agreement on economic TACs might be more difficult, however, since the fleets of some nations direct more of their effort toward skipjack than do the fleets of other nations. Similarly, because longliners catch so many species at the same time, setting capacity limits will be complicated unless allocations are made for all the species combined that the longliners catch. If all target species are included in a country allocation, then the task of determining appropriate capacity levels is a more tractable problem, the issue of "high-grading" (continuing to fish after the vessel has filled its capacity, and discarding previously-caught less valuable fish to make space for recently-caught more valuable ones) notwithstanding.

Once allocations are made, the number of vessels authorized to participate in the harvest of that allocation could be determined. This can be accomplished in several ways. The most straightforward approach would be to leave the determination of fleet size in the hands of each country with an allocation. The hope would be that each country would determine the carrying capacity of its fleet, and, if it is found to be greater than that needed to take the allocation, capacity would be reduced. Each country would probably partition its allocation among gear types and then, if necessary, limit the number of vessels in each partition. In cases for which there are fleets of artisanal or small-scale fishing craft that fish exclusively in the EEZ of a country, rather than limit capacity for them, which might be difficult or impossible to do, a portion of the catch allocation could be allotted to that fishing sector.

Leaving the task of setting fleet capacity to each country might not resolve the excess capacity problem. Countries differ with respect to management objectives; some are more interested in maximizing profits and keeping fleet capacity in balance with the resource, whereas others may be more interested in maintaining vessel efficiency at relatively low levels to ensure more vessels operate and that employment stays high. The danger, if the latter occurs, is that fleets would be larger than needed to take the allowable harvest, profits would be low, and there would be pressure to weaken conservation measures.

A more effective approach for ensuring that capacity is set at levels in balance with the allocation is to vest authority in the regional tuna body to determine the levels at which the fleets should be kept. The regional tuna body could carry out analyses to determine the appropriate fleet size for each gear type within each allocation. In this manner overall fleet capacity for the entire fishery could be kept in check, and a program to reduce excess capacity initiated.

Under this option, a buy-back program, such as the one discussed earlier, could be implemented. In this case, however, each nation with an allocation and fleet would be responsible for establishing its own buy-back program. National buy-back programs could set a fee to be paid by the industry that would be used to make the buy-backs, the governments themselves could fund the buy-back program or a combination of the two could be employed.

4.4.2 Allocating the catches to individual vessels

The assignment of IQs has been used to manage a number of fisheries (Squires, Kirkley and Tisdell, 1995; Squires and Kirkley, 1996; Squires *et al.*, 1998; Batstone and Sharp, 1999; National Research Council, 1999). These incentive-adjusting techniques have corrected problems of overcapacity. As mentioned above, the assignment of IQs removes the necessity for fishers to race to fill their quotas. Experience in other fisheries managed by IQs shows that fishers tend to utilize only enough capacity to capture their quotas. Economists have advised that, whenever possible, IQs should be used to manage fisheries (Cunningham and Gréboval, 2001). As with the case of assigning country allocations, the first step is to determine the TAC for the fishery in question, and then partition it among the users.

Because of the complex nature of most tuna fisheries, attempting to manage at the catch level, when that catch is assigned to participants, is difficult. These complexities were discussed above in the context of assigning quotas to nations. The situation is even more complex when attempting to assign the TAC to individual vessels or companies.

The first task that a regional body contemplating the assignment of IQs will need to address is the areas, species and gear types to which the IQs will apply. For example, will IQs be assigned to all gear types? In most fisheries purse-seines are the dominant gear, so any effective program would have to include this type of gear. Likewise, high-seas longline fleets operate in every major ocean area, and they harvest significant amounts of tunas, and also a variety of other species. They would also have to be included for any IQ program if that program is to be effective. In many coastal states there are fleets of small longline and handline vessels that confine their fishing activities to nearshore waters. Some of these fleets consist of large numbers of vessels, but their harvest of tunas comprises only a small percent of the total catch from the region. Many of these small vessels fish for species other than tunas for much of the year. To attempt to assign and monitor IQs for these small vessels may be impractical. A more efficient and practical means of handling such fleets would be to assign a certain share of the TAC to them as a single unit. Pole-and-line vessels also fish for tunas in all the regions. In some areas, such as the EPO, they number only a few vessels, but in other areas pole-and-line vessels take a significant share of the total catch. This category of vessel would also have to be included in any program of IQs for it to be successful. In some pole-and-line fisheries, such as that of the Maldives, in which there are many small vessels that fish during the day and return to port at night, the assignment of IQs to individual vessels may be difficult to administer. In such cases IQs might be better assigned to companies or fishing cooperatives, which would then be responsible for deciding on how many vessels would fish.

4.4.2.1 Gear and catches

In terms of tonnage, purse-seine vessels, on the average, catch several times the amounts of tuna caught by the other types of gear. Most purse-seine vessels capture various mixes of skipjack, yellowfin and bigeye tuna. Because yellowfin and bigeye are fully exploited in all oceans, it is anticipated that the TAC for these species would be the best current estimate of the surplus production for the period. For skipjack, however, because it is not fully exploited in most regions, a TAC would have to be determined on the basis of its impact on the catches of yellowfin and bigeye. Except when fishing for yellowfin tuna associated with dolphins in the EPO, it is generally not possible to catch a single species when setting the net. Without a TAC on skipjack, fishing could continue to the point that the yellowfin and bigeye would be overfished. It is, of course, possible to set limits on the catches of yellowfin and bigeye, but if the vessels were permitted to continue fishing for skipjack it is likely that they would discard yellowfin and bigeye at sea after their TACs for those species were achieved. The alternative would be to close all tuna fishing when the yellowfin and/or bigeye quota was filled, but this would discriminate against the vessels that had not filled their IQs. Therefore, in determining the IQs for purse-seine vessels, all three species would have to be considered. The species make-up by area must also to be considered. If so, then some IQs could be area-specific. In fact, Wilen (1988) suggested that if limited entry is area-specific, certain advantages would be gained. In the EPO, at least, different vessels operate in different areas of the region, and the species compositions of the catches are different in different areas. Ecuadorian purse-seine vessels fish mostly on fish associated with FADs in the area south of 5°N, where the catch is predominantly skipjack, mixed with lesser quantities of yellowfin and bigeye; Mexican and Venezuelan vessels fish mostly north of the equator on schools associated with dolphins and catch mostly yellowfin tuna, with much lesser amounts of skipjack. These characteristics of specific fisheries must be considered in determining the IQs.

Although longline vessels produce considerably less tonnage of tuna per year than do purse seiners, the value of their catch is much greater. Longlines are generally considered to be a passive gear, which has limited ability to select the target species. In reality, however, the species composition of the catch can be influenced somewhat by the areas of operation and the configuration of the gear (number of buoys between hooks, which determines the depths at which the hooks fish). Longliners normally catch two or three species of tuna, two or three species of billfish, and a variety of other species in each set of the gear. Because of these complexities in the longline fisheries, consideration should be given to computing IQs within strata of time, area and species.

Pole-and-line vessels fish mostly for yellowfin and skipjack, but occasionally harvest small amounts of bigeye. They can be much more selective with respect to the species that they target than can purse seiners and longliners. For example the Ghanaian and Maldivian pole-and-line fleets, which catch mostly skipjack, target mostly pure schools of skipjack where that species is the dominate tuna species available.

4.4.2.2 Determining IQs

The first step in determining an IQ is to select the area to which it will apply. This will be influenced by the distribution and movements of the various species and whether there are areas that are unique to certain species or gear types. IQs could be computed for each species separately, two or more species or all of species combined. Considering the fact that most of the catches by surface gear include yellowfin, skipjack and bigeye taken during the same fishing operations, the IQs might best be determined for all species combined. Before determining IQs, however, the TACs should be determined. As already mentioned, an overall TAC that includes the TACs for the individual species must be considered. For most of the species, with the exception of skipjack, the TACs would probably be set equal to the best estimates of the AMSY or the current sustainable production. Because in many areas skipjack is underfished, a TAC for that species would be set below what the AMSY might be. If appropriate, TACs could be computed for areas in which only certain species occur or in which only certain gear types operate. Initially, however, it may be more practical to compute the combined TAC for the entire region that the regional body implementing the program is responsible for.

Once the TAC is determined, the IQs can be determined. Because different fleets, and different components within the same fleets, target different species or mixes of species, it would not be practical to merely divide the TAC by the number of vessels operating in the fishery. This could require longliners to fish in a manner that is impossible for them to do, or some purse seiners to shift from catching mostly skipjack, to catching a mix of species for which they have had no experience fishing for in the past. Some means of assuring that a vessel could continue to fish in the same way, or nearly the same way, as it had in the past would have to be developed. One means of doing this could be accomplished by stratifying the recent levels of harvest into areas, gear types within these areas and average catches by species within these gear types. Based on these proportions, the IQ could specify the species compositions of the catches. If this were done properly, vessels would be able to fish their IQs in the same manner as they had been fishing before IQs were established. This would also tend to take away incentives that might develop for fishers to "high-grade." For example if an IQ were merely a percentage of the TAC, regardless of species, a vessel that normally fished for yellowfin would be able to discard any skipjack it caught to ensure that a full load of yellowfin was taken.

In some regions there are recreational and subsistence fisheries for tunas. In most cases the amounts of tunas taken by these fisheries are very small relative to commercial harvests, the most notable exception being the recreational fishery for bluefin in the western Atlantic Ocean. To attempt to assign IQs to individual non-commercial fisheries would be difficult, so the most practical approach might be to reserve a portion of the TAC for these uses. In addition, there are large numbers of small commercial fishing vessels in some coastal states, and it would be difficult to assign IQs to these vessels. One solution would be to reserve a portion of the TAC for all of these vessels, as was suggested for recreational and subsistence vessels. Alternatively, IQs could be assigned to groups of such vessels represented by fishing cooperatives or other such entities.

Tunas spend their entire lives in an oceanic environment, and, as conditions in the ocean vary, so does their abundance. In favorable years, recruitment, growth and survival increase, resulting in above-average levels of abundance, and in unfavorable years, abundance declines. Therefore any TACs set must be adjusted in accordance with natural fluctuations in abundance. Therefore, it would be unrealistic to attempt to set long-term TACs and IQs in absolute tonnages. As has been done for some other fisheries, this could be addressed by expressing IQs in terms of percentages of the TAC.

4.4.2.3 Assigning IQs

The analyses presented in Section 2 of this report concluded that all of the purse-seine and longline fleets in the oceans of the world have a greater fishing capacity than needed to harvest the available resources. If all the vessels in these fleets fished as efficiently as the most efficient ones, the numbers of vessels could be reduced without reducing the catches. Accordingly, when IQs are determined should every vessel receive a relatively small IQ, or should the number of vessels be limited and the amount of each IQ increased? If the latter, then fleet size could be brought quickly to lower and more efficient levels. However, to take this course of action would require the development of a method for selecting the vessels to receive IQs. The owners not receiving IQs would suffer severe economic hardship. One solution to this problem would be for the regional tuna body to auction off the IQs to the highest bidders, and to use the receipts from the auction to compensate the vessel owners who did not receive IQs. If this were done, a system to ensure that the vessels removed from the fishery did not move to other fisheries that already have an excess capacity problem would be needed. For example, the vessel owners who did not receive IQs would be required to scrap their vessels or convert them to some other use before receiving compensation.

Alternatively, all vessels currently in the fishery could be assigned IQs. This would mean that the excess capacity problem would continue. However, there would be a tendency for owners of more than one vessel to reduce the number of vessels that they operate to the least capacity needed to ensure that their IQ is harvested before the end of the fishing season. However, because many owners have only one vessel, there would continue to be an excess capacity problem. This excess capacity problem could be mitigated by making the IQs transferable. If they could be sold and purchased within the management scheme, the most efficient operators would tend to buy up the IQs from less efficient operators. The most efficient operators could then take their expanded IQs with less vessel capacity. Theoretically the fishery would become self regulating with regard to capacity, and the fleet would be reduced in capacity to the level that could take the allowable catch with fewer vessels.

The transferable IQs would provide a mechanism for those states that currently do not have tuna vessels, but would like to enter the fishery, to acquire them. Likewise, there would be the opportunity for individuals or groups who are opposed to fishing, for whatever reason, to purchase IQs and to then not use them to fish. Such groups might wish to acquire IQs from sectors of the fishery that have high bycatch rates of endangered, threatened or icon species.

The transferable IQs would, in essence, be a property right for those owning them. They could be bought, sold or utilized. Before assigning the IQs, the governments working through the regional tuna body would need to define the nature of the right. Would it be a right held in perpetuity that would form part of the estate of the owner, or would it be for a fixed period of years? In some fisheries IQs are held in perpetuity, are transferable, and are considered legal property (Batstone and Sharp, 1999). For many tuna vessels that are operated efficiently, loans for the purchase of the vessel are paid off within several years; therefore, the duration of the IQ might be set on the basis of the pay-off time, or on the basis of the expected life of the vessel. After that period the IQ would 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.

IQs, particularly when they are transferable, offer a number of interesting possibilities for addressing the excess capacity problem in tuna fisheries. However, the tuna fisheries are so complex that developing efficient and workable means of implementing management systems that use IQs will be difficult.

4.5 Licensing

Another approach that can be used to manage fishing capacity is to limit the entry of vessels into a fishery by requiring licences to participate in that fishery. This form of limited entry has been used in many national fisheries (Sinclair, 1983; Wilen, 1988; Townsend, 1990). Unlike IQs, a licensing system does not remove the incentive for fishers to increase fishing capacity. Experience in some other fisheries where licensing has been used to control capacity is that fishers have attempted to get around the constraints placed on them by increasing the carrying capacity or efficiency of the vessel they have licensed. Such input substitution, or "capital stuffing", has rendered many licensing schemes ineffective in managing fishing capacity.

Limiting entry can be a useful tool in managing tuna fishing capacity if the potential problems created by capital stuffing can be overcome in a licensing scheme. In most cases, working at the vessel level, such as vessel licensing or the regional vessel register discussed earlier, managing capacity would be less difficult than managing catches, as is evident from the discussions in Section 4.4.2. In the following paragraphs some suggestions for a licensing system are outlined for tuna fisheries.

Of course, the implementation of a licensing system in the tuna fisheries is complicated by the international nature of the fishery, as are rights-based management approaches. There are multiple nations involved in all tuna fisheries, some of which are developing coastal states with small or no fleets, while others are DWFNs with large, modern fleets. Those with few or no vessels want to acquire them, particularly if they are coastal states, and those with large fleets want to retain what they have. Because most of the fisheries are fully exploited, and there is excess capacity to take the catches, there must be limited access to the fisheries. Therefore there must be some means to control access in these tuna fisheries. This could be accomplished in several different ways. One way would be for each nation with vessels participating in the fishery to allot licences for its vessels, but under the guidelines issued by the regional tuna body. Another way would be for the regional tuna body to be vested with the authority to limit the number of vessels in the fishery and to issue the licences for the vessels authorized to fish. The latter method would be the most efficient means of managing a licensing system, but the issue of a perceived derogation of sovereignty might make the participating governments reluctant to transfer this authority to the regional body. The following discussion assumes that authority is vested in the regional body to manage the proposed licensing system; the fishery would no longer be one of open access, but rights to fish could be assigned to the participants.

With a licensing system, a regional tuna body would determine the appropriate number of vessels and the associated capacity needed to harvest the allowable catch for its area of responsibility, and then it would issue licences. There are several approaches for estimating the appropriate number of vessels and the associated capacity for the region under consideration. The DEA analysis discussed in Section 2 could provide insight for the purse-seine and longline fleets, the “rule-of-thumb” approach of NMFS (2002a and 2002b) could prove useful or an in-depth economic analysis could provide helpful guidelines for establishing such estimates. Licensing would be at the vessel level, and licences would be allotted to vessels on the basis of gear type and capacity. By including a gear type and capacity in the licensing unit, some undesirable elements of capital stuffing could be avoided. However, the incentive for fishers to increase the efficiency of their licensed vessel would not be affected. To adjust for these efficiency changes, studies to estimate capacity and productivity growth would have to be conducted, and the numbers of licences adjusted downward to compensate for these increases in efficiency. As is the case for several of the other schemes for managing fishing capacity, the small vessels, including subsistence and recreational vessels, would likely have to be managed under a slightly different approach than that envisioned for the larger vessels. Because of the large numbers of these small vessels, and the difficulty in administering any complicated licensing scheme, it might be more practical to issue licences to groups of vessels through cooperative arrangements or to manage their activities through the assignment of catch quotas. To some extent, defining licence groups by gear, capacity, area, etc., might also help promote cooperation among industry participants by transforming the open-access property rights structure into a set of regulated local commons (Wilen, 1988; Balard and Platteau, 1996).

As already pointed out, in almost every case there is actually more capacity available than is needed to harvest the catch. Therefore the regional tuna body would need to decide on how to initiate the program once a target capacity has been determined. One means of doing this would be to issue a licence to every longliner and purse seiner authorized by its government to fish in the region, and then commence a scheme to reduce the capacity to the target level. Another means would be to restrict the number of licences issued at the outset to the target level.

4.5.1 Unrestricted licensing with buy-backs

Under this option, a licence would be issued to every longline and purse-seine vessel authorized by its government to fish in the region to which the licence applies. The licence would apply to a single vessel, and its associated capacity would be included with the licence so as to prevent any increase in its capacity. The licence would be for all species within the responsibility of the issuing authority, thereby allowing the vessel to select the mix of species it wished to target. If the TACs were properly determined a balanced fishery would result.

The licence could be considered as a right to fish that the holder could buy or sell, or it could be considered as "rental" of property that could be harvested over a fixed period of time, but did not imply ownership on the part of the licence holder. If the licence is transferable, then it would be held in perpetuity, and if and when it is transferred among vessels, care would have to be exercised to ensure that the transfer applies to a vessel that would not be capable of generating a greater level of fishing mortality than the vessel from which the licence is being transferred. Because of the inherent difficulties in trying to standardize different gear types which exhibit different age-specific and species-specific fishing mortality rates, it would be simpler from the management point of view to allow only transfers between the same gear types, i.e. purse seiner to purse seiner, or longliner to longliner, and vessels of equal size. If the licence did not vest a right for the holder, but instead was a "rental", it would revert to the regional tuna body after its term expired for reissue.

Because there may be excess capacity licensed for some species that are fully exploited or overexploited, additional management measures would be needed. In some regions the catch of yellowfin and skipjack would need to be controlled because the species are fully exploited or overexploited. In some of these same areas skipjack is underexploited, and could sustain increased fishing effort, but because it is taken in mixed schools with yellowfin and bigeye, its levels of harvest may need to be controlled as well, in order to protect the other two species from overexploitation.

Even though under this scheme there will initially be more licences issued than are needed to take the available harvest, the regional tuna body may wish to add still more licences to the list to provide a very limited opportunity for some developing coastal states to enter the fishery. At the same time, in order to help manage the excess capacity problem, a fee could be charged for a licence. If set high enough, this could discourage some vessels from buying licences, and, indeed, some states from entering the fishery.

The funds generated through the sale of licences could be used to fund a buy-back program to reduce the number of licences, and corresponding vessels, to the target level. The same concerns and considerations presented in the earlier discussions on buy-backs would apply in this instance as well.

4.5.2 Restricting the number of licences initially issued

In the preceding paragraphs a licensing system in which, when initially implemented, every vessel operating in the fishery would be issued a licence was discussed. The important issue then was to introduce mechanisms for reducing the number of licences over time to the target level set by the regional tuna body. In the following paragraphs systems to reduce the numbers of vessels licensed at the beginning of the program are discussed, along with mechanisms for maintaining capacity at the target levels.

4.5.2.1 Fractional licences

Townsend (1992), Townsend and Pooley (1995) and Cunningham and Gréboval (2001) have suggested an alternate approach to buy-backs, which utilizes the concept of transferable fractional licences for reducing excess capacity. The technique involves the issuance of some fraction of a licence for each vessel in the fleet. The fraction would be calculated on the basis of the target fleet size as determined by the regional tuna body. When the system is implemented each participant in the fishery would be issued a fractional share of a licence. Without a full licence a participant would not be able to fish. Therefore, to fill out the licence, fractional shares would have to be purchased from someone else. For example, there might exist a fleet of 200 longline vessels and 200 purse-seine vessels in a region for which the regional tuna body has determined target levels of 150 longliners and 150 purse seiners. In order to get to the target level the regional tuna body would issue a 0.75 fractional share to each participant in the fishery, all or any part of which is transferable. Transfers would be allowed only within gear types and within capacity categories. Because the shares would be transferable, a market would be created for fractional shares. Through the sale of fractional licence shares, the number of full licences would soon approximate the target capacity levels. The fractional licensing system would not need a separate buy-back scheme associated with it, as it is, in effect, an industry-funded buy-back program.

As a result of the sales of the fractional licence shares, there would be vessels (50 purse seiners and 50 longliners in the hypothetical example given above) that would not be authorized to fish. The owners of those vessels would have been compensated for not being able to fish by the sale of their fractional shares. Because all purse-seine and longline fisheries suffer from problems of excess capacity the vessels without licences would not be moved to other fisheries. They would have to be scrapped or converted to some other use.

As with most other systems for managing capacity, some means of monitoring changing efficiency must be implemented. As efficiency increased, the numbers of licences would have to be reduced correspondingly.

4.5.2.2 Auctioning licences

Economists have long advocated the assignment of property rights in fisheries, and suggested the use of auctions to generate resource rent from the assignment of those rights. Such approaches have been successfully used in national fisheries, but to date these have not been applied to international fisheries because of the open-access nature of most international fisheries and the difficulty many governments have in moving away from that concept. Auctions offer some advantages for implementing a licensing system for managing capacity in the world's tuna fisheries.

Once the regional tuna body determines the target levels for fleet capacity in its region, which in almost every case would be less than the current fleet size, and the corresponding number of licences that it wishes to allot within each gear type and vessel size class, it could use an auction to sell the licences to the highest bidders. Such an approach would result in an immediate reduction of the fleet to near the desired target level. The regional tuna body would have to determine the terms of the licences being auctioned. The licences could be for fixed periods, for example, 10 years, and then returned to the regional tuna body for re-auctioning, or retirement if efficiency has continued to increase, or they could be held in perpetuity. If held in perpetuity the decision as to whether there should be an annual fee associated with the licence would have to be made.

There would be a great deal of opposition to the idea of auctions to sell licences, particularly from the less efficient operators, because they would be less able to bid effectively against the more efficient operators who would have more financial resources available to them. Governments would most likely have to compensate the unsuccessful bidders in some way for being driven out of the fishery. All or part of the revenues generated by the auction could be used for this purpose.

Because the most successful operators would be the successful bidders, there would not be a proportional decrease in potential fishing mortality with the decrease in vessel numbers or capacity. Additionally, with respect to the longliners, those staying in the fishery might concentrate their effort more on the higher priced *sashimi* fish such as bluefin and bigeye, rather than on the relatively lower priced yellowfin and albacore. To adjust for these possibilities, the regional tuna body would need to monitor efficiency changes in the licensed vessels, and, based on these studies, make further reductions in fishing capacity. Likewise there would need to be additional management measures, such as catch quotas, to ensure that the more desirable species are not overfished.

These further reductions in fishing capacity, which would be made to compensate for increased efficiency of the licensed vessels, could be achieved through a buy-back program. The funding for the buy-back program could come from the revenues generated by the auctioning of the licences.

Another source of opposition to such a program would be from the coastal states that do not have large purse-seine or longline vessels, but would like to acquire them. These states would argue that, as coastal states, and under the provisions of Article 116 of the LOSC, they should have special rights to bring vessels into the fishery. However, there is no more room for additional capacity. There are at least means of addressing this problem. First, it could be argued that there is not room for additional capacity, so if a nation or an individual wants to enter the fishery it would have to acquire a vessel in the same manner as anyone else, in this case through the auction. Second, when determining the number of licences to be auctioned, the regional tuna body could reserve a certain number for developing coastal states of the region, based on some predetermined set of criteria. Third, the regional tuna body could use part of the revenues generated from the sale of licences to assist developing coastal states meeting certain predetermined criteria to acquire vessels through the auction.

5. SUMMARY AND CONCLUSIONS

Although the studies referred to in Section 2 above have shown that there is more fishing capacity for purse-seine and longline vessels in all the major tuna fisheries than is needed to harvest the available resources, they do not show clearly by how much capacity should be reduced. Some idea of the magnitude of the excess capacity can be obtained from the data available for the tuna fishery of the EPO. The IATTC has suggested that the fleet of purse seiners in that region could be reduced by about 22 percent without decreasing the catches. It seems reasonable to assume that about the same reduction might apply to purse-seine fleets in many of the other major tuna fisheries. In the case of longline fleets, the OPRT has targeted a reduction of 20 percent. Purse seiners and longliners account for about 75 percent of the world catches of the principal market species of tuna. By resolving the excess capacity problem for these gear types, many of the threats of overexploitation could be contained and the fisheries could become economically more efficient. The problem would not be completely resolved, however, because other gear types take the remaining 25 percent of the catch. Unfortunately, data on the numbers and capacities of the vessels employing these gear types is limited.

Pole-and-line vessels account for about 18 percent of the remaining 25 percent of the world catch. Records of the numbers and capacity of pole-and-line vessels are not nearly as complete as they are for purse-seiners and longliners. There is an urgent need to collect such information and to undertake studies regarding the levels at which these fleets should be maintained. Each of the regional tuna bodies should collect and maintain lists of pole-and-line vessels, along with vessel characteristics, particularly characteristics related to vessel size, which operate in their regions. As a precautionary measure, once capacity limitations are implemented for purse seiners and longliners, consideration should be given to placing moratoria on the entry of new pole-and-line capacity into any of the fisheries for which limitations on the other gear have been implemented. This should be done for two reasons. First, pole-and-line capacity should be controlled until it is determined whether there is excess pole-and-line capacity. Second, if there are no controls on pole-and-line capacity there might be a flow of investment capital into new pole-and-line vessels because of restrictions on other gear types.

The remaining seven percent of the world catch of the principal market species of tuna is taken by a variety of other gear types. Most, but not all, albacore stocks are fully exploited. Therefore, from a practical point of view, it would be advantageous to implement capacity controls in the fisheries for albacore before the problem becomes acute, thereby rendering a solution more difficult. Trollers, which fish mostly for albacore, have already been the object of limited entry in some albacore fisheries. In New Zealand, consideration is being given to allowing no new entry of trolling vessels. In the Atlantic Ocean, ICCAT has requested that nations with vessels fishing for albacore limit the sizes of their fleets to the levels that they were a few years earlier. As is the case for pole-and-line vessels, there is some urgency for the regional tuna bodies to collect information on the numbers and capacities of trolling vessels, so that the need for capacity management can be evaluated. Tunas are also caught by small longliners, handlines, gillnets and other types of gear. As mentioned earlier, the numbers of small longline vessels that fish for tunas and related species are increasing in many coastal states. Most of these small longliners, and some hand-line vessels, take only small quantities of tunas during certain seasons, and they fish mostly within the EEZs of their flag states; most of their catches are other species, such as mahi-mahi and pargo. Some of their catch enters the commercial market, but some is for subsistence. Gillett (this collection) refers to the fisheries by small longliners, hand-line vessels, and other small craft, as "very small-scale fisheries", and estimates that they take about 320 thousand tonnes of tunas. It may be difficult for regional tuna bodies to monitor the number of vessels involved in such fisheries and to implement measures to control capacity for these fleets. It would probably be more efficient for controls on the numbers and capacities of these small fleets to be left in the hands of the coastal states, because the objectives of management for each of the states might be quite different than those for the region as a whole. However, there would need to be some conservation controls to prevent overfishing. These would come from the regional tuna bodies as catch quotas or closed areas or seasons.

Several options for dealing with the excess capacity problem for large purse seiners and longliners have been presented for consideration. These options have been grouped into two categories, one in which there is open access to the fisheries, and the other involving rights-based management.

5.1 Open-access options

All large-scale tuna fisheries were developed during a period when access to the resources was open to any fisher who wished to fish on the high seas, or who was willing to pay a licence fee to a coastal state to fish inside the waters over which that state had jurisdiction. It was, of course, partially a result of open access that heavy exploitation of tuna resources took place, leading to overfishing and the building of more fishing capacity than needed to harvest the available resources.

Although the concept of open access still prevails for most tuna fisheries, it is being eroded as regional tuna bodies are increasingly attempting to allocate the catches among participants and to limit the numbers of vessels authorized to fish. However, there still persists a strong desire on the part of much of the tuna industry and some states to continue open access for tunas. Therefore, the status quo was considered as one option for dealing with the issue of overcapacity in the world's tuna fisheries. Continuing the status quo implies that most measures for managing tuna resources would involve output controls such as catch quotas and minimum size limits, and would not address the problem of limiting fleet capacity. The result will be that fleets, which are already in excess of what is needed, will continue to grow. As fleets grow economic problems in the production sector of the fishery will grow as well. As economic pressures on fishers increase, there will be increasing efforts to weaken management controls. These patterns have prevailed in the past in many fisheries, including those for tunas. This is the primary reason that many of the fisheries resources of the world are overfished. It is clear that maintaining the status quo is not a desirable option for managing the fisheries for tunas.

Oliver (2002) suggested that the capacity of purse-seine fleets be reduced by closing off a certain percentage of the fish storage capacity of each vessel. This option would reduce the fish-carrying capacity of the fleet that was the target of these restrictions, but it would not reduce the number of vessels in the fishery, nor alter substantially the ability of the fleet to catch fish. The only reduction in the catches would be due to increased time spent running to and from port as a result of reductions in the carrying capacity of the vessels. In fact, due to improvements in efficiency not related to carrying capacity, the actual catches would probably not decline over the long term. Oliver (2002) also suggested an alternate scheme that would require vessels to spend more time in port than required for normal unloading so as to reduce the number of days spent at sea fishing. However, after unloading was completed, fishermen would probably use the extra time in port to conduct annual vessel maintenance, and would be able to substitute regular repair time in port with time at sea fishing. The net result in both cases would be no change in the number or size of the vessels fishing, and little change in the actual fishing mortality exerted by the vessels to which these controls were applied. Therefore, these two options do not appear to be the best means of addressing the excess capacity problem facing most tuna fisheries.

5.2 Limited-entry and rights-based options

Based on the analyses presented in this document, and the results presented in much of the literature cited herein, it seems clear that the common-property and open-access nature of fisheries has been the major cause of the decline in many of the world's fish stocks. If we are to move away from the problems of overfishing contributed to by the application of this concept of common property, the concept must be changed. Economists have long argued that by assigning certain rights for fishers to harvest a certain share of the resource, effective management of that resource could be more easily achieved. However, assigning property rights in fisheries is a delicate political issue. Vesting the authority in an international organization to assign property rights may be perceived as a derogation of sovereignty. However, to transfer such authority is recognition that the authority existed in the first place. It is also an issue of the "haves" *vs*. the "have-nots", i.e. nations with fleets *vs*. nations without fleets or with only very small fleets. Complicating this issue is the fact that many of the "haves" are DWFNs and many of the "have-nots" are developing coastal states. Some of these coastal states, particularly in the area of the western and central Pacific, control access to large portions of the tuna stocks, so without their input and concurrence in any program to assign property rights, the program would be doomed to failure. Therefore any attempts to address this issue must take into account the positions presented by the "have-nots". Several limited-entry and rights-based options for managing fishing capacity are presented in Section 4.3 of this report.

One series of these rights-based options is directed at the catch level, and deals with different ways of allocating the catch among participants, either countries or individual vessels.

It was pointed out that by assigning IQs, the incentive for fishers to increase fishing capacity beyond the level needed to harvest their IQs would be removed. These self-regulating mechanisms must be augmented by the introduction of programs to buy back excess fishing capacity, and to further reduce the capacity to compensate for increases in efficiency. It was pointed out, however, that the assignment of IQs in tuna fisheries would be complicated because of the complex nature of those fisheries. The fisheries are multi-species, multinational and multi-gear. Some fisheries have vessels from many nations fishing in the same area for the same species. Various types of gear are used to make the harvests, with some gear types being specific to certain nations. Some species are harvested mostly by a single gear type, or only two gear types. Some of the species being taken during a single operation of the gear are overexploited, while others are not fully exploited. Some nations concentrate on one species, and other nations on different species. The definition of IQs and the efficient administration of an IQ program would be difficult for many of the tuna fisheries.

A more practical approach to capacity management might be best directed at the vessel level, rather than the catch level, particularly given the state of property rights and sovereignty. Two such vessel-level options are presented in Section 4.3. One of these is a modification of the IATTC's RVR, (which is, in essence, a weaker form of limited entry), with a buy-back scheme for reducing the current capacity of tuna fleets, and to take account of increases in vessel efficiency. The other option outlines a system for limited entry of vessels into tuna fisheries. One scheme allots a licence to each vessel in the fishery, but includes buy-back mechanisms for reducing capacities to target levels. The other scheme provides for auctioning either full or fractional shares of licences, with a buy-back provision to compensate for increases in efficiency of licensed vessels.

Of the various options presented, it appears that those directed at the vessel level would be the easiest to design and administer. Over the short term, it appears that RVRs would be most likely to be accepted by the governments making up the various regional tuna bodies.

6. RECOMMENDATIONS

The foregoing discussion of the DEA results and the initiatives taken by the OPRT provide clear evidence that excess fishing capacity is endangering the health of the world's tuna stocks. There is an urgent need to implement programs to address this excess capacity problem. The process of developing acceptable programs to reduce capacity will be difficult to achieve. The regional tuna bodies should consider implementing, in the immediate future, measures to place moratoria on the growth of capacity in all tuna fisheries. Even though information is not available on the numbers and capacities of pole-and-line, small longline and other types of vessels that fish on the high seas, the moratoria should apply to these vessels as well. A moratorium for the western and central Pacific could be achieved by strictly adhering to the principles of the Palau Arrangement, and in other areas by the introduction of RVRs. The immediate implementation of moratoria, coupled with other management measures, would help to prevent any further overfishing of the tuna stocks.

Along these same lines, the WTPO has called for the establishment of a world-wide vessel register similar to the RVR of the IATTC, but without the provision for transfer of vessels, which would freeze capital stock. If implemented, this would limit world purse-seine capacity to present levels. It would be helpful if governments placed a high priority on assisting the WTPO to implement this initiative.

There is a strong need for the regional tuna bodies to collect information on the numbers, capacities and characteristics of other tuna vessels, such as pole-and-line vessels and trollers, so that it can be used to determine whether excess capacity exists for these fleets and, if so, to what levels they should be adjusted.

For a long-term solution to the excess capacity problem, rights-based management of tuna resources should be considered. Because of the complexity of the tuna fisheries, preference should be given at the outset to evaluating options that are directed at the vessel level, rather than at the catch level. RVRs, coupled with buy-back programs, provide good possibilities for achieving this objective.

Whatever mechanisms are selected for managing fishing capacity, it is essential that there be some means of ensuring that the provisions of the program are complied with. This will require surveillance and monitoring schemes, which might require the use of on-board observers and/or global positioning satellite (GPS) equipment aboard the vessels. This would be particularly important for areas where the boundaries of the areas of concern of the regional tuna bodies abut or overlap. It would also be important to have some means of exchanging information among the regional tuna bodies regarding their programs to limit capacity and what the effects of these may be on the programs in other regions. Also important would be some mechanisms for dealing with IUU vessels. These mechanisms could take the form of various multilateral restrictions and sanctions imposed by the participating governments. A permanent committee, comprised of representatives of each of the regional tuna bodies, would be necessary to accomplish these objectives.

Finally, it is clear that tuna fisheries are at a critical juncture. With the exception of Atlantic bluefin, southern bluefin and bigeye, most stocks of tuna are not overfished. Since overfishing is the result of too much fishing capacity, and since there is too much fishing capacity in most of the tuna fisheries of the world, it is urgent that programs be implemented to stop the growth in capacity before resource degradation and economic chaos result, and to bring that capacity to levels in balance with the productivity of the resources.

ACKNOWLEDGEMENTS

The author thanks the FAO Fisheries Department for financing this publication and the reported study. He is particularly grateful to Dr. Jacek Majkowski, Fishery Resources Officer, Marine Resources Service, of the FAO Fisheries Department for organizing it and for his assistance. The report was written within the framework of FAO Project GCP/INT/851/JPN.

The author also thanks Dr. William Bayliff of the Inter-American Tropical Tuna Commission and Dr. Dale Squires of the U.S. National Marine Fisheries Service for reviewing this manuscript.

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