Tuna fishing capacity: perspective of the purse-seine fishing industry on factors affecting it and its management

Julio Morón
Member, Board of Directors, World Tuna Purse-Seine Organization
Organización de Productores Asociados de Grandes Atuneros Congeladores (OPAGAC)
Ayala 54, 28001 Madrid, Spain
opagac@arrakis.es

ABSTRACT

The tuna fisheries are multi-gear fisheries directed mostly at different life stages of skipjack, yellowfin, bigeye and albacore. Up to now, international management of tuna fisheries has been concentrated mainly on the outputs of tuna fisheries, *i.e.* catch, and much less on inputs *i.e.* effort and fishing capacity. Currently, assessments of tuna stocks are based largely on long series of catch and effort data, which are complete, or nearly so, for some fisheries, but not so for others, due to the extensive practice of Illegal, Unreported and Unregulated (IUU) fishing and the poor sampling coverage of some industrial fleets and many artisanal fleets. It is clear that that there must be limits on fishing capacity. Data for Spanish purse seiners that fish in the Indian Ocean indicate that the efficiencies of the individual vessels have been increasing, so this must be taken into consideration in selection of measures to control input.

1. INTRODUCTION

The status of most stocks of tunas is now highly uncertain because of different and complex elements, mainly political, that do not allow the members of the various regional fisheries organizations (RFOs) concerned with tunas to reach agreements that could lead to effective management.

The history of fisheries management tells us that no fishery under an open-access scheme has been able to maintain the resources at rational levels of exploitation (Gréboval, 1999; Gréboval and Munro, 1999; Cunningham and Gréboval, 2001). If the application of limited-access schemes has been difficult in local fisheries, which are normally controlled by a single country, one can imagine the difficulties that this has in tuna RFOs, with so many countries and so many interests involved.

Tuna fisheries, by the migratory nature of the species of fish involved, are, in principle, subject to open access to all participants—vessels of countries that are presently fishing and vessels of coastal countries with adjacency to the resource. Transition from an open-access fishery to a limited-access fishery has proven to be extremely difficult for tuna RFOs to implement, with only one scheme in operation (in the eastern Pacific Ocean), and this for only a segment of the fleet (the purse-seine fleet) (Resolution C-02-03 (Resolution on the Capacity of the Tuna Fleet Operating in the Eastern Pacific Ocean (Revised)) of the Inter-American Tropical Tuna Commission (IATTC).

The tuna fisheries are multi-gear fisheries directed at different life stages of skipjack, *Katsuwonus pelamis*, yellowfin, *Thunnus albacares*, bigeye, *T. obesus*, albacore, *T.*

alalunga and, to a lesser extent, three species of bluefin, *T. thynnus*, *T. orientalis* and *T. maccoyii*. Estimating an appropriate level of fishing capacity for even one fishery is a challenging problem. Up to now, international management of tuna fisheries has been concentrated mainly on the outputs of tuna fisheries, *i.e*. catch, and much less on inputs *i.e.* effort and fishing capacity. In contrast to other fisheries, indices of abundance are not obtainable from catch and effort data for purse-seine fisheries for tunas.

Currently, assessments of tuna stocks are based largely on long series of catch and effort data, which are complete, or nearly so, for some fisheries, but not so for others, due to the extensive practice of Illegal, Unreported and Unregulated (IUU) fishing and the poor sampling coverage of some industrial fleets and many artisanal fleets.

The levels of exploitation of the world tuna resources are reaching or have reached critical points for many stocks of fish, and management actions by most of the RFOs are urgently needed. Unfortunately, however, because of lack of information, this is difficult to do.

The World Tuna Purse-Seine Organization (WTPO), since its creation in 2001, has been calling for limitations on fleet capacity appropriate to the tuna stocks that they exploit to be applied by all the RFOs as the principal element for effective management.

2. THE FAO INTERNATIONAL PLAN OF ACTION FOR THE MANAGEMENT OF FISHING CAPACITY

The immediate objective of the FAO IPOA for the Management of Fishing Capacity (FAO, 1999) is "for States and RFOs, to achieve world-wide, preferably by 2003 but not later than 2005, an efficient, equitable and transparent management of fishing capacity. Inter alia, States and regional fisheries organizations confronted with an overcapacity problem, where capacity is undermining achievement of long-term sustainability outcomes, should endeavour initially to limit at present level and progressively reduce the fishing capacity applied to affected fisheries".

It is clear that sometimes the good faith of governments in approving documents, such as the FAO IPOA for the Management of Fishing Capacity, for voluntary application within the FAO framework proves to be useless when some countries do not cooperate because the actions conflict with their political, social or economic interests. Of the five RFOs, only one, the IATTC, has been even partially successful in limiting fishing capacity, and that success was realized for only one segment of the fleet, purse seiners.

3. FACTORS AFFECTING FISHING CAPACITY

3.1 Effective fishing effort

The major problem affecting the estimates of tuna purse-seine capacity, is to correlate any measure used in capacity (*e.g.* cubic meters of storage space for the catch, gross tonnage (GT) or maximum tonnage of frozen fish that the vessel can carry) with fishing effort (days at sea, days fishing, *etc.*) and its reflection of effective fishing effort. Pella and Psaropulos (1975), Gascuel, Fonteneau and Foucher (1993), Fonteneau, Gaertner and Nordstrom (1999) and Soto, Morón and Pallerés (2000) have attempted to estimate the increases in fishing efficiency of purse-seine vessels with time, but, for the most part, their results have not been regularly taken into consideration in stock assessment.

The lack of the basic information with which to estimate the increases in fishing efficiency is a major problem that scientists encounter when addressing this problem. Tuna scientists have paid little attention to changes in fishing gear and techniques, which are key elements to consider in estimating the increases in fishing capacity of purse-seine vessels. Among the technical advances that have been identified as principal causes of increases in fishing efficiency are increased size of the vessels, the use of bird radar, sonar, echo sounders, fish-aggregating devices (FADs), radio buoys, satellite buoys, satellite information on sea-surface temperature, sea-level height, currents, ocean fronts, *etc.* (Increased size of the vessels contributes to efficiency because larger vessels are faster, and can search greater areas per unit of time than can smaller vessels.) Details as to when these elements were introduced to the tuna purse-seine fisheries and the extents to which they are used are unknown in most cases, and it would now be difficult or impossible to obtain this information.

FIGURE 1
Catches per vessel by vessels of the Spanish purse-seine fleet in the Indian Ocean from 1984 to 2004, with the logarithmic trend

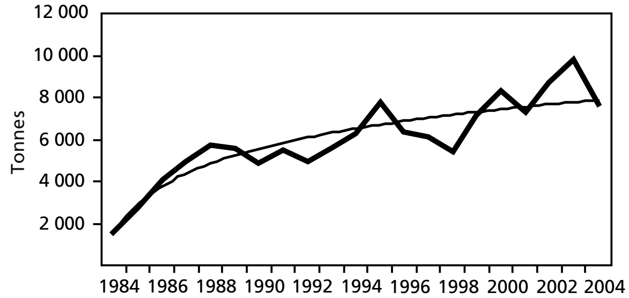


FIGURE 2
Catches per GT by vessels of the Spanish purse-seine fleet in the Indian Ocean from 1984 to 2004, with the logarithmic trend

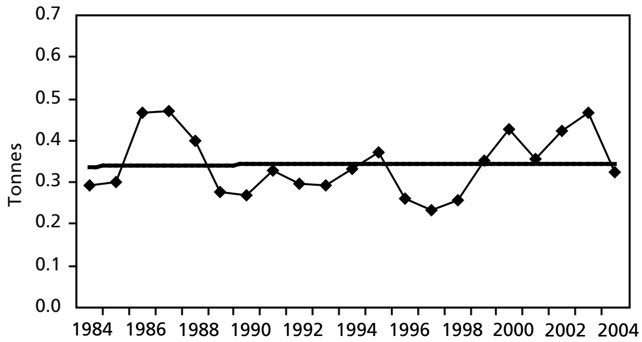
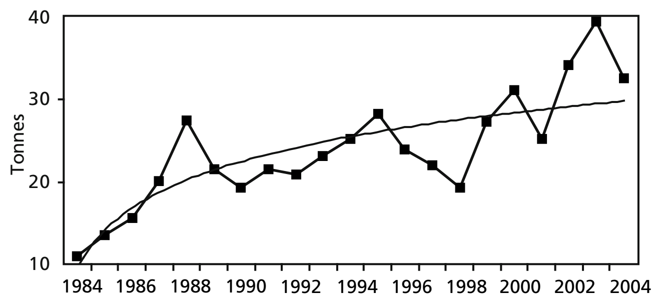


FIGURE 3
Catches per day of fishing by vessels of the Spanish purse-seine fleet in the Indian Ocean from 1984 to 2004, with the logarithmic trend



Let us illustrate this with an example for the Spanish purse-seine fishery in the Indian Ocean. The Indian Ocean purse-seine fishery for skipjack and yellowfin could be considered a virgin fishery before the arrival of vessels from Spain and France in 1984. The stocks of skipjack and yellowfin could not be considered virgin stocks, however, because they were exploited by coastal fisheries, which targeted mainly skipjack, and longline fisheries, which took significant amounts of yellowfin, before the introduction of purse-seine fishing.

The trends in the catch rates for the Spanish fleet in the Indian Ocean, are quite similar for catch per vessel (Figure 1) and catch per days fishing (Figure 3), but very different for catch per GT (Figure 2). None of the three could be correlated with the estimated trends in abundance, which should be greater at the beginning of exploitation and less when the effort increases, as predicted by most biomass dynamic models (Hilborn and Walters, 1992: pages 76-89).

The average catch per vessel has increased by about 11 percent per year since the inception of the fishery in 1984. The increase in the catch per vessel during the first few years of activity (1984-1988) was probably due to familiarization of the fishermen with fishing conditions. After that, from about 1989 to 1993, the catches per vessel were approximately stable at about 5 500 tonnes. Then the catches per vessel increased again, averaging about 8 000 tonnes per vessel from 1999 to 2004). That increase in catch per vessel is the result of increased fishing efficiency, rather than to increased abundance of fish.

Despite the flat trend line in the catch rate as catch per total capacity in GT, the average increase during the entire period is about 3 percent per year, due mainly to the increase during the 1999-2004 period, when the average size of the vessels increased from about 800 GT to about 1 200 GT.

The general trend of the catch per days fishing indicates a yearly increase of about 4 percent for the entire period, but with four different periods:

- An increase during the early years (1984-1988), which is the logical situation in an underexploited fishery.
- A large decrease during 1989-1990, followed by a steady increase until 1995, probably due to the introduction of the use of FADs.
- A decline until 1998, corresponding to a large increase in fishing effort, averaging about 6 000 fishing days. (During the early years of the fishery the effort was never as great as 5 000 fishing days.)
- A period of great increase after 1999, which is probably related to technological changes that have increased the effective fishing effort, rather than to increased abundance of fish.

Various technical innovations have increased the effective fishing effort of the purse-seine fishery by increasing the ability of the fishermen to detect the presence of fish. In addition, other technical innovations have made it possible to set and retrieve the net and bring the catch aboard the vessel more quickly, which, in turn, increases the time available for searching for fish. Based on the research of Gascuel, Fonteneau and Foucher (1993) and Fonteneau, Gaertner and Nordstrom (1999), the Standing Committee for Research and Statistics (SCRS) of the International Commission for the Conservation of Atlantic Tunas (ICCAT), considered that there had been a 3 percent yearly increase of the effective fishing effort of the purse-seine fishery in the Atlantic Ocean. The Scientific Committee of the Indian Ocean Tuna Commission (IOTC) reached the same conclusion for the Indian Ocean, and this estimate coincided with the results of Morón (2004). This adjustment is useful, but it does not solve the basic problem of estimating the effective fishing effort in tuna purse-seine fisheries.

As we have shown, different catch rates can provide different estimates of the relative abundance of the fish. Therefore, a combination of effort and capacity estimates should be incorporated into any approach to estimation of optimal fishing capacity.

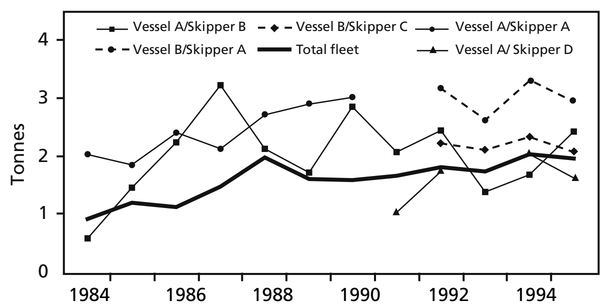
3.2 Skipper factor

The skill of the skipper (and the rest of the crew) of a vessel obviously affects its catches. (The skill of the rest of the crew can be ignored, as the most skillful skippers are able to attract the most skillful crews, so the effects of the two factors cannot be separated.) Few studies of the skill of the skippers of tuna purse-seine vessels have been made.

Some information on the catches per day of fish by four skippers aboard two vessels is presented in Figure 4. It can be seen that Skipper A was the most skillful, as his catches per hour of fishing exceeded those of the other skippers, except in 1987, whether he was aboard Vessel A or Vessel B. Skipper B, who was aboard Vessel A during every year of the 1984-1995 period, produced above-average catches during all but three of

FIGURE 4

Catch rates (tonnes per hour of fishing) of four skippers on two different vessels, compared with average catch rates of all skippers of the Spanish fleet operating in the Indian Ocean from 1984 to 1995 (redrawn from Morón, 2004)



those years. (Vessels often have different skippers on different trips made during the same year.) Skipper C, who was aboard Vessel B during 1992-1995, produced above-average catches in all four of those years. Skipper D, who was aboard Vessel A during 1991-1992 and 1994-1995 produced below-average catches in two of those four years.

Unfortunately, as was the case for technological improvements, extensive information on which skippers were aboard which vessels during which trips is not readily available, so it would be difficult or impossible to conduct detailed analyses of the effect of skippers on fishing success.

3.3 The multispecific nature of the purse-seine fisheries for tunas

The multispecific nature of the purse-seine fisheries for tunas complicates the management of tuna purse-seine fishing capacity. The purse-seine catches of tunas in the Indian Ocean include two principal species, skipjack and yellowfin. Bigeye are also caught, but the amounts are much less than those of skipjack and yellowfin.

The percentages of those three species in the purse-seine catches of tunas in four major ocean fishing areas are shown in Table 1. It is well known that the purse-seine catches in the western Pacific are dominated by skipjack (68 percent) and that those in the eastern Pacific are dominated by yellowfin (64 percent). The purse-seine catches of tunas in the Atlantic have a greater proportion of yellowfin (53 percent), whereas those of the Indian Ocean have a greater proportion of skipjack (50 percent). The percentages of bigeye in the purse-seine catches range from 3 to 7 percent.

The multispecific nature of the purse-seine fishery for tunas makes management of the three species difficult, as there is no level of fishing effort that is appropriate for all three species.

It is widely accepted that skipjack are not overfished in any the four major ocean fishing areas (IATTC, 2005; ICCAT, 2005; IOTC, 2005; SCTB, 2005), although in certain areas of the Atlantic there may be local depletion of skipjack (ICCAT, 2005).

Yellowfin are exploited at about the MSY level in the eastern Pacific and the Atlantic (IATTC, 2005; ICCAT, 2005), but are somewhat above that level in the Indian Ocean and the western Pacific (IOTC, 2005; SCTB, 2005).

All of the bigeye stocks are considered to be overexploited (IATTC, 2005; ICCAT, 2005; IOTC, 2005; SCTB 2005).

When looking at the species compositions of the catches in the major fishing areas we observe different trends in the percentages of the various species in the catches.

The percentages of the three species in the purse-seine catches of the western and central Pacific Ocean are shown in Figure 5. The percentages that were yellowfin increased from the early 1960s to the mid-1970s, and then declined, making up only about 20 percent of the catch during the 1990s

TABLE 1
Average percentages of skipjack, yellowfin and bigeye in the purse-seine catches in the four major fishing areas (Sources: IOTC, ICCAT and Lawson, 2005)

Average proportion of each species	Skipjack	Yellowfin	Bigeye
Indian (1984-2004)	50%	44%	7%
Atlantic (1966-2004)	39%	53%	6%
Western Pacific (1951-2004)	68%	29%	3%
Eastern Pacific (1950-2004)	33%	64%	4%

FIGURE 5
Percentages of species in the purse-seine catches of the western and central Pacific Ocean from 1951 to 2004 (from Lawson, 2004)

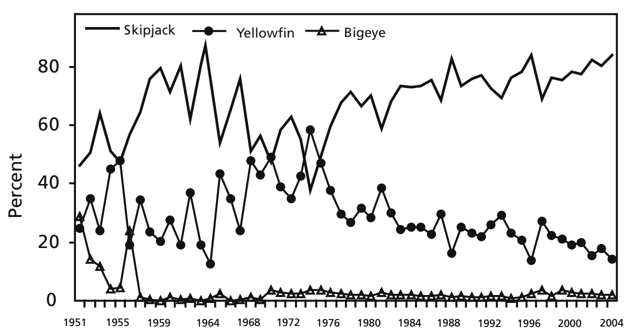


FIGURE 6
Percentages of species in the purse-seine catches of the eastern Pacific Ocean from 1951 to 2004

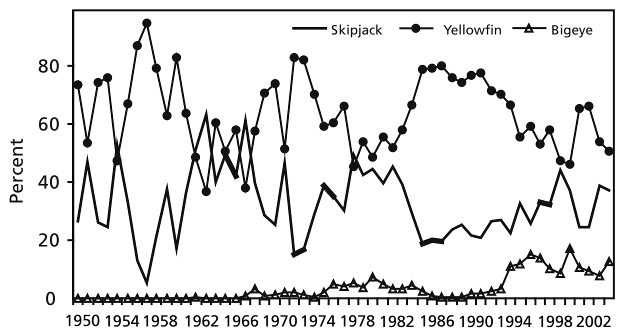
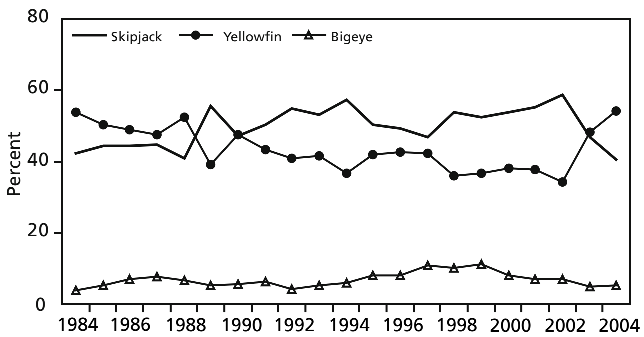


FIGURE 7
Percentages of species in the purse-seine catches of the Indian Ocean from 1984 to 2004



and early to mid-2000s. Skipjack, on the other hand, made up more than 50 percent of the catch in most years, and the percentages tended to increase after the mid-1970s. This increase could not be entirely due to the use of FADs, as FADs did not come into use until the early 1990s. The percentages of bigeye in the catches were relatively high during the early to mid-1950s, but then levelled off at less than 5 percent of the total catches.

The purse-seine catch of eastern Pacific Ocean has been dominated by the yellowfin since the early 1950s, except for a period during the 1960s when the skipjack and yellowfin catches were about equal (Figure 6). Since then the yellowfin catches have exceeded those of skipjack, except in 1978, and far exceeded those of skipjack from the mid-1980s to the mid-1990s. It should be noted that the percentage of the catch that was bigeye increased after 1993. It averaged 12 percent of the total during 1995-2004—greater than the percentage of bigeye in any other ocean fishing area. That increase in the estimated catches of bigeye was due mostly to the introduction of fishing on schools associated with FADs, but also to improved sampling of the catches, as bigeye had sometimes been recorded as yellowfin prior to the early 1990s.

The percentages of the catches of skipjack and yellowfin in the purse-seine fishery of the Indian Ocean are nearly equal, with the catches of yellowfin exceeding those of skipjack during 1984-1988 and 2004, and those of skipjack exceeding those of yellowfin during 1989, 1991 and 1993-2002 (Figure 7). About 10 percent of the catch was bigeye during the late 1990s, but it has been reduced to about 5 percent during recent years.

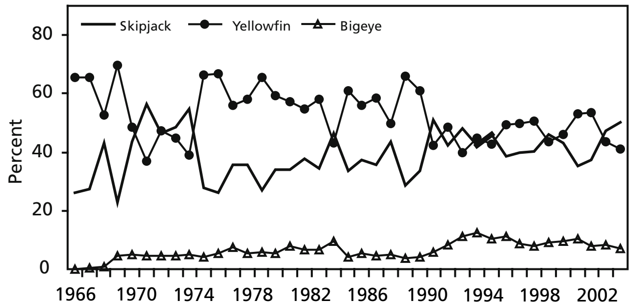
The percentages of the catches of yellowfin exceeded those of skipjack in the purse-seine fishery of the Atlantic Ocean from 1966 to 1990, except for 1971-1974 and 1984. Since 1991, the percentages of the catches of yellowfin and skipjack have been about equal (Figure 8). The percentages of bigeye increased during the early 1990s, averaging almost 10 percent from 1992 to 2004. This increase was probably due to the introduction of the use of FADs during the early 1990s.

Because, as noted above, the different species have been affected differently by the fisheries, we must consider the possibility of to applying different management options for the different species. In some cases, however, a species can be adversely affected by a fishery that is not directed at that species. For example, purse-seine fisheries are directed at skipjack and yellowfin, but their catches include minor amounts of bigeye. Most of the purse-seine catches of bigeye are taken in sets on FADs.

The decline in abundance of bigeye is the result of heavy fishing effort by longliners, catches of juvenile bigeye by purse seiners and unfavourable environmental conditions. Any management action taken should be directed at all fleets exploiting

FIGURE 8

Percentages of species in the purse-seine catches of the Atlantic Ocean from 1966 to 2004



the species under consideration, in this case both the longline and purse-seine fleets. The condition of bigeye led to studies of the interactions between the purse-seine and longline gear during the early 1990s (Shomura, Majkowski and Langi, 1994), without clear conclusions on the effects of the different gear types on one another.

Limitation of fishing capacity, a specific management action, should be applied immediately to the industrial fleets (mainly longline and purse seine) that exploit the two major tropical tuna stocks, bigeye and yellowfin, which are fully exploited or overexploited. This would prevent the situation from worsening. Once limitation of fishing capacity is in effect, other management measures could be implemented to regulate the exploitation of each species at its optimum level, whatever the reference point utilized.

4. EXISTING MEASURES FOR MANAGING TUNA FISHING CAPACITY

As we mentioned previously, the first actual management measure taken to control purse-seine capacity in a major fishing area was Resolution C-02-03 of the IATTC, "Resolution on the Capacity of the Tuna Fleet Operating in the Eastern Pacific Ocean (Revised)". Before that, the Palau Arrangement (FFA, 1992), was the first management instrument implemented at a subregional level to control a purse-seine fishery, setting a limited number of vessels to be licensed by the signatory countries of the Palau Arrangement. These are the only effective examples of fleet management in tropical tuna fisheries. Both are directed only at purse-seine fisheries. The numbers of purse-seine vessels, the importance of their catches and the fact that their catches are unloaded at relatively few major locations, which facilitates monitoring and control and minimizes IUU fishing, has made this fleet the first target for management..

4.1 The IATTC

Resolutions to limit the capacity of the tuna purse-seine fleet in the eastern Pacific Ocean (EPO) were approved by the IATTC at its 62nd meeting in October 1998 and by correspondence on 19 August 2000. After four years of intense negotiations and six meetings of the Special Working Group on Fishing Capacity, the 69th meeting of the IATTC adopted Resolution C-02-03.

Resolution C-02-03 provides every participant ("Parties to the IATTC, and States and regional economic integration organizations …, and fishing entities that have applied for membership of the Commission or that cooperate with the management and conservation measures adopted by the Commission.) in the fishery a maximum fish-carrying capacity for its purse-seine fleet, with a not-well-defined provision for capacity transfer among participants. One of the major problems in the application of this resolution has been transfer of vessels among participants, which was not resolved until June 2005, at the 73rd meeting of the IATTC.

Resolution C-02-03 resulted in allocation of a maximum carrying capacity for each country, which was first measured in tonnes of carrying capacity, and later transformed into cubic metres of well volume, a more objective measure of carrying capacity. The countries whose fleets had less carrying capacity than the amounts that were allocated to them were given time periods in which to increase their capacities to the maxima that they were permitted to have. The principal goal of the negotiations was to freeze the overall fleet capacity at the level of 1998, although some changes were introduced between the time the negotiations began and the adoption of the resolution in 2002.

The issue of transfer of vessels among participants has been a problem. Some countries allow free entry and exit of vessels, recognizing rights of vessel owners to transfer their registrations from one country to another, but there are others that consider the fleet capacity to be a non-transferable right that belongs to the country. In the latter case, if a vessel owner transfers the registration of his vessel to another country, the government of the first country considers that it retains the same capacity allocation, and that it can issue the allocation of the transferred vessel to another vessel. The net result, unfortunately, has been that the total carrying capacity of purse seiners in the EPO increased from about 162 thousand tonnes in 1998 to about 206 thousand tonnes in 2004 (IATTC, 2005: Table A-11).

4.2 The Palau Arrangement

Concerns about the level of exploitation of tuna resources in the western and central Pacific Ocean (Muller and Wright, 1990), was the driving force to prepare the ground for the signatories of the Palau Arrangement. This arrangement first set a maximum number of purse-seine vessels to be licensed by the members of the Parties to the Nauru Agreement (PNA; Federated States of Micronesia, Kiribati, Marshall Islands, Nauru, Palau, Papua New Guinea, Solomon Islands and Tuvalu) in 1990, giving access to 164 purse-seine vessels in the EEZs of the PNA members, including the adjacent high seas of the WCPO in which purse-seine vessels operate. This concept is based on the legal framework of the United Nations Convention on the Law of the Sea, and for that reason it has received major support from countries that have large vessels that fish in the WCPO. The limit was later raised from 164 to 205 purse-seine vessels in 1993 (Dunn, Rodwell and Joseph, 2006).

This limit will remain effective until the new Vessel Day Scheme (VDS) enters into force in 2007. The reason for the change is to "enhance sustainability of the Western and Central Pacific purse seine fishery by controlling the level of fishing effort" from the biological perspective. From the economic perspective "it aims to increase economic benefits to resource-owning states by creating a real limit on fishing days that will create a demand from vessel operators for these days" (Dunn, Rodwell and Joseph, 2006).

The first concern of the vessel operators is the way that the number of days may be set. The general intention is to limit fishing effort to the 2004 levels, but there might be other elements taken in account when finalizing the total allowable effort, with particular focus on fishery development. There are other exemptions that will be considered in the new scheme to the Multilateral Treaty on Fisheries with the United States (UST) (FFA, 1987) and the FSM Arrangement for Regional Fisheries Access (FSMA) (FFA, 1994) that will reduce the number of days available for the rest of the operators.

The different fees to be paid in accordance with vessel size and the possibility of carrying over fishing days to future years, borrow fishing days from future years and transfer fishing days among PNA members could be, in a way, limited by the three-year limit of the scheme. This might result in situations in which no fishing days were transferred in one year, and an excess of fishing days were offered in the following year, producing excessive fishing effort in the latter year.

5. CONCLUSION

Hilborn and Walters (1992) mention a first principle on fisheries management: "You cannot determine the potential yield from a fish stock without overexploiting it". We believe that that time has not arrived for skipjack, but the other two species caught by the purse-seine gear, yellowfin and bigeye, are fully exploited or overexploited.

Unfortunately, the fishing effort for those two species is greater than that corresponding to the MSY levels, and scientists who have studied them recommend that the effort for the major gears that exploit them be limited or reduced.

Hilborn and Walters (1992) propose a second principle that is of key importance for the purpose of the management of tuna fishing capacity: "The hardest thing to do in fisheries management is reduce fishing pressure". In applying limitations on current fishing capacity in the four major tuna fishing areas, we will not address the problem of effort reduction. With a capacity limitation we only reduce the speed at which the problem worsens, because the effective fishing effort will continue to increase due to technological advances and other factors, and therefore the stocks will still be subjected to increasing fishing pressure.

A management scheme for the tropical tuna fleets should take into consideration the following principles:

- Recognizing the difficulties in assessing the fishing capacities that are appropriate to each stock status, applying the Precautionary Approach and the application of an immediate fleet capacity limitation to the current number of vessels operating in the four areas studied by for RFOs (IATTC, ICCAT, IOTC and WCPFC) should be the first priority.
- Any fleet capacity scheme should be applied equally to all the industrial fleets exploiting the two major tropical tuna species, yellowfin and bigeye, that are currently fully exploited or overexploited.
- Until a practical quantitative tool can be developed and adequate data that can be used with that tool to estimate fleet capacity relative to stock status, the total fish-carrying capacity of the current vessels, (preferably in cubic metres), should be used as the limiting factor for capacity.
- Under a RFO state-based capacity scheme, privately-generated rights should be considered by governments to allow free transfer of vessels among members of the RFOs in order to avoid later increases of capacity, which should provide legal security for vessel operators operating in different countries.
- Only vessels flying the flag of members or cooperating parties (CPCs) of the RFOs that are currently fishing in the areas studied by the RFOs and listed in the registers of those RFOs should be allowed to fish in those areas.
- Only vessels listed in the registers of the RFOs should be allowed to unload, transfer, store or market fish caught in the waters of the RFOs. Furthermore, the countries should not permit exportation or importation of fish that were caught by vessels that were not listed in the vessel registers of the RFOs responsible for the areas in which the fish were caught. Vessels that fish in areas for which they are not listed in the vessel registers will be considered to be engaged in IUU fishing.
- In order to link responsible fishing with responsible marketing, a marketing certificate should be issued to each vessel included in the RFO register, and only fish caught by vessels with certificates can be bought and sold.

Burrows (2006) mentions that "Perceptions of stakeholders must be addressed equally as well as facts in the allocation process if decisions are to be supported". This is a final remark that we want to address, because the lack of communication among stakeholders (mainly operators of small vessels registered in developing coastal countries and operators of larger vessels registered in distant countries) sometimes leads to intervention by third parties (government agencies, consultants, non-governmental organizations, *etc.*) with different interests or agendas. Any proposed management scheme should include involvement and support of the major stakeholders affected by the application of schemes to maximize the levels of compliance.

6. REFERENCES

Burrows, R. 2006. Stakeholder involvement in the allocation process. Sharing the Fish Conference 2006. Fremantle, Australia: 12 pp.

Cunningham, S. & Gréboval, D. 2001. Managing fishing capacity: a review of policy and technical issues. *FAO Fish. Tech. Paper* No. 409: 60 pp. Rome.

Dunn, S., Rodwell, L. & Joseph, G. 2006. The Palau Arrangement for the management of Western Central Pacific purse seine fishery–Management Scheme (Vessel Day Scheme). Sharing the Fish Conference 2006. Fremantle, Australia: 7 pp.

FAO. 1999. International Plan of Action on Fishing Capacity. Rome.

FFA. 1987. Treaty on fisheries between the government of certain Pacific Island states and the government of the United States of America. Forum Fisheries Agency, Honiara, Solomon Islands.

FFA. 1992. Palau Arrangement for the Management of the Western Pacific Purse Seine Fishery. Forum Fisheries Agency, Honiara, Solomon Islands.

FFA. 1994. Federated States of Micronesia Arrangement for Regional Fisheries Access. FFA Report 94/42: 40 pp. Forum Fisheries Agency, Honiara, Solomon Islands.

Fonteneau, A., Gaertner, D. & Nordstrom, V. 1999. An overview of problems in the catch per unit of effort and abundance relationship for the tropical purse seine fisheries. *Coll. Vol. Sci. Pap. Inter. Comm. Conser. Atlantic Tunas*, 49 (3): 258-278.

Gascuel, D., Fonteneau, A. & Foucher, E. 1993." Analyse de l'évolution des puissance de pêche par l'analyse des cohortes: application aux senneurs exploitant l'albacore (*Thunnus albacares*) dans l'Atlantique est. *Aquat. Living Resour.* 6: 15-30.

Gréboval, D. (ed.). 1999. Managing fishing capacity: selected papers on underlying concepts and issues. *FAO Fish. Tech. Paper* No. 386: 206 pp. Rome.

Gréboval, D. & Munro, G. 1999. Overcapitilization and excess capacity in world fisheries: underlying economics and methods of control. *In* D. Gréboval (ed.) Managing Fishing Capacity. *FAO Fish. Tech. Paper* No. 386. Rome.

Hillborn, R. & Walters, C.J. 1992. *Quantitative Fisheries Stock Assessment*: 570 pp. Chapman and Hall, New York.

IATTC. 2005. Tunas and billfishes in the eastern Pacific Ocean in 2004. *Inter-Amer. Trop. Tuna Comm., Fish. Status Rep.* No. 3: 119 pp. La Jolla, California.

ICCAT. 2005. Report of the 2005 meeting of the Standing Committee on Research and Statistics (SCRS) (Madrid, Spain, October 3 to 7, 2005): 185 pp. http://www.iccat.es/Documents/SCRS/SCRS%202005%20ENG.pdf.

IOTC. 2005. Report of the Eighth Session of the Scientific Committee. Victoria, Seychelles, 7-11 November 2005: 82 pp. http://www.iotc.org/files/proceedings/2005/sc/IOTC-2005-SC-R[EN].pdf

Lawson, T.A. (ed.). 2005. Western and Central Pacific Fisheries Commission Tuna Fishery Yearbook 2004. Western and Central Pacific Fisheries Commission, Pohnpei, Federated States of Micronesia: 188 pp.

Morón, J. 2004. Estudio sobre la pesca de túnidos y evaluación de la capturabilidad de la flota española de cerco en el Océano Índico Occidental. Tesis Doctoral, Departamento de Zoología y Antropología Física, Facultad de Ciencias Biológicas, Universidad Complutense, Madrid: 194 pp.

Muller, D.A.P. & Wright, A. 1990. The western Pacific purse seine fishery: a summary of concerns. FFA Report 90/27. Forum Fisheries Agency, Honiara, Solomon Islands.

Pella, J.J. & Psaropulos, C.T. 1975. Measures of tuna abundance from purse-seine operations in the eastern Pacific Ocean adjusted for fleet-wide evolution of increased fishing power, 1960-1971. Inter-Amer. Trop. Tuna Comm., Bull. 16 (4): 279-400.

SCTB (Standing Committee on Tuna and Billfish, Secretariat of the Pacific Community)**.** 2005. Report of the seventeenth meeting of the standing committee on tuna and billfish. 9-18 August 2004. Majuro (Republic of the Marshall Islands). Oceanic Fisheries

Programme, Secretariat of the Pacific Community: 176 pp. http://www.spc.org.nc/oceanfish/Html/SCTB/SCTB17/SCTB17_Final_Report.pdf.

Shomura, R.S., Majkowski, J. & Langi S. (eds.). 1994. Interactions of Pacific tuna fisheries. Proceedings of the First FAO Expert Consultation on Interactions of Pacific Tuna Fisheries. 3-11 December 1991. Noumea, New Caledonia. Vol. 1: Summary Report and Papers on Interaction. *FAO Fish. Tech. Paper* No. 336, Vol. 1: 326 pp. Rome.

Soto, M., Morón, J. & Pallarés, P. 2000. Standardized catch rates for yellowfin (*Thunnus albacares*) from the Spanish purse seine fleet (1984-1995). IOTC Proceedings No. 3: 266-275. http://www.iotc.org/files/proceedings/2000/wptt/IOTC-2000-WPTT-04.pdf.