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TARGET SIZE FOR THE TUNA FLEET IN THE EASTERN PACIFIC OCEAN

1. INTRODUCTION

The first meeting of the Permanent Working Group on Fleet Capacity on September 3-4 1998 examined the question of the size of the purse-seine fleet that fishes for the tunas in the eastern Pacific Ocean (EPO). The document *Considerations regarding limiting the growth in capacity of the international tuna purse-seine fleet in the eastern Pacific Ocean* prepared for that meeting concluded that "the current carrying capacity of the fleet, 135,000 metric tons, is large enough to generate the amount of fishing effort or mortality required to catch the [average maximum sustainable yield (AMSY)] of yellowfin and the recommended catch of bigeye from the EPO. It is also capable of generating the amount of fishing effort that produced the highest catch of all species combined in the history of the fishery."

The figure of 135,000 metric tons (t) has been converted into 158,000 cubic meters (m^3) using a multiplier of 1.17051. This rounded figure has been used since 1999 in various documents and resolutions of the Commission as the desired target capacity for the purse-seine fleet, including the *Plan for Regional Management of Fishing Capacity* and the *Resolution on the capacity of the tuna fleet operating in the Eastern Pacific Ocean (revised)* of June 2002.

At the 4th meeting of the Permanent Working Group on Fleet Capacity on July 31-August 2 2000, the target figure was extensively discussed and alternative numbers arising from different management regimes were considered. At the 6th meeting of the Permanent Working Group on Fleet Capacity on March 7-8 2002, the target figure of 158,000 m^3 for the purse-seine fleet was again discussed, taking into account especially the developments in the fishery since 1998, particularly the increased catches of skipjack. The 69th meeting of the IATTC in June 2002 considered the 158,000 m^3 target size of the purse-seine fleet and endorsed it within the context of the Capacity resolution approved at that meeting.

The Permanent Working Group on Fleet Capacity, at its 7th meeting on February 20-21 2004, requested that a target for the size of the purse-seine fleet and also a target for the size of the longline fleet be discussed by the Working Group on Stock Assessment. Accordingly, this document reviews again the question of the size of the purse-seine fleet, and offers some views on a possible target size for the longline fleet that fishes for tunas and billfishes in the EPO.

2. METHODOLOGICAL CONSIDERATIONS

It is difficult to establish a size to which a fleet should be limited. One approach would be to keep it at a size that can take the maximum harvest from the fishery, while at the same time ensuring the sustainability of each stock. In the EPO this is complicated by the fact that there are two main fishing gear types (purse-seine and longline) and three main modes of purse-seine fishing (for unassociated schools of tunas and for tunas associated with dolphins and with floating objects) and that more than one species is frequently caught in a single set.

Likewise, the interaction between the concept of maximum harvest and the objective of sustainability of each stock may create a management inconsistency that might be resolved only by developing independent species-specific fishing methods and management objectives. Thus, the question of an "optimal" fleet size depends to a large extent on management objectives.

For the EPO, however, given the current mix of fishing gears, set types, and species in the fishery, it is logical and prudent to take into account in the establishment of target figures the status of the yellowfin stock and the fishery-related connections between the bigeye and skipjack stocks, particularly considering that a large part of the fleet is not targeting yellowfin, and that the catches of skipjack tuna have increased considerably since 1995, and especially in 1999 and 2000.

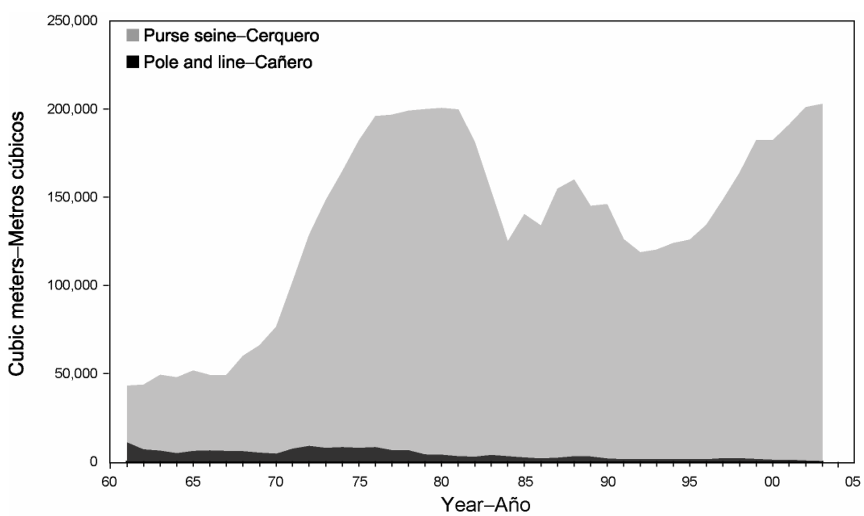
Another important consideration is the efficiency of the fleet. Because improvements in fishing gear, equipment, and techniques generate more effort and more fishing mortality, any figure for "current" optimal fleet size must be considered an upper limit for the desired target. In the case of the purse-seine fisheries, it also depends to a large extent on the composition of the fleet, as vessels of different capacity classes usually have different fishing efficiencies.

The target fleet capacity will also clearly depend on the productivity of the stocks, which changes over time.

3. TARGET PURSE-SEINE FLEET SIZE

One general idea in limiting the size of the fleet is that otherwise the catches per vessel will decline, and the economic pressures on individual vessels will be so great that it would be very difficult to sustain an efficient conservation program. In general, two approaches to establishing a target size for the purse-seine fleet could be considered, one based simply on historical fleet size and its management repercussions, and the other on data on catches and indicators such as catch per unit of effort, yield per recruit and total spawning biomass.

In the first approach the past management of purse-seine tuna fisheries in the EPO is considered in relation to historical fleet size. Fleet size increased rapidly in the early 1970s, reaching about 196,500 m^3 in 1980-1981. It then fell to 121,650 m^3 in 1984, and remained at an average of about 135,000 m^3 until the mid-1990s, when it began to increase again, mirroring the growth of the early 1970s. Fleet size was about 183,800 m^3 in 1999-2001, in 2002 was at 200,075 m^3, and the preliminary figure for 2003 is 202,301 m^3, at an historical maximum.



Regarding restrictions on fishing for yellowfin in the Commission's Yellowfin Regulatory Area (CYRA), the length of the fishing season became shorter during the late 1960s, and by 1970 and through 1977 the fishery was open to unrestricted fishing only 3 or 4 months per year. This clearly coincided with the period of fleet expansion during those years. The length of the fishing season increased gradually during the late 1970s, and there were no restrictions from the early 1980s until 1997. Again, this coincided clearly with the drastic reductions in fleet size followed by a period of relatively low fleet size. Tellingly, when the size of the fleet began to increase again in recent years, there was a need for restrictions once more, beginning in 1998.

Although there are variations in the closures by species and set types, restrictions averaging about 58 days have been recommended for each year since 1999, the year in which the fleet size grew considerably beyond the target capacity of 158,000 m^3, to 180,009 m^3. Under this simple reasoning, the purse-seine fleet is therefore at least 16% (58/365) above the size that would produce the effort necessary for the season to last the whole year. The average fleet size during 1999-2002 was 190,758 m^3; reducing this by 16% would result in a total capacity of 160,236 m^3, which is very close to the target level of 158,000 m^3.

As the closures are the result of the interaction of stock status and fleet performance, the results of this simple analysis are consistent with, and confirm the validity of, the original conclusion that a fleet size of a maximum of about 158,000 m^3 is capable of producing the amount of effort that would keep the fishery and the stocks in good condition. If the purse-seine fleet size were at levels of the early 1980s and early 1990s, there would be no need to shorten the fishing season to conserve yellowfin tuna.

This simple approach could be refined if the number of sets that the purse-seine fleet makes is considered a proxy for purse-seine capacity. About 40% of purse-seine capacity has targeted tunas associated with dolphins, or 10,800 sets per year for the period 1999-2003. This type of fishing is exclusively conducted by large vessels, and catches predominantly medium to large yellowfin tuna (221,778 t on average). Reducing this capacity by 16% would bring the annual number of sets on schools associated with dolphins to 9,072, a level commensurate with the 158,000 m^3 total capacity target.

During the same period, 38.4% of the capacity (10,335 sets per year) has targeted fish in unassociated schools. This type of set is conducted by a mixture of small (55%) and large vessels (44%), and the catch (150,475 t on average) is also a mixture of small yellowfin (59.8%) and skipjack (38.8%). Very little bigeye tuna is taken in this type of fishing. Reducing this capacity by 16% would bring the annual number of sets on unassociated schools to 8,681 also a level commensurate with the 158,000 m^3 total capacity target.

During the same period, purse-seiners that fish on schools associated with floating objects accounted for 21.5% of the capacity, or about 5,782 sets per year (13.3% on natural objects, 85.3% on fish-aggregating devices, or FADS). Most of this type of fishing is carried out by large vessels (88.4%), and the catch (232,433 t on average) is a mixture of the three most important tuna species (18.5% small yellowfin, 62.7% skipjack, and 18.3% small bigeye tuna). It is in this type of fishing, and especially on large vessels fishing with FADs where increased reduction in capacity is called for to conserve bigeye. Recent analyses indicate a 16% capacity reduction is not enough. A 50% reduction would be a precautionary approach with this part of the purse-seine fleet, according to the most recent assessment, bringing down the number of sets per year to around 2,891.

These reduced figures add up to 20,644 sets per year, which implies a reduction of around 23.3% of the average number of sets of all types during 1999-2003 (26,915). If this reduction is applied to the average fleet size during 1999-2002 discussed above (190,758 m^3), a figure of 44,447 m^3 of excess capacity is obtained. The corresponding target fleet size of 146,311 m^3 would be more in line with recent assessment results, especially for bigeye tuna and yellowfin tuna.

The second approach to establishing an optimal size for the purse-seine fleet involves simulating various levels of fishing mortality for the three set types, and examining fishery indicators such as yield per recruit, spawning biomass, and catches of the three main tuna species (yellowfin, bigeye, and skipjack) in the different set types. These simulations have been part of the regular assessment work the last few years.

The approach was specifically used to look at the issue of target capacity for the purse-seine fleet in an analysis of the maximum number of sets on floating objects that the fishery could support prepared for the 68th meeting of the Commission (19-22 June 2001), and in a study of alternatives to the proposed target of 158,000 m^3 reported in the background paper for the 4th meeting of the Permanent Working Group on Fleet Capacity, held in Panama on 31 July-2 August 2000.

Estimates of sustained yields were calculated for each of the three species, for both surface and longline fisheries, because management decisions taken for the purse-seine fleet would affect other components of the fishery. The estimates for yellowfin and bigeye were made using the A-SCALA stock assessment model, while a simpler procedure that assumes that catch is proportional to fishing effort was used for skipjack.

In a more detailed study, the 1999 levels of fishing effort were used as the base case, and the effort that maximizes yellowfin yield was calculated, using combinations of various levels of effort for the three modes of fishing. In another set of simulations, effort levels for the three set types of 40% over the 1999 level and 40% below the 1999 level were used.

The results of the two approaches are consistent. For example, the capacity of the part of the fleet fishing only for tunas associated with dolphins could increase by 90% and still be sustainable. However, this would reduce the spawning biomass to only 16% of its unexploited level, increase the catch of yellowfin tuna by only 5% (11,000 t), and reduce the average catch per vessel fishing for tunas associated with dolphins by about 50%. Thus, while the fishery would still be sustainable if the capacity of the fleet fishing for tunas associated with dolphins were allowed to increase, the catch per vessel would be significantly reduced, and the catch would be only slightly increased.

If, in addition, the effort on floating objects and unassociated schools were reduced to 75% of the 1999 level, the catch of skipjack would decrease by 66,000 t, while that of bigeye would increase by only 2,000 t.

Because the curve that relates yield to fishing effort for yellowfin tuna is flat near the AMSY, increases or decreases in fleet size would have relatively little effect on the AMSY of yellowfin. Thus, these results (and the consistent simulations carried out each year as part of the regular assessment work) show that there are advantages for the fishery in maintaining a fleet size that maximizes the combined catch of yellowfin, bigeye, and skipjack while keeping catch per vessel and longline yields at healthy levels. A total capacity of 158,000 m^3 for the purse-seine fleet would achieve this result.

4. TARGET LONGLINE FLEET SIZE

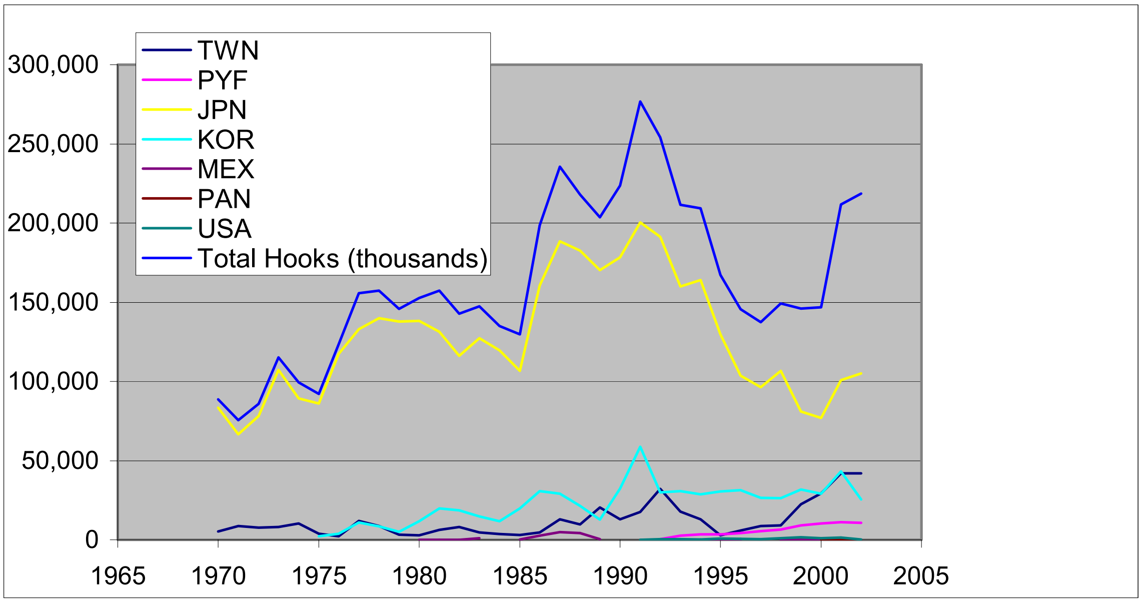
Industrial longline vessels larger than 24 m in length, with freezing capability have been recently referred to as LSTLV (large-scale tuna longline vessels). What has been considered commonly the longline tuna fleet in the EPO consists mostly of vessels of this type. The problem of establishing a target size for this fleet is in some respects similar to the one on purse-seine fisheries. However, detail of reporting and data availability on purse-seine fisheries is much better. For example, catch and effort data have been available only recently for all the major fleets fishing in the EPO, and only for the last few years, and the Commission's Vessels Register is more complete for the purse-seine vessels than it is for longline vessels. One significant limitation of the register is that it contains lists of longline vessels authorized to fish, but very little information is available on a timely basis on vessels actually fishing in the EPO.

One important difference with purse-seine fishing is that longline gear takes generally large individuals, so most of the catches in the EPO consist of bigeye tuna and, to a lesser extent, of yellowfin and albacore tuna. Skipjack is seldom taken by the longline fleet. Billfishes are also important targets of this fishery, especially swordfish and marlins, as well as several types of sharks.

Although the issue of longline effort has been discussed extensively in recent years, the topic of the number of LSTLVs and of the "optimal" longline capacity has not been approached formally. However, the declining catch and catch rates, and the status of main stocks, have led some governments to seek ways to reduce longline capacity. In this regard Japan's initiative to reduce the number of LSTLVs in its fleet by 20% (132 vessels) by the scrapping of vessels in accordance with the FAO International Plan of Action for the Management of Fishing Capacity is noteworthy. States and fishing entities with LSTLVs have been encouraged to undertake initiatives similar to that of Japan with respect to fleet reduction in the EPO, and not to increase their fishing effort in the EPO, in recent resolutions by the Commission. Chinese Taipei, Korea, and other longline fishing partners have taken or are considering taking similar steps.

Annual longline catches of bigeye tuna fluctuated at around 50,000 t during 1970-1985 for the Japanese fleet, the largest component of the fishery. Catch increased during the late 1980s and the early 1990s, reaching a peak of 101,373 t in 1991 for all fleets (85,011 t for Japan). Combined catch declined after that, reaching a low of 30,116 t in 1999. In 2001 the combined catch of bigeye tuna was 62,287 t, and 50,347 t in 2002. The annual combined catch of yellowfin has remained relatively stable during 1985-1999, averaging about 20,000 t. The catch was 25,005 t in 2001 and 13,643 t in 2002.

Nominal effort was more than 100,000 (x1000 hooks) from 1976 to 1996 for Japan, ranging from 103,650 to 200,360 in 1991 and declining to 77,022 (x 1000 hooks) in 2000. The nominal effort for Japan, Korea and Chinese Taipei was 135,429 (x1000 hooks) in 2000. However, in 2001 the effort for Japan increased to 100,824 (x1000 hooks), the effort for Japan, Korea and Chinese Taipei increased to 185,889 (x1000 hooks), and the effort for all fleets combined increased to 211,719 (x1000 hooks), with a catch of 107,800 t of all major species combined. Although data are incomplete, effort for all fleets combined appears to have increased even more for 2002, to more than 218,000 (x1000 hooks).



In considering a target fleet size for the EPO, the approach of calculating target capacity based on recent closures used for the purse-seine fleet would not work, as, until recently, there have been no restrictions on the longline fishery in the EPO. The first management measure of this kind is being implemented in 2004, with the objective of ensuring that the annual longline catch of bigeye tuna in the EPO will not exceed the level of 2001.

For the longline fishery, the simulations described above for the purse-seine fleet have consistently showed that the bigeye yield in the longline fishery would increase if the effort on floating objects were reduced, while the yellowfin yields would increase appreciably if the purse-seine effort were drastically reduced. In general, for bigeye tuna and yellowfin tuna, reducing surface effort, especially on small fish, and preventing their discard would increase the spawning biomass ratio, the yield per recruit, and the catches taken by both the surface and the longline fleets. However, such a reduction would also decrease significantly the catch of skipjack tuna.

Recent simulations, in the 2004 bigeye tuna assessment, taking into account low levels of recruitment and increased mortality, have considered effort reductions on purse-seines and longliners, both separately and together, providing insight into the interactions of the two gears. Projections indicate that, if fishing mortality rates continue at their recent (2002 and 2003) levels, longline catches and SBR will decrease to extremely low levels. Presently the purse-seine fishery on floating objects has the greatest impact on bigeye tuna. Restrictions that apply only to a single fishery (*e.g*. longline or purse-seine), particularly restrictions on longline fisheries, would be insufficient to allow the stock to rebuild to levels that would support the AMSY. Large (50%) reductions in effort (on bigeye tuna) from the purse-seine fishery would allow the stock to rebuild toward the AMSY level, but restrictions on both longline and purse-seine fisheries are necessary to rebuild the stock to the AMSY level in 10 years.

The optimal fishing effort for bigeye tuna for the purse-seine and longline fisheries is shown in Figure 1. For any level of longline effort, the graph shows the purse seine effort that would allow the AMSY to be taken and vice versa. If only the purse-seine fishery was operating the AMSY would be considerably less but current effort would be about the level required to produce the AMSY. This suggests that if there were no longline fishery, current purse-seine effort would be near optimal. If bigeye were caught only in the longline fishery the AMSY would be almost double that estimated for all gears combined. To achieve this AMSY level, longline effort would need to be considerably increased. This would result in effort near the levels observed in the late 1980s and early 1990s. This suggests that, prior to the expansion of the purse-seine fishery on floating objects, the bigeye stock was probably near a level that would have produced an AMSY of over 100,000 t.

The level of fishing effort by all gears that is estimated to produce AMSY is about 62% of the current (average for 2000 and 2001) level of effort (if fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity in both fisheries are maintained). Decreasing effort by 38% of its present level would increase the long-term average yield by about 8%, and would increase the spawning potential of the bigeye stock by about 156%.

The choice of what changes in each of the fleets would be necessary to reach an optimal position on the graph is a management decision to be made by the Commission

The implications for fleet capacity depend on how reductions in effective effort are made. For longlines the target species is bigeye and changes in effort will be roughly proportional to changes in the number of vessels or hooks. The purse-seine fishery catches mostly skipjack and it may be possible to reduce effective effort on bigeye by changing fishing practices. Simply reducing the fleet size is probably not the best way of reducing effective fishing effort.

5. CONCLUSION

It is clear that tradeoffs of many types must be carefully considered in establishing a target fleet size for both components of the EPO tuna fleet, because, at least in respect of bigeye tuna, the optimal size of one fleet depends on that of the other. However, it is clear that the current purse-seine fleet size (preliminary estimates for 2003 are above 202,000 m^3) is well above the level that would result in longer fishing seasons and economic benefits and facilitate management and conservation of bigeye and yellowfin tuna. Similarly, it is clear that the current longline fleet size is considerably above the level that would facilitate management and conservation of bigeye tuna, given the current fishing practice of the purse-seine vessels using FADs.

A target size of 158,000 m^3 still seems appropriate from the point of view of optimizing the purse-seine fleet for yellowfin tuna.

For bigeye tuna the situation is more complex, both because longline and purse-seine fishing are important, and because it may be that effective bigeye effort could be reduced by means other than reducing the size of the fleet. The choice of what reduction in fishing effort should be used as a target is one the Commission should make. However if equal reductions were to be made in both the purse-seine effort and the longline effort, the longline fleet target would be reduced be 62% of the average of effort for 2001 and 2002 or to a fleet that could deploy about 133,000 (x1000 hooks). However, considering the limited data, especially for the longline fleet (annual data on some large scale fleets and on the numerous artisanal vessels in the EPO are unavailable), fleet composition (by individual vessels) and any future changes in efficiency, and bycatch issues, the optimal target for both components of the tuna fleet in the EPO will continue to be a moving target.

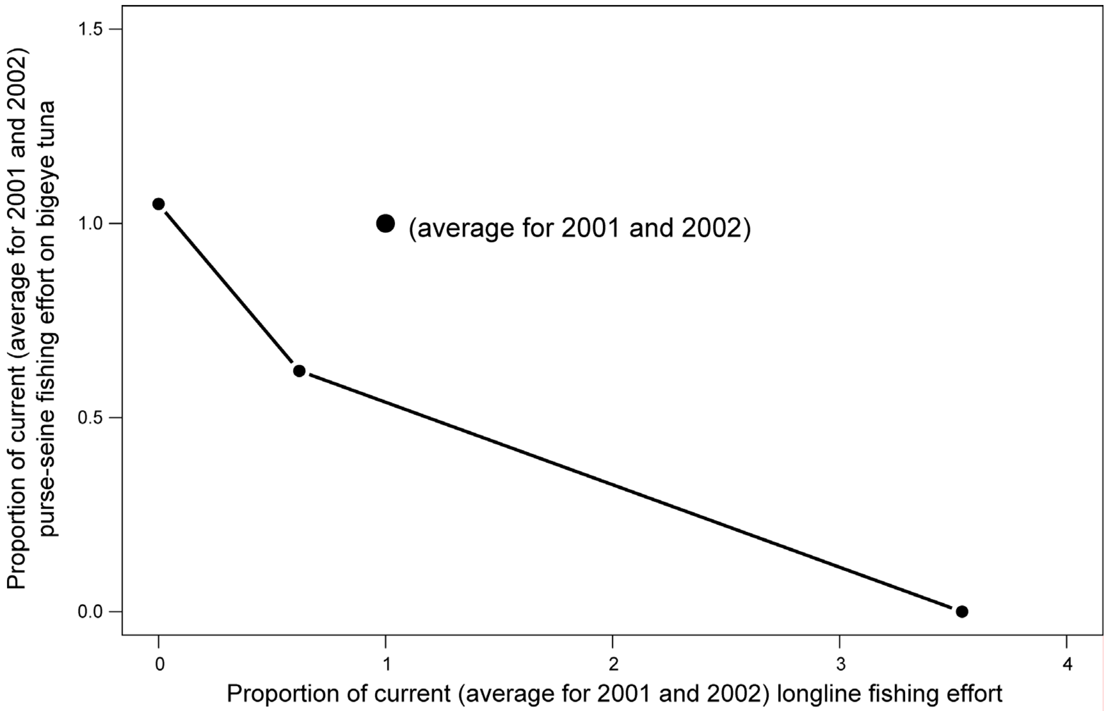


Figure 1. Optimal fishing effort mortality for bigeye tuna