INTER-AMERICAN TROPICAL TUNA COMMISSION
COMISIÓN INTERAMERICANA DEL ATÚN TROPICAL

WORKING GROUP ON STOCK ASSESSMENTS

5TH MEETING

LA JOLLA, CALIFORNIA (USA)
11-13 MAY 2004

DOCUMENT SAR-5-07

TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN IN 2003

INTRODUCTION

This report provides a summary of the fishery for tunas in the eastern Pacific Ocean (EPO), an assessment of the stocks of tunas and billfishes that are exploited in the fishery, and an evaluation of the pelagic ecosystem in the EPO.

The report is based on data available to the IATTC staff in March 2004.

All weights of catches and discards are in metric tons (t).

1. THE FISHERY FOR TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN

1. THE SURFACE FLEET, AND CATCHES AND LANDINGS OF TUNAS AND BILLFISHES

1.1. The surface fleet

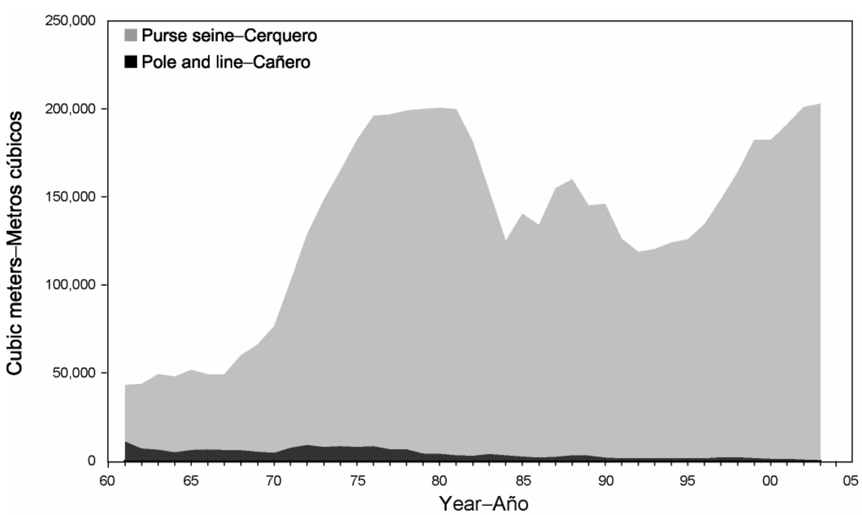
The IATTC maintains detailed records of gear, flag, and fish-carrying capacity for most of the vessels that fish with surface gear for yellowfin (*Thunnus albacares*), skipjack (*Katsuwonus pelamis*), bigeye (*Thunnus obesus*), and/or Pacific bluefin (*T. orientalis*) tuna in the eastern Pacific Ocean (EPO). Historically, detailed records have not been maintained for most longline vessels, nor for sport-fishing vessels and small craft such as canoes and launches, although recently the staff has begun compiling and maintaining these records for such vessels based in EPO ports, and will continue to do so in the future. The fleet described here includes purse seiners and pole-and-line vessels (hereafter referred to as surface gear) that have fished all or part of the year in the EPO for these four species.

Historically the owner's or builder's estimates of carrying capacities of individual vessels, in tons of fish, were used until landing records indicated that revision of these estimates was required. The vessels were grouped, by carrying capacity, originally in short tons and later in metric tons, into six size classes.

During the past several years the IATTC staff has used well volume, in cubic meters, instead of weight, in metric tons, to measure the carrying capacities of the vessels. Since a well can be loaded with different densities of fish, measuring carrying capacity in weight is subjective, as a load of fish packed into a well at a higher density weighs more than a load of fish packed at a lower density. Using volume as a measure of capacity eliminates this problem. The size classes and well volumes are as follows:

Class	1	2	3	4	5	6
Volume (cubic meters)	<53	53-106	107-212	213-319	320-425	>425

The IATTC staff began collecting capacity data by volume in 1999, but has not yet obtained this information for all vessels. For vessels for which reliable information on well volume is not available, the estimated capacity in metric tons is multiplied by 1.17 to convert it to cubic meters. This conversion factor is consistent with the density at which the fish were packed into the wells of the vessels at the time that the size classification was developed. It was also applied to all capacity data for 1961-1998 to facilitate comparisons among years (Table 1-1 and figure below).



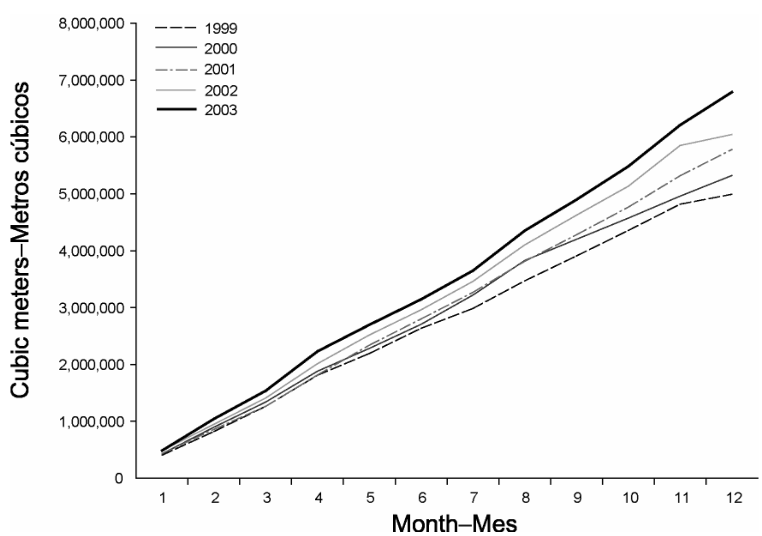
Carrying capacity, in cubic meters of well volume, of the surface fleet in the EPO, 1961-2003

Until about 1960 fishing for tunas in the EPO was dominated by pole-and-line vessels operating in the more coastal regions and in the vicinity of offshore islands and banks. During the late 1950s and early 1960s most of the larger pole-and-line vessels were converted to purse seiners, and by 1961 the EPO surface fleet was dominated by these vessels. From 1961 to 2003 the number of pole-and-line vessels decreased from 93 to 4, and their total well volume from about 11 to 1 thousand cubic meters (m^3). During the same period the number of purse seiners increased from 125 to 217, and their total well volume from about 32 thousand to 202 thousand m^3, an average of about 931 m^3 per vessel. An earlier peak in numbers and total well volume of purse seiners occurred from the mid-1970s to the early 1980s, when the number of vessels reached 282 and the total well volume about 196 thousand m^3, an average of about 695 m^3 per vessel.

The construction of new purse seiners, which began during the mid-1960s, resulted in an increase in the total well volume of the surface fleet from about 49 thousand m^3 in 1966 to about 196 thousand m^3 in 1976. From 1976 to 1981 the total well volume increased slightly. The construction of new vessels continued, but this was mostly offset by losses due to sinkings and vessels leaving the fishery. The catch rates in the EPO were low during 1978-1981 due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 125 thousand m^3. In early 1990 the U.S. tuna-canning industry adopted a policy of not purchasing tunas caught during trips during which sets on tunas associated with dolphins were made. This caused many U.S.-flag vessels to leave the EPO, with a consequent reduction in the fleet to about 119 thousand m^3 in 1992. With increases in participation of vessels of other nations in the fishery, the total well volume has increased steadily since 1992, and in 2003 was 203 thousand m^3.

The 2002 and preliminary 2003 data for numbers and total well volumes of purse seiners and pole-and-line vessels that fished for tunas in the EPO are shown in Tables 1-2a and 1-2b. The fleet was dominated by vessels operating under the Mexican and Ecuadorian flags during2003. The Mexican fleet had about 25 percent and Ecuador about 24 percent of the total well volume during 2003, while vessels registered in Venezuela and Spain had about 16 and 6 percent respectively. Vessels registered in Bolivia, Vanuatu and Colombia each comprised about 4 percent of the total well volume.

Class-6 purse seiners made up about 90 percent of the total well volume of the surface gear operating in the EPO during 2003. The cumulative capacity during 2003 is compared to those of the previous four years in the figure.



Cumulative capacity of the surface fleet at sea, by month, 1999-2003

The monthly average, minimum, and maximum total well volumes at sea (VAS), in thousands of cubic meters, of vessels that fished at the surface for tunas in the EPO during 1993-2002, and the 2003 values, are shown in Table 1-3. The monthly values are averages of the VAS estimated at weekly intervals by the IATTC staff. The fishery was regulated during some or all of the last four months of 1998-2003, so the VAS values for September-December 2003 are not comparable to the average VAS values for those months of 1993-2002. The VAS values for 2003 exceeded the maximum VAS values for 1992-2002 for every month. The average VAS values for 1993-2002 and 2003 were 89 thousand m^3 (59 percent of total capacity) and 133 thousand m^3 (66 percent of total capacity), respectively.

1.2. Catches and landings

1.2.1. Tunas

1.2.1a. Surface catches

Estimates of the catches and landings of tunas come from several sources, including logbooks kept by the fishermen, data recorded by observers aboard the vessels, unloading data provided by canneries and other processors, and export and import records. All data for 2003 are preliminary. Estimating the total catch for a fishery is difficult, due to the lack of information on fish that are caught, but, for various reasons, discarded at sea. Data on fish discarded at sea by Class-6 vessels have been collected by observers since 1993. This information allows for better estimation of the total amounts of fish caught by the surface fleet. Estimates of the total amount of catch that is landed (hereafter referred to as retained catch) are based principally on data from unloadings. Annual estimates of the retained and discarded catches of the various species of tunas captured by vessels of the EPO surface fleet are shown in Table 1-4, which also includes catch data for U.S.-flag sport-fishing vessels and other miscellaneous types of surface gear. In the case of bluefin, the recreational catches have become an increasingly important component of the total catch in recent years.

The statistics for 2003 are compared to those for 1988-2002. There were no restrictions on fishing for tunas in the EPO during 1987-1997. However, as mentioned previously, there were restrictions on fishing during some or all of the last four months of 1998-2003. Furthermore, regulations placed on purse-seine vessels directing their effort at tunas associated with dolphins have probably affected the way these vessels operate, especially since the late 1980s. Also, as mentioned previously, there was a major El Niño event during 1982-1983, which made the fish less vulnerable to capture. The fishing effort remained relatively low during 1984-1986. During 1997-1998 another major El Niño event occurred in the EPO.

The average annual retained catch of yellowfin in the EPO by surface gear during 1988-2002 was 278 thousand metric tons (t) (range: 219 to 421 thousand t). The preliminary estimate of the retained catch of yellowfin in 2003, 399 thousand t, was the second largest on record, exceeding the average for 1988-2002 by 44 percent. The average amount of yellowfin discarded at sea by the surface fisheries during 1993-2003 was about 2.0 percent of the total surface catch (retained catch plus discards) of yellowfin (range: 0.9 to 2.6 percent).

During 1988-2002 the annual retained catch of skipjack from the EPO averaged 127 thousand t (range 63 to 266 thousand t). The preliminary estimate of the retained catch of skipjack in 2003, 260 thousand t, is 105 percent greater than the average for 1988-2002, and slightly less than the record catch of 1999. The average amount of skipjack discarded at sea during 1993-2003 was about 11.5 percent of the total catch of skipjack (range: 7.4 to 18.2 percent).

Prior to 1994 the average annual retained catch of bigeye in the EPO by surface gear was about 5 thousand t (range: <1 to 15 thousand t). Following the development of fish-aggregating devices (FADs), placed in the water by fishermen to aggregate tunas after 1993, the annual retained catches of bigeye increased from 29 thousand t in 1994 to 35 to 52 thousand t during 1995-1999, to a record high of 70 thousand t in 2000. A preliminary estimate of the retained catch in the EPO in 2003 is 41 thousand t.

The average amount of bigeye discarded at sea by the surface fisheries during 1993-2003 was about 7.1 percent of the total surface catch of bigeye (range: 2.7 to 11.3 percent). It is difficult to distinguish small bigeye from small yellowfin. Therefore, since 2000 a species-composition sampling scheme has been used to improve the estimates of the catches of small yellowfin and bigeye by purse-seine vessels. Since bigeye are more often misidentified as yellowfin than the reverse, this has tended to increase the recorded catches of bigeye and decrease those of yellowfin.

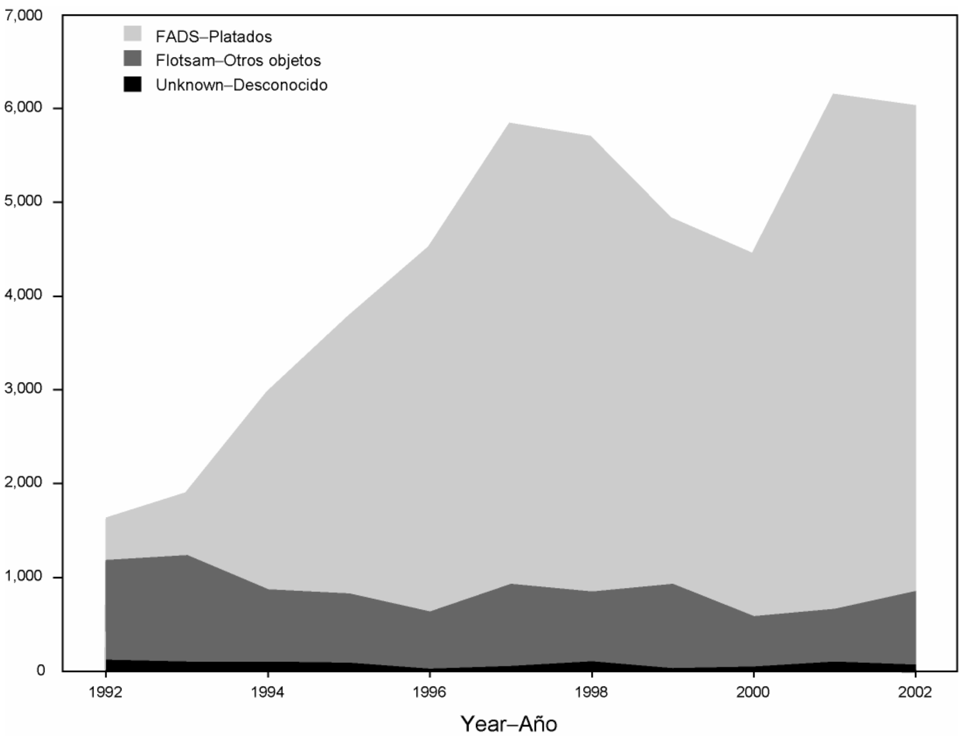
While yellowfin, skipjack, and bigeye comprise the most significant portion of the retained catches of the surface fleet in the EPO, bluefin (*Thunnus orientalis)*, albacore (*Thunnus alalunga*), black skipjack (*Euthynnus lineatus)*, bonito (*Sarda orientalis*), and other species contribute to the overall harvest in this area. The total retained catch of these other species by these fisheries was about 4 thousand t in 2003, which is well below the 1988-2002 annual average retained catch of about 8 thousand t (range: 2 to 17 thousand t). The estimated retained and discarded catches of these species for the 1970-2003 period are presented in Table 1-4.

The retained catches in the EPO during 2002, by flag, and the landings of EPO-caught tunas taken by surface gear in the EPO, by country, are given in Table 1-5a, and preliminary estimates of the equivalent data for 2003 are given in Table 1-5b. The estimated retained catch of all species in the EPO during 2003 was about 704 thousand t, which was about 13 percent greater than that for 2002, 622 thousand t, and much greater than the average for 1988-2002 of 440 thousand t. Ecuadorian-, Mexican-, and Venezuelan-flag vessels harvested about 28, 26, and 15 percent, respectively, of the retained catches of all species made in 2003. Other countries with significant catches were Colombia and Vanuatu (4 percent), Spain (5 percent), and Panama (6 percent).

The landings are fish unloaded from fishing vessels during a calendar year, regardless of the year of catch. The country of landing is that in which the fish were unloaded or, in the case of transshipments, the country that received the transshipped fish. Preliminary landings data (Table 1-5b) indicate that, of the 680 thousand t of tunas landed in 2003, 47 percent was landed in Ecuador and 25 percent in Mexico. Other countries with significant landings of tunas caught in the EPO included Colombia (9 percent) and Costa Rica (6 percent) . It is important to note that when final information is available the landings currently assigned to various countries may change due to exports from storage facilities to processors in other nations.

Tunas are caught by surface gear in three types of schools, associated with dolphins, associated with floating objects, such as flotsam or FADs, and associated only with other fish (unassociated schools). Estimates of the numbers of purse-seine sets of each type in the EPO during the 1987-2003 period, and the retained catches of these sets, are listed in Table 1-6. The estimates for Class-1 to -5 vessels were calculated from logbook data in the IATTC statistical data base, and those for Class-6 vessels were calculated from logbook data and from the observer data bases of the IATTC, Ecuador, Mexico, the United States, and Venezuela. The greatest numbers of sets on schools associated with floating objects and on unassociated schools of tuna were made from the mid-1970s to the early 1980s. Despite opposition to fishing for tunas associated with dolphins and the refusal of U.S. canners to accept tunas caught during trips during which sets were made on dolphin-associated fish, the numbers of sets made on fish associated with dolphins decreased only moderately during the mid-1990s, and in 2003 were the greatest recorded..

There are two types of floating objects, flotsam and FADs. The occurrence of the former is unplanned from the point of view of the fishermen, whereas the latter are constructed by fishermen specifically for the purpose of attracting fish. FADs have been in use for only a few years, but their importance has increased during that period, while that of flotsam has decreased, as shown by the data in Table 1-7 and the figure below.



Number of sets on floating objects by Class-6 vessels, 1992-2002

The average annual distributions of the logged catches of yellowfin, skipjack, and bigeye, by set type, by purse seiners in the EPO during 1987-2002 (1994-2002 for bigeye), are shown in Figures 1-1a, 1-2a, and 1-3a, and preliminary estimates for 2003 are shown in Figures 1-1b, 1-2b, and 1-3b. The distributions of the catches of yellowfin and skipjack during 2003 were similar to those of 1987-2002, although some differences are evident. Bigeye are not often caught by surface gear north of about 7°N. The distribution of the catch of bigeye during 2003 was similar to those of 1994-2002. With the development of the fishery for tunas associated with FADs described above, the relative importance of the nearshore areas has decreased, while that of the offshore areas has increased, as is apparent when comparing Figures 1-3a and 1-3b.

The total retained catch per cubic meter of well volume (CPCMWV) for the vessels that fish at the surface for tunas in the EPO provides an index of trends in annual relative gross income for vessels of various size groups. To provide more detail in this index than would be available if the IATTC's historical six classes of vessel capacity classification were used, the vessels are assigned to eight size groups.

Estimates of the CPCMWVs for 1990-2003 are presented in Table 1-8 for the EPO and for all ocean fishing areas from which vessels of the EPO tuna fleet harvested fish, by size group, area, and species. Yellowfin, skipjack, and bigeye contribute the most to the CPCMWVs for the larger vessels, while other species, which include other tunas, and also other miscellaneous fishes, make up an important part of the CPCMWVs of the smaller vessels in many years. Bigeye became more important for the larger vessels after 1993. During the years in which the majority of the EPO tuna fleet exerted most or all of its fishing effort in the EPO, the CPCMWVs for the EPO and all ocean fishing areas were nearly the same. During the 1990-2002 period the CPCMWV in the EPO for all vessels and all species averaged 2.8 t , with a range of 2.4 to 3.3 t; for yellowfin it averaged 1.8 t, with a range of 1.5 to 2.1 t, and for skipjack it averaged 0.8 t, with a range of 0.5 to 1.5 t. The corresponding average for bigeye for the 1994-2002 period was 0.3 t, with a range of 0.2 to 0.4 t. The preliminary estimates for 2002 are 3.2, 2.2, 0.8, and 0.2 t for all species, yellowfin, skipjack, and bigeye, respectively.

1.2.1b. Longline catches

Data on the retained catches for most of the larger longline vessels operating in the EPO, and for an increasing portion of the smaller ones, are obtained from various sources. The distribution of the fishing effort by Japanese longliners in the EPO during 1993-1997 is shown in Figure 1-4.. Longline vessels, particularly the larger ones, direct their effort primarily at bigeye and yellowfin tuna. The annual retained catches of yellowfin, skipjack, bigeye, bluefin, and albacore by these fisheries are shown in Tables 1-9a-1-9f. During 1985-1999 the retained catches of yellowfin remained relatively stable, averaging about 20 thousand t (range: 13 to 33 thousand t) per year, or about 7 percent of the total retained catches of yellowfin. Prior to 1986 the retained longline catches of bigeye averaged about 50 thousand t (range: 29 to 73 thousand t); in 1986 they increased significantly, to 100 thousand t, and remained high during 1986-1994, averaging about 85 thousand t (range: 70 to 101 thousand t). During 1970-1993, prior to the increased use of FADs and resultant greater catches of bigeye by purse-seine vessels, the longline fisheries, on average, accounted for about 93 percent of the retained catches of this species from the EPO. During 1995-1999 the annual retained catches of bigeye by the longline fisheries ranged from about 29 to 56 thousand t (average: 43 thousand t), which is well within the pre-1986 historical range, but significantly less than the retained catches during 1986-1994. Small amounts of skipjack are caught by longline vessels, as shown in Table 1-9b.

The average weights of tunas caught by the Japanese longline fishery during 1971-1997 ranged from 29.4 to 43.0 kg for yellowfin and 43.4 to 64.2 kg for bigeye. In comparison, the average weights of yellowfin caught in 2003 by sets on dolphin-associated fish, unassociated fish, and fish associated with floating objects ranged from 13.5 to 37.3 kg, 8.7 to 9.6 kg, and 2.6 to 4.6 kg, respectively (Figure 1-6a), and those of bigye caught in association with floating objects ranged from 5.0 to 9.7 kg (Figure 1-8a).

Staff members of the IATTC and the National Research Institute of Far Seas Fisheries of Japan have conducted cooperative studies of the Japanese longline fishery in the EPO since the early 1960s, and 11 reports on this fishery, covering the years 1956-1997, have been published in the IATTC Bulletin series.

1.2.2. Billfishes

Swordfish (*Xiphias gladius*) are fished in the EPO with longline gear and gillnets, and occasionally with recreational gear. Most of those caught with commercial gear are retained. Blue marlin (*Makaira nigricans*), black marlin (*M. indica*), striped marlin (*Tetrapturus audax*), shortbill spearfish (*T. angustirostris*), and sailfish (*Istiophorus platypterus*) are fished with longline and recreational gear, and they are occasionally caught by purse-seine vessels. Most of the longline-caught marlins, spearfish, and sailfish are retained, and most of those caught with commercial surface gear, with the exception of blue marlin, are discarded at sea. Information on the commercial catches and bycatches of billfishes in the EPO is given in Table 1-10. Little information is available on the recreational catches of billfishes, but they are believed to be substantially less than the commercial catches for all species.

2. SIZE COMPOSITIONS OF THE CATCHES OF TUNAS

2.1. Surface catches

Length-frequency samples are the basic source of data used for estimating the size and age compositions of the various species of fish in the landings. This information is necessary to obtain age-structured estimates of the population for various purposes, including age-structured population modeling. The results of age-structured population modeling can be used to estimate recruitment, which can be compared to spawning biomass and oceanographic conditions. Also, the estimates of mortality obtained from age-structured population modeling can be used, in conjunction with growth estimates, for yield-per-recruit modeling. The results of such studies have been described in several IATTC Bulletins, in all of its Annual Reports since that for 1954, and in its Stock Assessment Reports.

Length-frequency samples of yellowfin, skipjack, bigeye, Pacific bluefin, and occasionally black skipjack from catches of purse-seine, pole-and-line, and recreational vessels in the EPO are collected by IATTC personnel at ports of landing in Ecuador, Mexico, Panama, the USA ,and Venezuela. The catches of yellowfin and skipjack were first sampled in 1954, bluefin in 1973, and bigeye in 1975. Sampling has continued to the present.

The methods for sampling the catches of tunas are described in the IATTC Annual Report for 2000. Briefly, the fish in a well of a purse seiner or pole-and-line vessel are selected for sampling only if all the fish in the well were caught during the same calendar month, in the same type of set (floating-object, unassociated school, or dolphin), and in the same sampling area. These data are then categorized by fishery (Figure 1-5), based on the staff's most recent stock assessments.

Data for fish caught during the 1998-2003 period are presented in this report. With the exception of bluefin, two length-frequency histograms are presented for each species: the first shows the data by stratum (gear type, set type, and area) for 2003, and the second shows the combined data for each of the 1998 – 2003 period. For bluefin, the histogram shows the 1998-2003 catches by commercial and recreational gear, combined. Samples from 872 wells (including those from recreational vessels) were taken during 2003. Although a small amount of catch was recorded from pole-and-line vessels in 2003, no samples were taken from these vessels. The length-frequency estimates were based on data from small purse seiners fishing on unassociated schools of fish whose catches are typically fish of the same sizes as those caught by as pole-and-line vessels.

There are ten yellowfin surface fisheries defined for stock assessments: four floating-object, two unassociated school, three dolphin, and one pole-and-line (Figure 1-5). The last fishery includes all 13 sampling areas. Of the 872 wells sampled, 670 contained yellowfin. The estimated size compositions of the fish caught during 2003 are shown in Figure 1-6a. Similar to 2002, the majority of the yellowfin catch was taken by dolphin sets in the Northern and Inshore areas, but the largest fish, on average, were caught in dolphin sets in the Southern area. The average weights of yellowfin in most areas and fisheries were less than those of 2002, the exception being the Inshore floating-object fishery and the Northern dolphin fishery, for which the average weights increased slightly. The average weight of fish caught in the Southern floating-object fishery remained the same. The majority of the yellowfin catch during 2003 was taken in dolphin sets in the Northern and Inshore areas. Significant catch was taken by dolphin sets in the South and in the two unassociated fisheries. Only a negligible amount of catch was made by pole-and-line vessels during the second half of 2003.

The estimated size compositions of the yellowfin caught by all fisheries combined during 1998-2003 are shown in Figure 1-6b. The average weights of yellowfin caught were the lowest since 1999. More modes are evident in the graph for 2003 than in those of the previous five years.

There are eight skipjack fisheries defined for stock assessments: four floating-object, two unassociated school, one dolphin, and one pole-and-line. The last two fisheries include all 13 sampling areas. Of the 872 wells sampled, 531 contained skipjack. The estimated size compositions of the fish caught during 2003 are shown in Figure 1-7a. The majority of the skipjack catch was taken in floating-object sets, particularly in the Southern area. The average weights of skipjack caught in floating-object sets during 2003 were greater than those of 2002, except in the Inshore area, where it remained the same. The majority of the skipjack catch during the first quarter of 2003 was taken in unassociated and floating-object sets in the South, and by floating-object sets in the Inshore area. The catches remained high in the Southern and Inshore floating-object fisheries during the second quarter, and, in addition, the catches were high in the Northern floating-object fishery. During the latter half of 2003, the majority of the skipjack was caught in the Equatorial area in the floating-object fishery, and by the fourth quarter nearly half of the skipjack catch was taken in floating-object sets in the Equatorial area. Negligible amounts of skipjack were caught by pole-and-line vessels during 2003.

The estimated size compositions of the skipjack caught by all fisheries combined during 1998-2003 are shown in Figure 1-7b. The smaller fish (40 to 50 cm) were caught primarily in the first half of the year, and the larger ones (60 to 70 cm) were caught primarily during the second half of 2003.

There are seven bigeye surface fisheries defined for stock assessments: four floating-object, one unassociated school, one dolphin, and one pole-and-line. The last three fisheries include all 13 sampling areas. Of the 872 wells sampled, 165 contained bigeye. The estimated size compositions of the fish caught during 2003 are shown in Figure 1-8a. Since 2001, the majority of the bigeye catch has been taken in sets on floating objects in the Southern area, whereas in 2000 the majority of the catch was taken in floating-object sets in the Equatorial area. In addition, significant amounts of bigeye catch were taken in the Northern and Equatorial floating-object fisheries during 2003. A small amount of bigeye was caught in unassociated school sets Negligible amounts of bigeye were taken in floating-object sets in the Inshore area and in dolphin sets. There were no recorded catches of bigeye by pole-and-line vessels.

The estimated size compositions of the bigeye caught by all fisheries combined during 1998-2003 are shown in Figure 1-8b. The average weight of the fish has decreased steadily since 2000, when the largest recorded catch of bigeye was taken, and the average weight of bigeye in 2003 was the lowest since 1998.

Pacific bluefin are caught by surface gear by both commercial and sport-fishing vessels off California and Baja California from about 23°N to 35°N, with most of the catch being taken during May through October. During 2003 bluefin were caught between 25°N and 31°N from January through November. The majority of the catch of bluefin by commercial and recreational vessels was taken during July to September. In the past, commercial and recreational catches have been reported separately. In 2003, however, 64 samples were taken from recreational vessels and only 7 from commercial vessels (from the total of 872 samples for 2003), making it infeasible to estimate the catches and size compositions separately. Therefore, the commercial and recreational catches of bluefin were combined for the 1998-2003 period. The estimated size compositions are shown in Figure 1-9. The commercial catch (3247 t) of bluefin far exceeded the recreational catch (391 t).

Black skipjack are caught incidentally by fishermen who direct their effort toward yellowfin, skipjack, and bigeye tuna. The demand for this species is low, so most of the catch is discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. Because only four samples of black skipjack were taken from the 872 wells sampled during 2003, length-frequency histograms for this species are not presented in this report.

2.2. Longline catches

The estimated size compositions of the catches of yellowfin and bigeye in the EPO by Japanese longliners during 1997-2001 are shown in Figures 1-10a and 1-10b. The average weights of both yellowfin and bigeye taken by the Japanese longline fishery have remained about the same throughout the existence of the fishery. Additional information on the size compositions of the fish caught by the Japanese longline fishery is available in IATTC Bulletins describing that fishery.

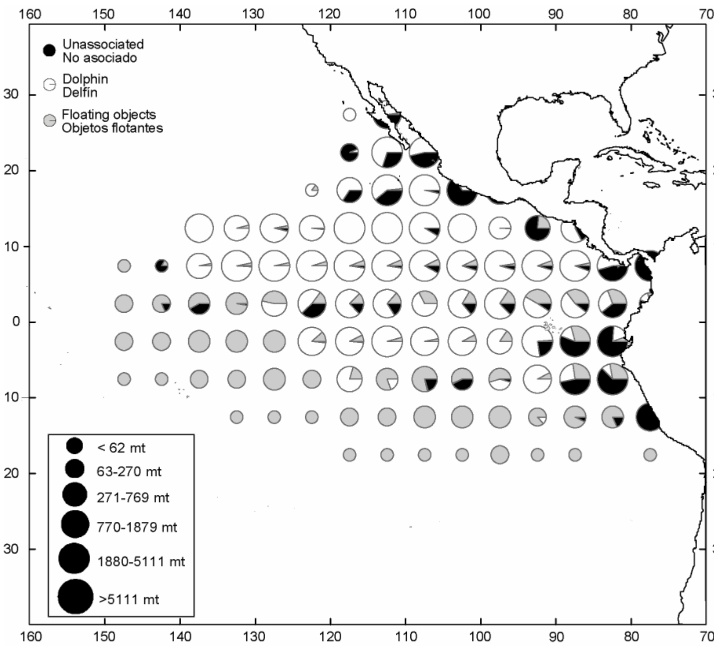


FIGURE 1-1a. Average annual distributions of the logged purse-seine catches of yellowfin, by set type, 1987-2002.
FIGURA 1-1a. Distribución media anual de las capturas registradas de aleta amarilla, por tipo de lance, 1987-2002.

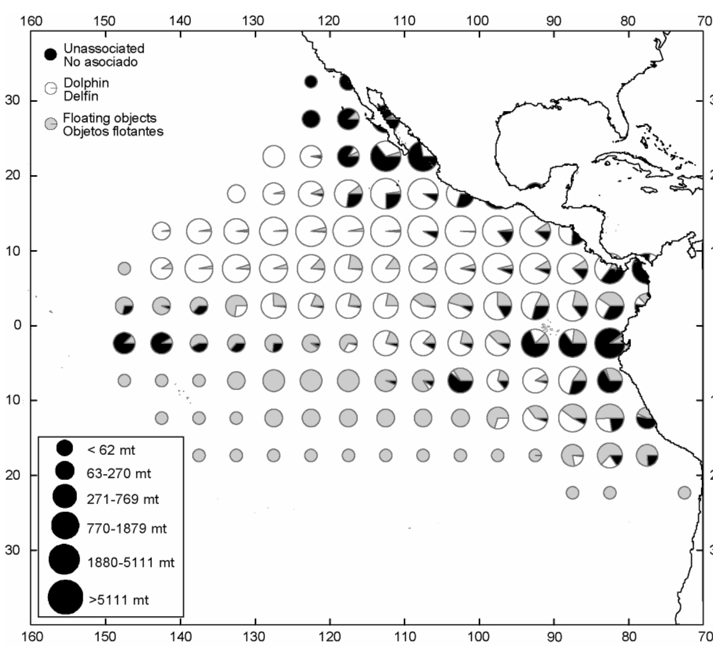


FIGURE 1-1b. Average annual distributions of the logged purse-seine catches of yellowfin, by set type, 2003 (preliminary).
FIGURA 1-1b. Distribución media anual de las capturas registradas de aleta amarilla, por tipo de lance, 2003 (preliminar).

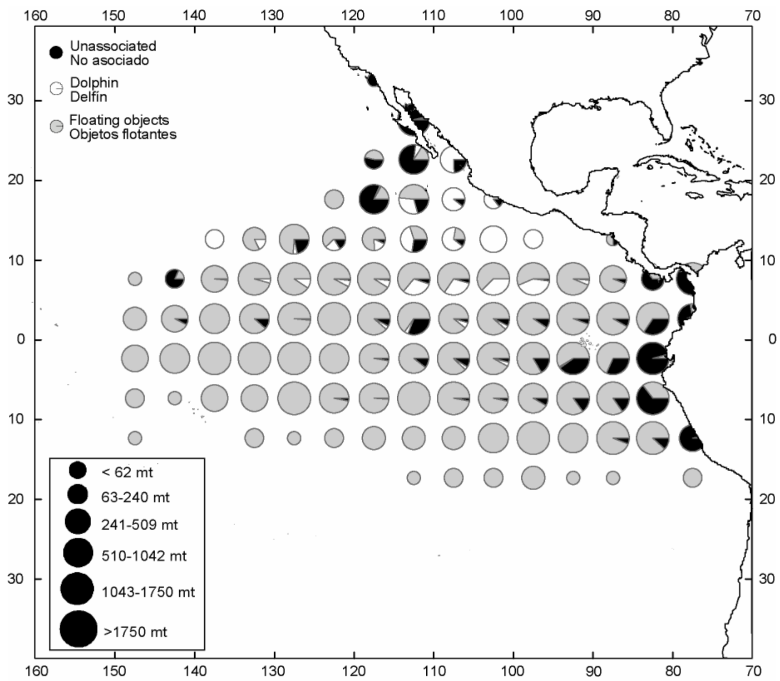


FIGURE 1-2a. Average annual distributions of the logged purse-seine catches of skipjack, by set type, 1987-2002.
FIGURA 1-2a. Distribución media anual de las capturas registradas de barrilete, por tipo de lance, 1987-2002.

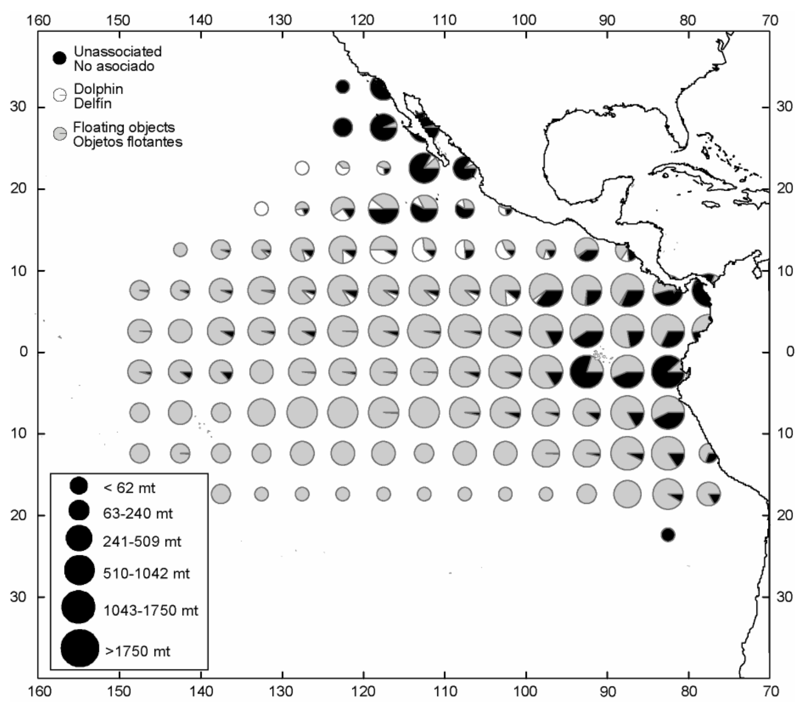


FIGURE 1-2b. Average annual distributions of the logged purse-seine catches of skipjack, by set type, 2003 (preliminary).
FIGURA 1-2b. Distribución media anual de las capturas registradas de barrilete, por tipo de lance, 2003 (preliminar).

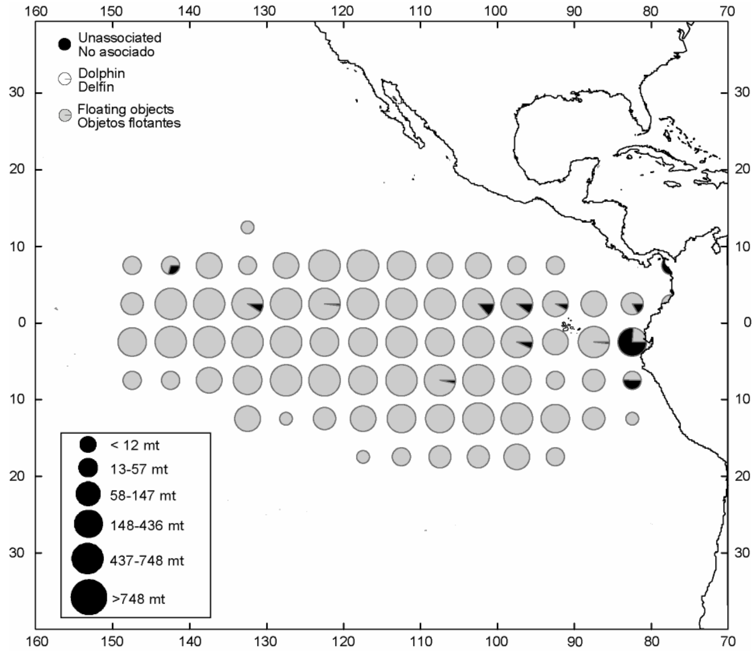


FIGURE 1-3a. Average annual distributions of the logged purse-seine catches of bigeye, by set type, 1994-2002.

FIGURA 1-3a. Distribución media anual de las capturas registradas de patudo, por tipo de lance, 1994-2002.

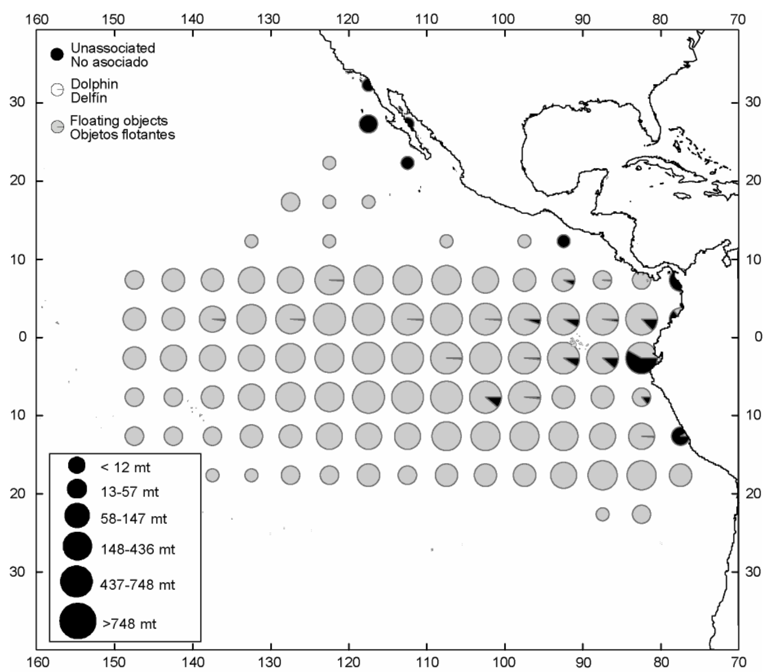


FIGURE 1-3b. Average annual distributions of the logged purse-seine catches of bigeye, by set type, 2003 (preliminary).

FIGURA 1-3b. Distribución media anual de las capturas registradas de patudo, por tipo de lance, 2003 (preliminar).

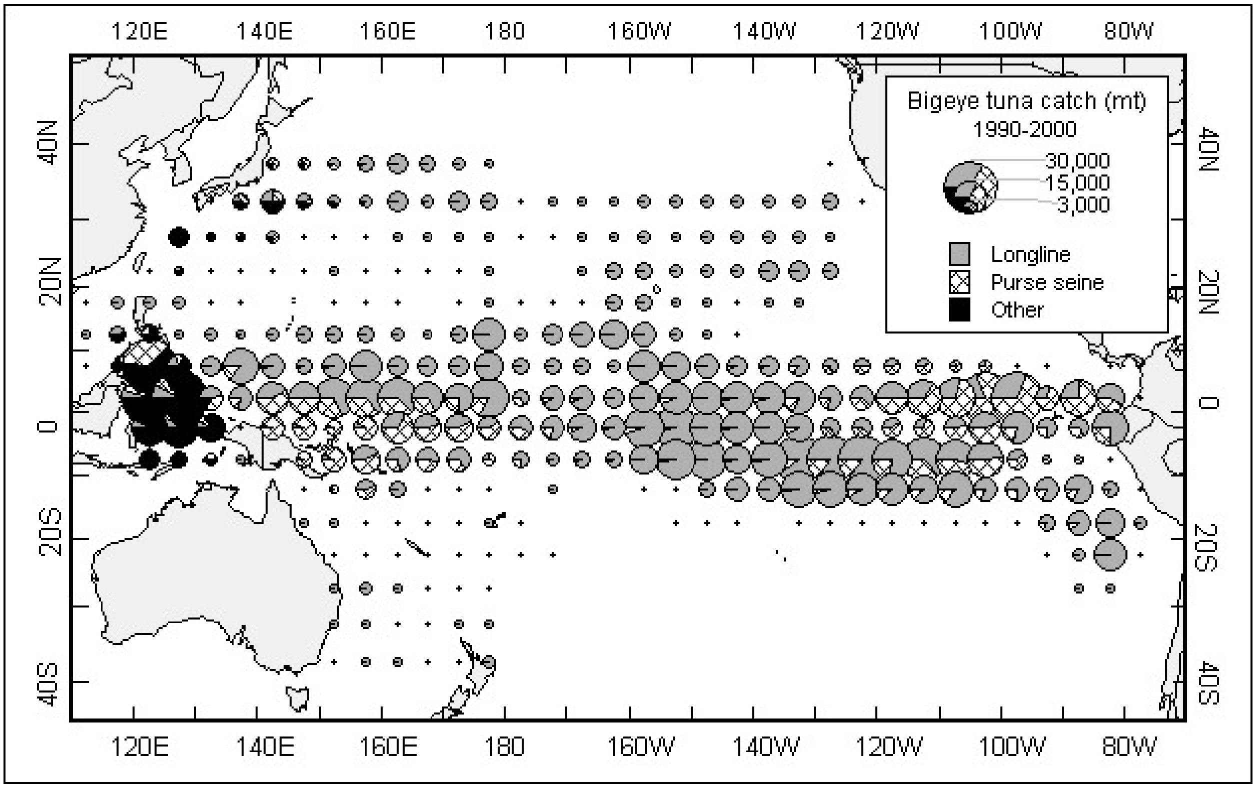


FIGURE 1-4. Distribution of catches of bigeye tuna in the Pacific Ocean, in metric tons, 1990–2000. (after Secretariat of the Pacific Community, Ocean Fisheries Programme, Tuna Fish. Assess. Rep. 4: Figure 37). The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.

FIGURA 1-4. Distributción de las capturas de atún patudo en el Océano Pacifico, en toneladas métricas, 1990–2000. (adaptado de la Secretaría de la Comunidad del Pacífico, Ocean Fisheries Programme, Tuna Fish. Assess. Rep. 4: Figura 37). El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la zona de 5° x 5° correspondiente.).

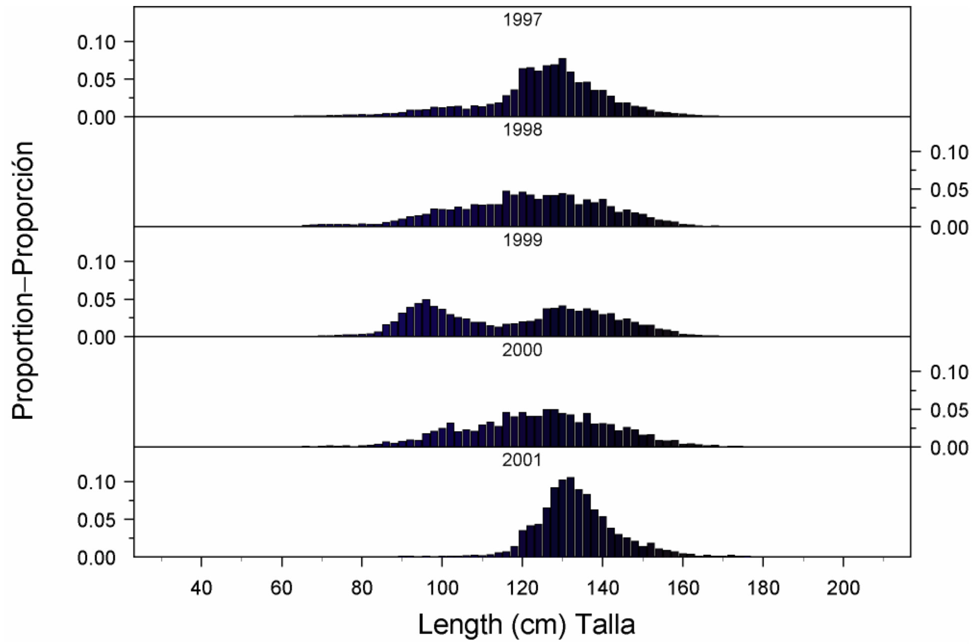


FIGURE 1-5. Estimated size compositions of the catch of yellowfin tuna by the Japanese longline fishery in the EPO, 1997-2001.
FIGURA 1-5. Composición por tallas estimada de la captura de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 1997-2001.

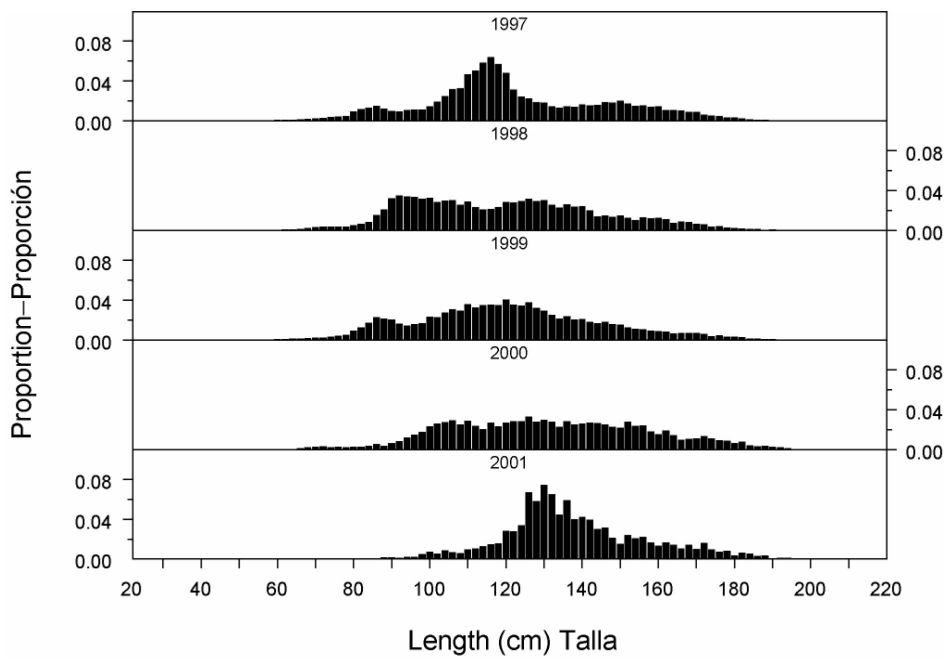


FIGURE 1-6. Estimated size compositions of the catch of bigeye tuna by the Japanese longline fishery in the EPO, 1997-2001.
FIGURA 1-6. Composición por tallas estimada de la captura de atún patudo por la pesquería palangrera japonesa en el OPO, 1997-2001.

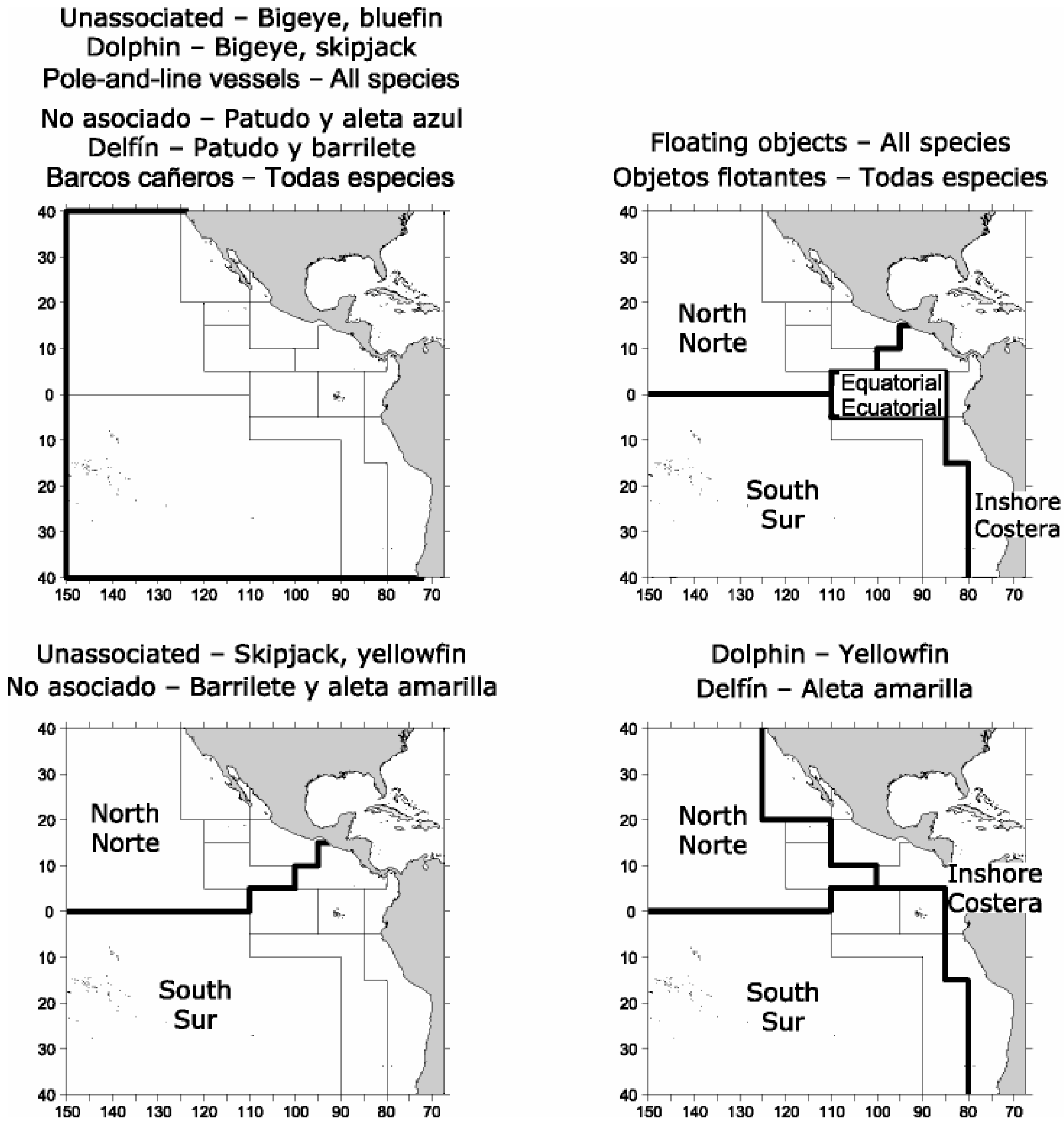


FIGURE 1-7. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

FIGURA 1-7. Las pesquerías definidas por el personal de la CIAT para la evaluación de las poblaciones de atún aleta amarilla, barrilete, y patudo en el OPO. Las líneas delgadas indican los límites de las 13 zonas de muestreo de frecuencia de tallas, y las líneas gruesas los límites de las pesquerías.

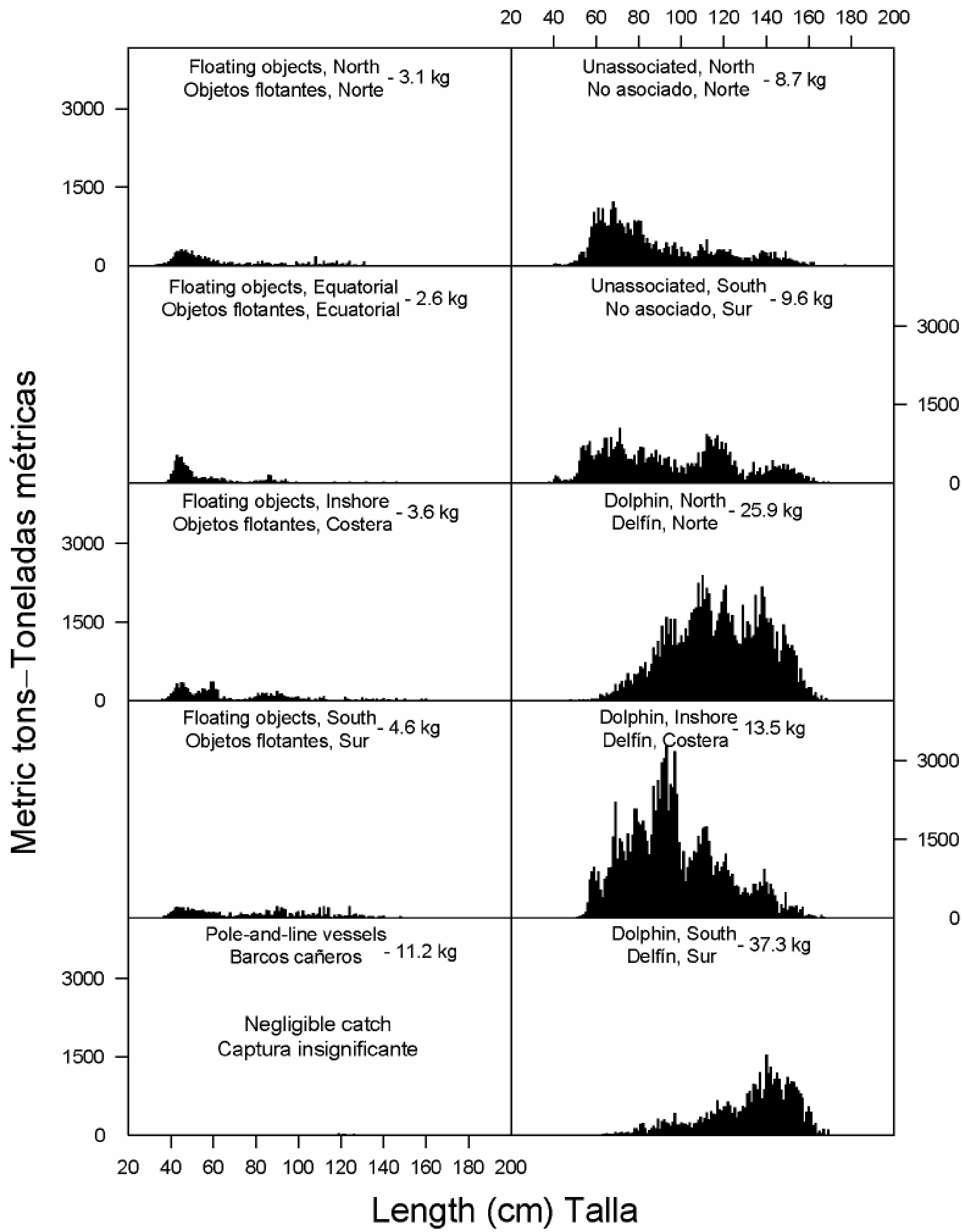


FIGURE 1-8a. Estimated size compositions of the yellowfin caught in each fishery of the EPO during 2003. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA 1-8a. Composición por tallas estimada para el aleta amarilla capturado en cada pesquería del OPO en 2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

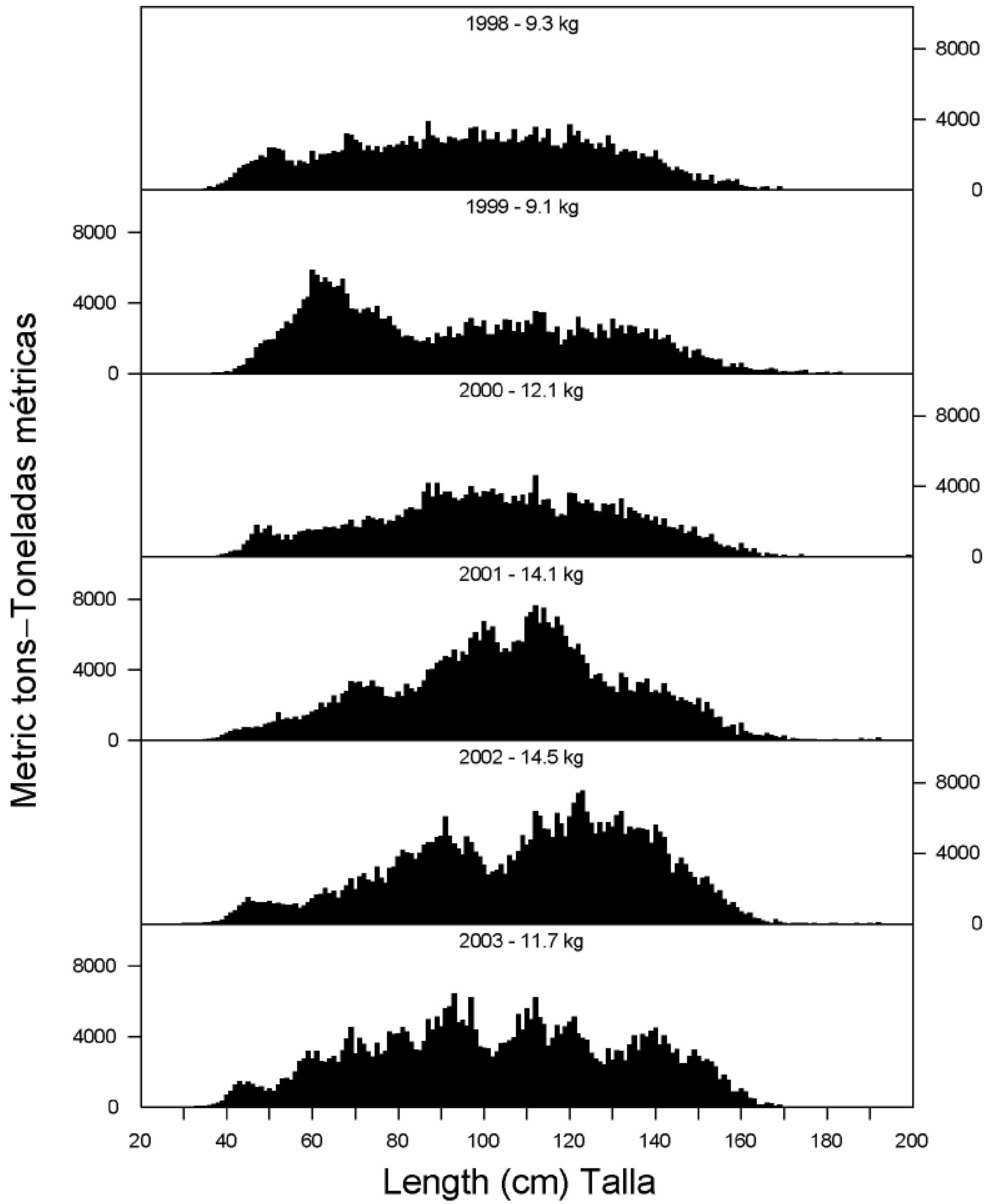


FIGURE 1-8b. Estimated size compositions of the yellowfin caught in the EPO during 1998-2003. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA 1-8b. Composición por tallas estimada para el aleta amarilla capturado en el OPO durante 1998-2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

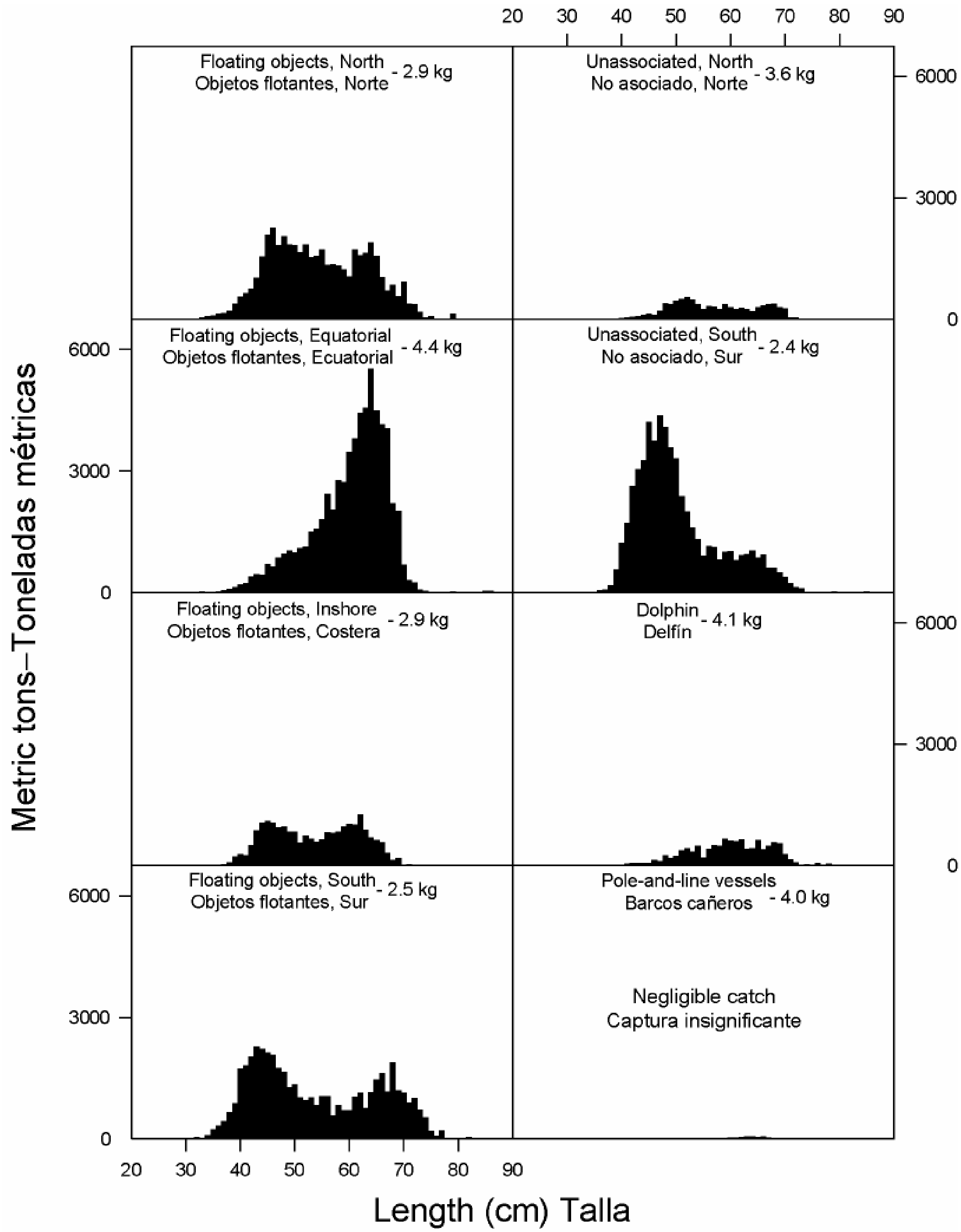


FIGURE 1-9a. Estimated size compositions of the skipjack caught in each fishery of the EPO during 2003. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA 1-9a. Composición por tallas estimada para el barrilete capturado en cada pesquería del OPO en 2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

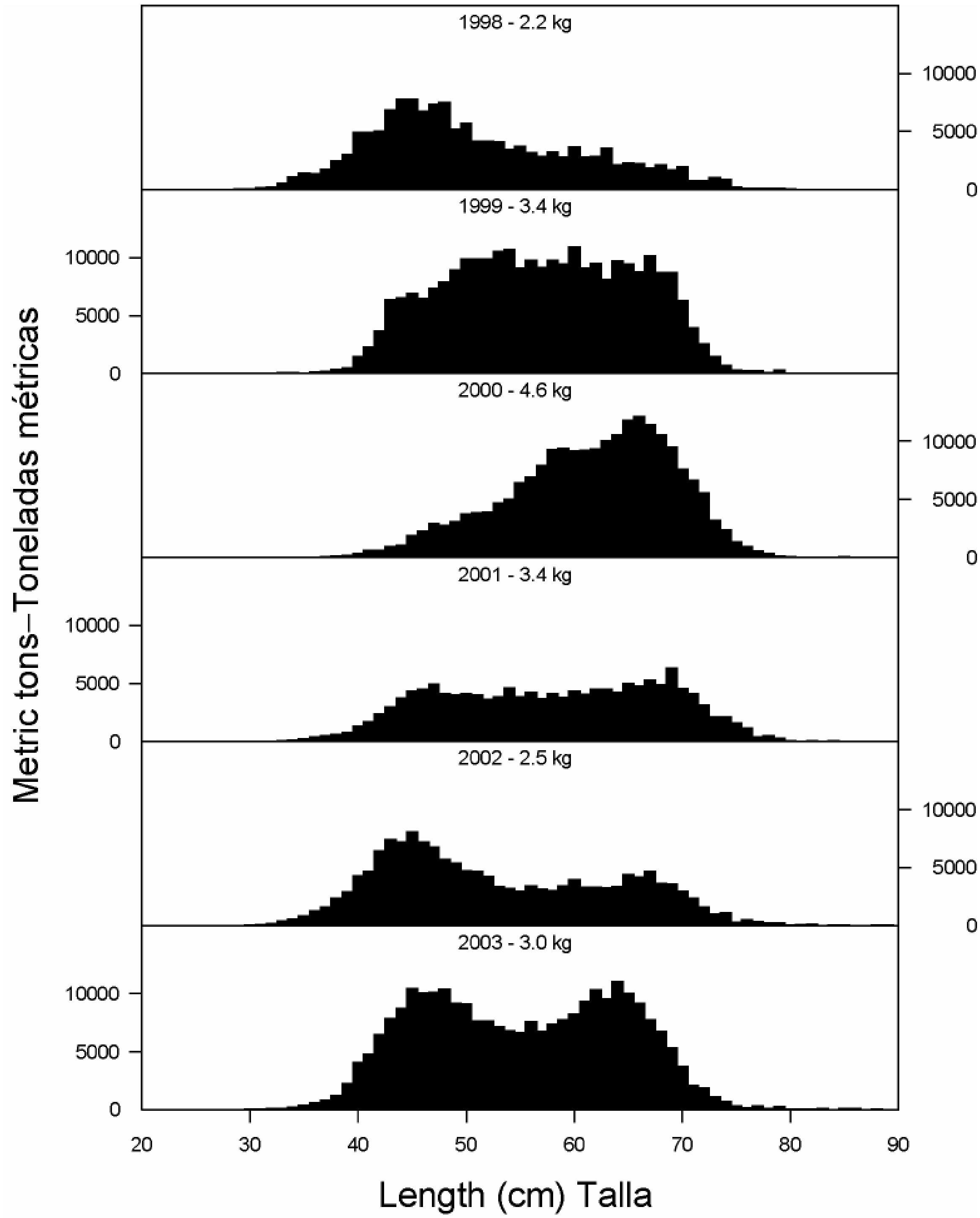


FIGURE 1-9b. Estimated size compositions of the skipjack caught in the EPO during 1998-2003. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA 1-9b. Composición por tallas estimada para el barrilete capturado en el OPO durante 1998-2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

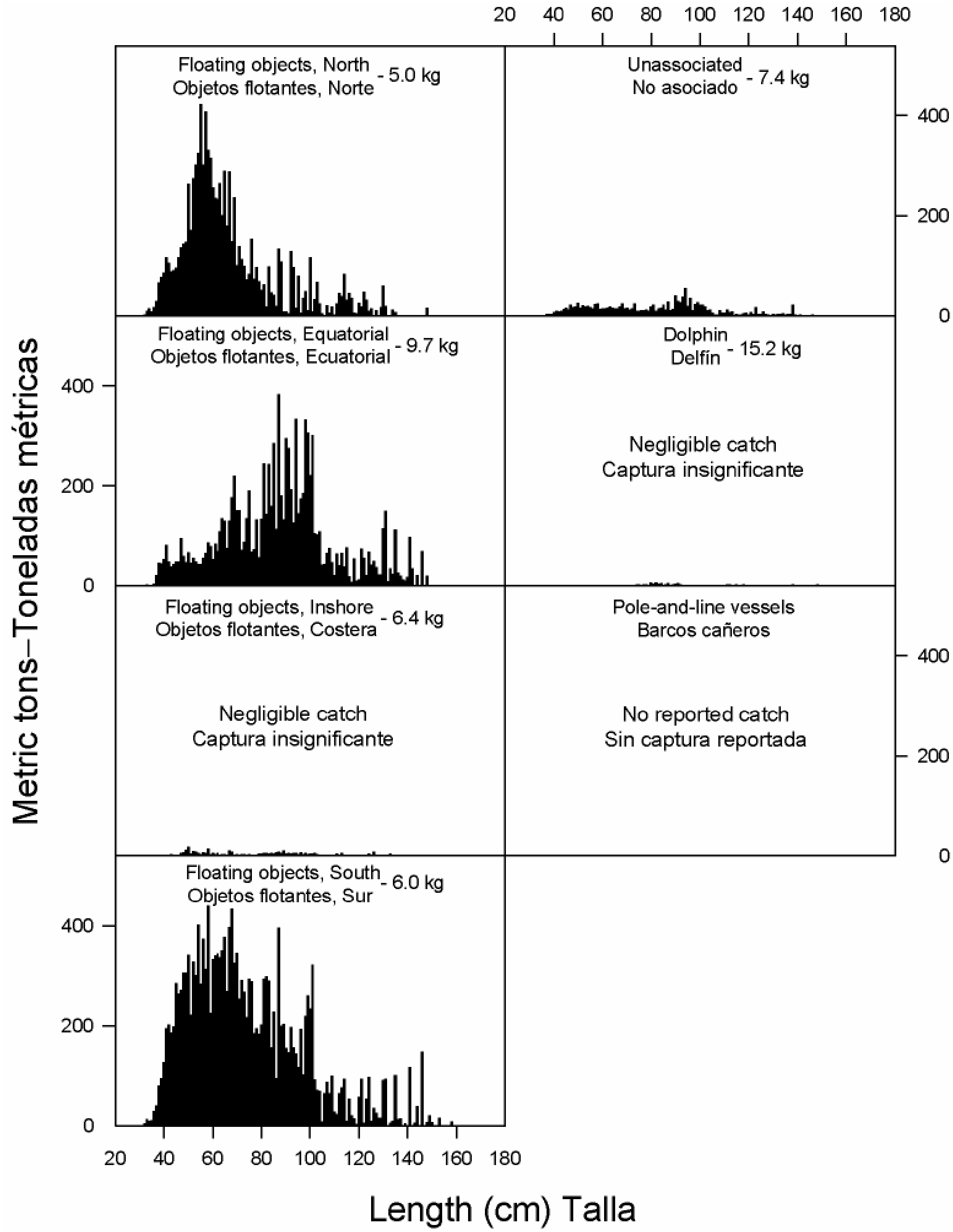


FIGURE 1-10a. Estimated size compositions of the bigeye caught in each fishery of the EPO during 2003. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA 1-10a. Composición por tallas estimada para el patudo capturado en cada pesquería del OPO en 2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

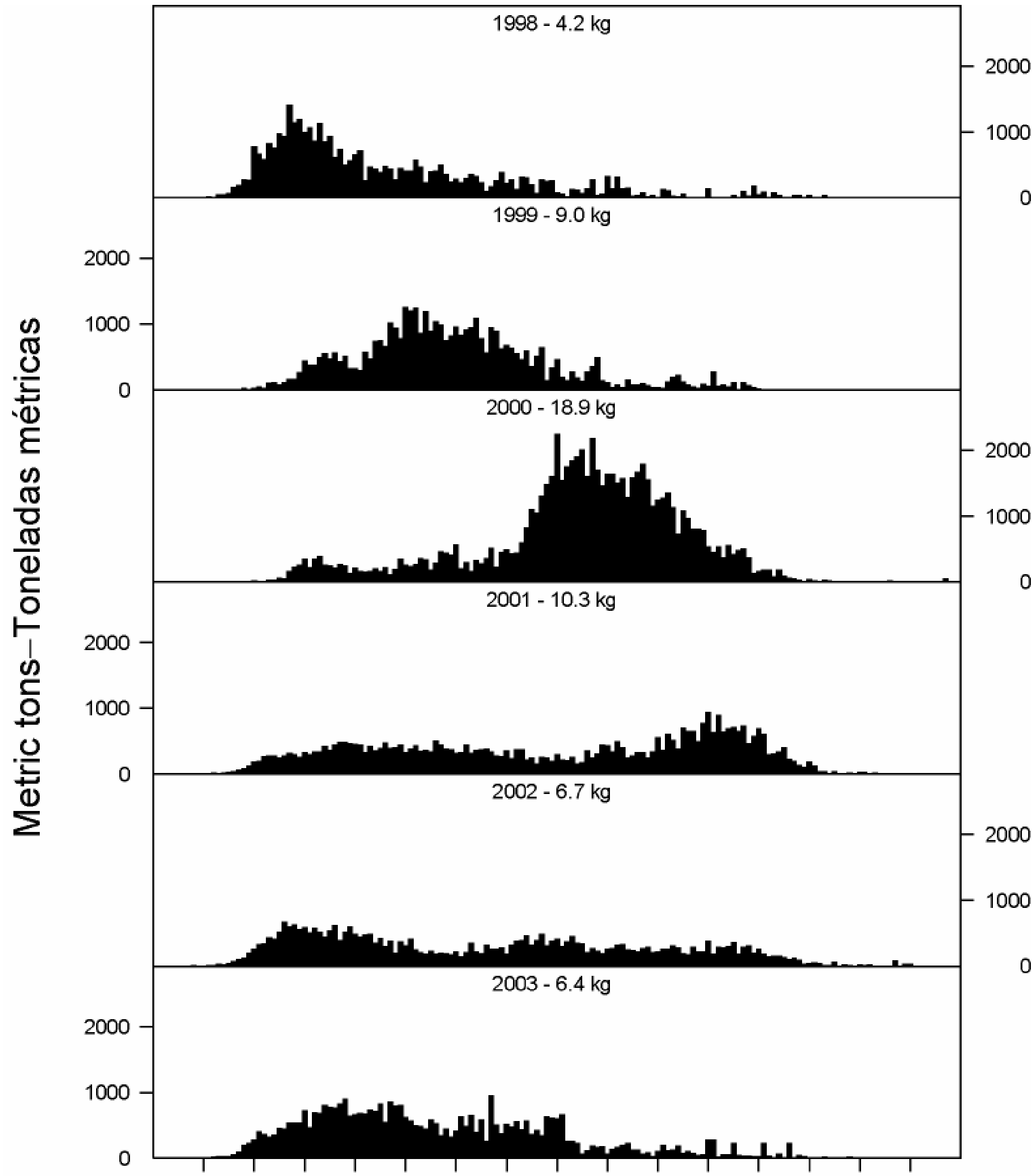


FIGURE 1-10b. Estimated size compositions of the bigeye caught in the EPO during 1998-2003. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA 1-10b. Composición por tallas estimada para el patudo capturado en el OPO durante 1998-2003. En cada recuadro se detalla el peso promedio de los peces en las muestras.

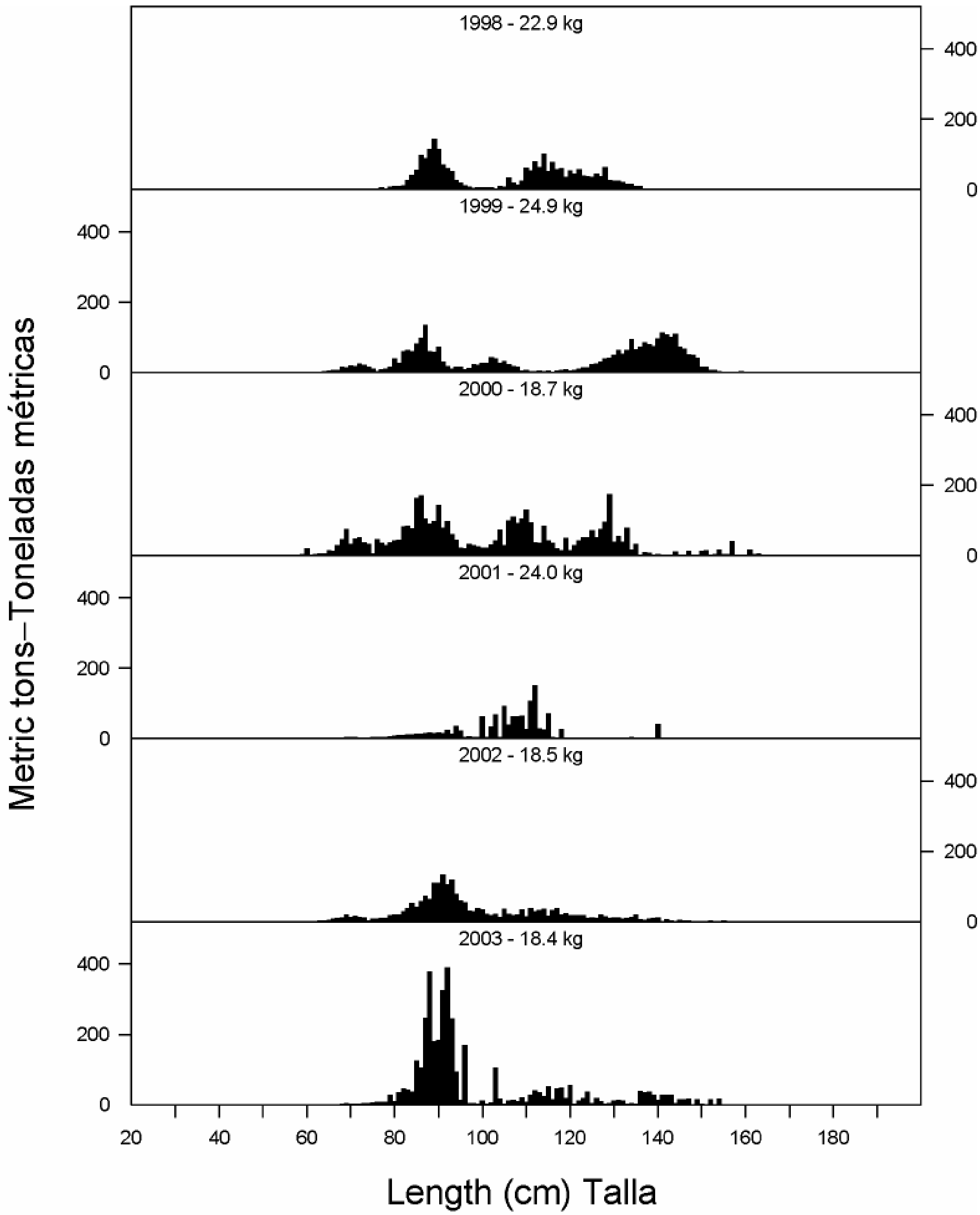


FIGURE 1-11. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 1998-2003. The values at the tops of the panels are the average weights.
FIGURA 1-11. Captura estimada de aleta azul del Pacífico por buques cerqueros y deportivos en el OPO durante 1998-2003. El valor en cada recuadro representa el peso promedio.

TABLE 1-1. Numbers and well volumes, in cubic meters, of purse seiners and pole-and-line vessels of the eastern Pacific Ocean (EPO) tuna fleet. Information for 1950-1960 (in short tons) is given in Table1 of the IATTC Annual Report for 1988, and information for 1961-1969 (in cubic meters) is given in Table1 of the IATTC Annual Report for 2002. The data for 2003 are preliminary.

TABLA 1-1. Número y volumen de bodega, en metros cúbicos, de los buques cerqueros y cañeros de la flota atunera del Océano Pacífico oriental (OPO). En la Tabla1 del Informe Anual de la CIAT de 1988 se presentan los datos de 1950-1960 (en toneladas cortas), y en la Tabla1 del Informe Anual de la CIAT de 2002 se presentan los datos de 1961-1969 (en metros cúbicos), Los datos de 2003 son preliminares.

Year	Purse seiners		Pole-and-line vessels		Total	
	Number	Well volume	Number	Well volume	Number	Well volume
Año	Buques cerqueros		Barcos cañeros		Total	
	Número	Volumen de bodega	Número	Volumen de bodega	Número	Volumen de bodega
1970	162	71,689	49	4,569	211	76,258
1971	191	94,423	102	5,916	293	100,338
1972	210	119,418	108	7,123	318	126,540
1973	219	140,150	106	7,279	325	147,429
1974	234	156,203	111	8,246	345	164,450
1975	253	174,016	102	7,862	355	181,879
1976	254	187,512	99	7,508	353	195,020
1977	253	189,967	79	5,766	332	195,733
1978	271	192,259	68	5,352	339	197,610
1979	282	195,494	45	4,223	327	199,717
1980	270	196,476	46	4,072	316	200,548
1981	251	196,484	39	3,249	290	199,733
1982	223	178,234	36	2,877	259	181,111
1983	215	149,404	52	3,681	267	153,085
1984	175	121,650	40	3,245	215	124,895
1985	178	137,814	25	2,574	203	140,387
1986	166	131,806	17	2,060	183	133,867
1987	177	152,351	29	2,376	206	154,727
1988	189	156,636	36	3,274	225	159,910
1989	178	141,956	30	3,135	208	145,091
1990	172	143,946	23	2,044	195	145,990
1991	155	124,501	19	1,629	174	126,131
1992	160	117,017	19	1,612	179	118,629
1993	152	118,730	15	1,543	167	120,272
1994	167	122,214	20	1,725	187	123,939
1995	175	124,096	20	1,784	195	125,880
1996	183	132,731	17	1,639	200	134,370
1997	194	146,533	23	2,105	217	148,637
1998	203	161,560	22	2,217	225	163,777
1999	208	180,652	14	1,656	222	182,308
2000	205	180,895	12	1,269	217	182,164
2001	205	189,865	10	1,259	215	191,124
2002	218	200,075	6	925	224	201,000
2003	213	202,301	4	526	217	202,827

TABLE 1-2a. Estimates of the numbers and carrying capacities, in cubic meters, of purse seiners and pole-and-line vessels operating in the EPO in 2002 by flag, gear, and size class. Each vessel is included in the totals for each flag under which it fished during the year, but is included only once in the fleet total. Therefore the totals for the fleet may not equal the sums of the individual flag entries. PS = purse seine; LP = pole-and-line vessel.

TABLA 1-2a. Estimaciones del número de buques cerqueros y de carnada que pescan en el OPO en 2002, y de la capacidad de acarreo de los mismos, en metros cúbicos, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el total de la flota; por consiguiente, los totales de las flotas no son siempre iguales a las sumas de las banderas individuales. PS = cerquero; LP = buque cañero.

Flag	Gear	Size class—Clase de arqueo							Well volume
Bandera	Arte	1	2	3	4	5	6	Total	Volumen de bodega
				Number—Número					
Belize—Belice	PS	-	-	1	-	-	1		1,
Bolivia	PS	-	-	2	1	-	7		7,
Colombia	PS	-	-	2	1	2	5		7,
Ecuador	PS	-	7	12	12	8	37		47,
España—Spain	PS	-	-	-	-	-	5		12,
Guatemala	PS	-	-	-	-	-	4		7,
Honduras	PS	-	-	-	-	-	2		1,
México	PS	-	-	5	4	11	36		48,
	LP			6	-	-	-		
Nicaragua	PS	-	-	-	-	-	1		1,
Panamá	PS	-	-	-	2	-	8		11,
Perú	PS	-	-	-	-	-	1		1,
El Salvador	PS	-	-	-	-	-	3		5,
USA—EE.UU.	PS	-	-	2	-	-	9		13,
Venezuela	PS	-	-	-	-	-	24		30,
Vanuatu	PS	-	-	-	-	1	4		5,
Unknown—Desconocido	PS	-	-	-	-	-	1	1	
Grand total—Total general	PS	-	7	24	20	22	145	218	
	LP	-	-	6	-	-	-	6	
	PS + LP	-	7	30	20	22	145	224	
				Well volume—Volumen de bodega					
Grand total—Total general	PS	-	758	4,397	5,566	9,831	179,523	200,075	
	LP	-	-	925	-	-	-	925	
	PS + LP	-	758	5,322	5,566	9,831	179,523	201,000	

TABLE 1-2b. Preliminary estimates of the numbers and carrying capacities, in cubic meters, of purse seiners and pole-and-line vessels operating in the EPO in 2003 by flag, gear, and size class. Each vessel is included in the totals for each flag under which it fished during the year, but is included only once in the fleet total. Therefore the totals for the fleet may not equal the sums of the individual flag entries. PS = purse seine; LP = pole-and-line vessel.

TABLA 1-2b. Estimaciones preliminares del número de buques cerqueros y de carnada que pescan en el OPO en 2003, y de la capacidad de acarreo de los mismos, en metros cúbicos, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el total de la flota; por consiguiente, los totales de las flotas no son siempre iguales a las sumas de las banderas individuales. PS = cerquero; LP = buque cañero.

Flag	Gear	Size class—Clase de arqueo							Well volume
Bandera	Arte	1	2	3	4	5	6	Total	Volumen de bodega
				Number—Número					
Belize—Belice	PS		-	1	-	-	1		
Bolivia	PS		-	2	1	-	7		7,
Colombia	PS		-	1	1	2	5		7,
Ecuador	PS		5	11	11	9	37		47,
España—Spain	PS		-	-	-	-	5		12,
Guatemala	PS		-	-	-	-	3		5,
Honduras	PS		-	-	-	-	2		1,
México	PS		-	3	6	11	38		50,
	LP		1	3	-	-	-		
Panamá	PS				1	-	13		17,
Perú	PS		-	-	-	-	2		2,
El Salvador	PS		-	-	-	-	3		5,
USA—EE.UU.	PS		-	2	-	-	6		8,
Venezuela	PS		-	-	-	-	25		32,
Vanuatu	PS		-	-	-		6		7,
Grand total—	PS		5	19	20	21	148	213	
Total general	LP		1	3	-	-	-	4	
	PS + LP		6	22	20	21	148	217	
				Capacity—Capacidad					
Grand total—	PS	-	551	3,552	5,577	9,328	183,293	202,301	
Total general	LP	-	101	425	-	-	-	526	
	PS + LP		652	3,977	5,577	9,328	183,293	202,827	

TABLE 1-3. Minimum, average, and maximum values, in thousands of metric tons, for monthly capacities of purse seiners and pole-and-line vessels at sea in the EPO during 1992-2003, and the 2003 values.
TABLA 1-3. Valores mínimos, medios, y máximos, en miles de toneladas métricas, de la capacidad mensual de buques cerqueros y cañeros en el mar de OPO durante 1992-2003, y los valores de 2003.

	Month—Mes											
	1	2	3	4	5	6	7	8	9	10	11	12
Minimum—Mínima,1992-2002	48.9	67.9	59.7	64.2	61.7	62.7	65.0	60.3	61.0	52.9	60.0	33.1
Average—Promedio,1992-2002	84.8	93.0	90.1	92.7	89.9	92.4	92.8	91.0	91.6	90.6	86.4	75.1
Maximum—Máxima,1992-2002	121.4	121.9	124.4	121.4	130.0	115.9	128.2	121.8	116.0	121.6	120.3	122.9
2003	121.6	134.0	139.4	139.9	138.7	134.1	128.6	126.7	123.8	129.5	135.3	138.7

TABLE 1-4. Estimated retained and discarded catches by surface gear, in metric tons, of the EPO tuna fleet. "YFT+SKJ" = yellowfin + skipjack; "Others" includes other tunas, sharks,and miscellaneous fishes. The 2002 and 2003 data are preliminary. Additional information concerning this table is given in the text.
TABLA 1-4. Estimaciones de capturas retenidas y descartadas, en toneladas métricas, por artes de superficie de la flota atunera del OPO. "YFT+SKJ" = aleta amarilla + barrilete; "Otros" incluye otros atunes, tiburones, y peces diversos. Los datos de2002 y2003 son preliminares. En el texto se presenta información adicional sobre esta tabla.

Year	Yellowfin			Skipjack			Bigeye			Bluefin		
	Retained	Discarded	Total	Retained	Discarded	Total	Retained	Discarded	Total	Retained	Discarded	Total
Año	Aleta amarilla			Barrilete			Patudo			Aleta azul		
	Retenido	Descartado	Total	Retenido	Descartado	Total	Retenido	Descartado	Total	Retenido	Descartado	Total
1970	155,642		155,642	55,973		55,973	1,332		1,332	3,966		3,966
1971	122,722		122,722	104,520		104,520	2,566		2,566	8,360		8,360
1972	177,128		177,128	33,409		33,409	2,238		2,238	13,347		13,347
1973	205,253		205,253	43,954		43,954	1,979		1,979	10,744		10,744
1974	210,364		210,364	78,803		78,803	890		890	5,617		5,617
1975	202,186		202,186	124,344		124,344	3,945		3,945	9,582		9,582
1976	236,234		236,234	126,354		126,354	10,243		10,243	10,645		10,645
1977	198,811		198,811	86,327		86,327	7,051		7,051	5,490		5,490
1978	179,923		179,923	169,858		169,858	11,532		11,532	5,402		5,402
1979	189,674		189,674	132,024		132,024	7,532		7,532	6,127		6,127
1980	159,432		159,432	130,669		130,669	15,421		15,421	2,939		2,939
1981	181,805		181,805	119,529		119,529	10,091		10,091	1,095		1,095
1982	125,184		125,184	98,551		98,551	4,366		4,366	3,156		3,156
1983	94,482		94,482	58,195		58,195	3,260		3,260	871		871
1984	145,060		145,060	60,551		60,551	5,936		5,936	907		907
1985	216,994		216,994	49,460		49,460	4,396		4,396	4,103		4,103
1986	268,314		268,314	63,553		63,553	1,939		1,939	5,091		5,091
1987	271,945		271,945	62,020		62,020	776		776	1,033		1,033
1988	288,992		288,992	85,416		85,416	1,053		1,053	1,426		1,426
1989	289,503		289,503	92,403		92,403	1,470		1,470	1,229		1,229
1990	273,370		273,370	72,580		72,580	4,711		4,711	1,576		1,576
1991	239,036		239,036	63,225		63,225	3,740		3,740	510		510
1992	239,696		239,696	83,911		83,911	5,497		5,497	2,039		2,039
1993	232,071	5,040	237,111	87,357	10,589	97,946	8,069	585	8,654	879	0	879
1994	219,261	4,614	223,875	74,534	10,314	84,848	29,375	2,305	31,680	1,062	0	1,062
1995	223,773	5,345	229,118	138,210	16,621	154,831	37,279	3,262	40,541	874	0	874
1996	250,285	6,660	256,945	112,118	24,970	137,088	51,110	5,786	56,896	8,259	0	8,259
1997	258,042	5,631	263,673	161,888	31,867	193,755	51,627	5,627	57,254	2,813	3	2,816
1998	265,782	4,718	270,500	145,115	22,856	167,971	35,154	2,853	38,007	2,239	0	2,239
1999	294,871	6,628	301,499	265,502	26,813	292,315	40,674	5,166	45,840	3,092	54	3,146
2000	272,372	6,815	279,187	210,477	26,364	236,841	70,287	5,624	75,911	4,123	0	4,123
2001	397,433	7,921	405,354	144,523	13,516	158,039	42,961	1,261	44,222	1,362	4	1,366
2002	421,443	3,956	425,399	160,394	12,793	173,187	35,677	977	36,654	2,116	6	2,122
2003	399,256	5,265	404,521	259,798	22,811	282,609	40,720	1,978	42,698	3,639	0	3,639

TABLE 1-4. (continued)
TABLA 1-4. (continuación)

Year	Albacore			Bonito			Black skipjack			Others			All species combined		
	Retained	Discarded	Total	Retained	Discarded	Total	Retained	Discarded	Total	Retained	Discarded	Total	Retaine	Discarded	Total
Año	Albacora			Bonito			Barrilete negro			Otros			Todas las especies		
	Retenido	Descartado	Total	Retenido	Descartado	Total	Retenido	Descartado	Total	Retenido	Descartado	Total	Retenido	Descartado	Total
1970	4,476		4,476	4,738		4,738				27		27	226,155		226,155
1971	2,490		2,490	9,600		9,600	6		6	61		61	250,324		250,324
1972	4,832		4,832	8,872		8,872	601		601	367		367	240,795		240,795
1973	2,316		2,316	7,864		7,864	1,674		1,674	355		355	274,138		274,138
1974	4,783		4,783	4,436		4,436	3,742		3,742	985		985	309,620		309,620
1975	3,332		3,332	16,838		16,838	511		511	277		277	361,016		361,016
1976	3,732		3,732	4,370		4,370	1,526		1,526	1,327		1,327	394,430		394,430
977	1,981		1,981	11,275		11,275	1,458		1,458	1,950		1,950	314,343		314,343
1978	1,745		1,745	4,837		4,837	2,170		2,170	808		808	376,273		376,273
1979	327		327	1,805		1,805	1,366		1,366	1,249		1,249	340,103		340,103
1980	601		601	6,125		6,125	3,680		3,680	1,109		1,109	319,977		319,977
1981	739		739	5,717		5,717	1,911		1,911	1,008		1,008	321,895		321,895
1982	553		553	2,121		2,121	1,338		1,338	783		783	236,052		236,052
1983	456		456	3,829		3,829	1,236		1,236	1,709		1,709	164,038		164,038
1984	5,351		5,351	3,514		3,514	666		666	987		987	222,972		222,972
1985	919		919	3,604		3,604	296		296	536		536	280,307		280,307
1986	133		133	490		490	595		595	1,140		1,140	341,256		341,256
1987	417		417	3,326		3,326	561		561	1,615		1,615	341,692		341,692
1988	288		288	9,550		9,550	1,267		1,267	1,297		1,297	389,289		389,289
1989	22		22	12,095		12,095	783		783	1,072		1,072	398,577		398,577
1990	209		209	13,856		13,856	791		791	944		944	368,038		368,038
1991	834		834	1,288		1,288	446		446	649		649	309,729		309,729
1992	255		255	978		978	104		104	763		763	333,243		333,243
1993	1	-	1	599	12	611	104	3,950	4,054	314	1,981	2,295	329,395	22,157	351,552
1994	85	-	85	8,692	145	8,837	188	805	993	419	522	941	333,616	18,705	352,321
1995	465	2	467	8,009	55	8,064	187	1,415	1,602	172	668	840	408,969	27,368	436,337
1996	83	-	83	655	1	656	704	2,417	3,121	219	1,052	1,271	423,433	40,886	464,319
1997	60	-	60	1,104	5	1,109	101	2,582	2,683	148	3,407	3,555	475,784	49,122	524,906
1998	124	-	124	1,337	5	1,342	528	1,857	2,385	168	1,233	1,401	450,446	33,522	483,968
1999	274	-	274	1,720	-	1,720	178	3,412	3,590	218	3,096	3,314	606,529	45,169	651,698
2000	157	-	157	636	-	636	293	1,885	2,178	357	1,496	1,853	558,702	42,184	600,886
2001	20	-	20	18	-	18	2,051	1,261	3,312	373	766	1,139	588,741	24,729	613,470
2002	32	-	32	-	-	-	1,462	1,939	3,401	578	1,828	2,406	621,702	21,499	643,201
2003	31	-	31	-	-	-	429	1,511	1,940	333	1,143	1,476	704,206	32,708	736,914

TABLE 1-5a. Estimates of the retained catches and landings, in metric tons, of tunas caught by surface gear in the EPO in 2002, by species and vessel flag (upper panel) and location where processed (lower panel). Miscellaneous = other species, including other tunas, sharks, and miscellaneous fishes.

TABLA 1-5a. Estimaciones de las capturas retenidas y descargas de atún capturado con artes de superficie en el OPO en 2002, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. Miscelanea = otras especies, incluyendo otros túnidos, tiburones, y peces diversos.

Flag	Yellowfin	Skipjack	Bigeye	Bluefin	Bonito	Albacore	Black skipjack	Miscel-laneous	Total	Percent of total
Bandera	**Aleta amarilla**	**Barrilete**	**Patudo**	**Aleta azul**	**Bonito**	**Albacora**	**Barrilete negro**	**Miscel-ánea**	**Total**	**Porcentaje del total**
Colombia	30,806	2,516	151	-	-	-	-	329	33,802	5.4
Ecuador	40,030	78,682	18,544	-	-	-	871	171	138,298	22.3
España—Spain	5,209	22,043	4,692	-	-	-	-	-	31,944	5.1
México	151,469	9,571	-	1,715	-	28	366	-	163,149	26.2
Panamá	20,386	7,569	1,299	-	-	-	-	-	29,254	4.7
U.S.A.—EE.UU.	8,762	3,647	1,717	401	-	3	224	64	14,818	2.4
Venezuela	120,302	3,942	287	-	-	-	-	-	124,531	20.0
Vanuatu	5,718	6,791	1,906	-	-	-	-	-	14,415	2.3
Other—Otros[1]	38,761	25,633	7,081	-	-	1	1	14	71,491	11.6
Total	421,443	160,394	35,677	2,116	-	32	1,462	578	621,702	
Colombia	62,055	5,970	1,695	-	-	-	-	-	69,720	10.7
Costa Rica	36,418	3,510	873	-	-	-	-	-	40,801	6.3
Ecuador	113,953	129,104	30,800	-	-	-	871	883	275,611	42.3
España—Spain	33,230	15,277	3,630	-	-	-	-	-	52,137	8.0
México	148,076	9,535	22	1,710	-	28	366	-	159,737	24.5
U.S.A.—EE.UU.	7,148	1,752	311	401	-	3	224	64	9,903	1.5
Venezuela	39,044	918	45	-	-	-	-	-	40,007	6.1
Other-Otros[2]	2,261	1,883	-	2	-	-	-	-	4,146	0.6
Total	442,185	167,949	37,376	2,113	-	31	1,461	947	652,062	

[1] Includes Belize, Bolivia, El Salvador, Guatemala, Honduras, Nicaragua, Peru, and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.

[1] Incluye Belice, Bolivia, El Salvador, Guatemala, Honduras, Nicaragua, Perú, y no identificados. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

[2] Includes Panama, Peru, and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.

[2] Incluye Panamá, Perú y no identificados. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

TABLE 1-5b. Preliminary estimates of the retained catches and landings, in metric tons, of tunas caught by surface gear in the EPO in 2003, by species and vessel flag (upper panel) and location where processed (lower panel). Miscellaneous = other species, including other tunas, sharks, and miscellaneous fishes.

TABLA 1-5b. Estimaciones preliminares de las capturas retenidas y descargas de atún capturado con artes de superficie en el OPO en 2003, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. Miscelánea = otras especies, incluyendo otros túnidos, tiburones, y peces diversos.

Flag	Yellowfin	Skipjack	Bigeye	Bluefin	Albacore	Bonito	Black skipjack	Miscel-laneous	Total	Percent of total
Bandera	**Aleta amarilla**	**Barrilete**	**Patudo**	**Aleta azul**	**Albacora**	**Bonito**	**Barrilete negro**	**Miscel-ánea**	**Total**	**Porcentaje del total**
Colombia	23,255	4,656	159	-	-	-	-	-	28,070	4.0
Ecuador	41,641	133,919	17,933	-	-	-	62	271	193,826	27.5
España—Spain	4,921	22,586	5,629	-	-	-	-	-	33,136	4.7
México	162,506	19,400	77	3,225	-	28	198	40	185,474	26.3
Panamá	30,930	11,309	3,022	-	-	-	2	-	45,263	6.4
U.S.A.—EE.UU.	1,196	6,746	2,254	413	-	-	165	22	10,796	1.5
Venezuela	91,551	10,697	1,335	-	-	-	-	-	103,583	14.7
Vanuatu	3,889	18,162	5,421	-	-	-	2	-	27,474	3.9
Other—Otros[1]	39,367	32,323	4,890	1	-	3	-	-	76,584	10.9
Total	399,256	259,798	40,720	3,639	-	31	429	333	704,206	
Colombia	50,035	8,077	1,410	-	-	-	6	-	59,528	8.8
Costa Rica	35,709	2,438	345	-	-	-	-	-	38,492	5.7
Ecuador	83,796	203,321	34,204	-	-	2	50	66	321,439	47.3
España—Spain	9,685	160	82	-	-	-	-	-	9,927	1.5
México	145,943	19,357	77	3,220	-	28	142	100	168,867	24.8
U.S.A.—EE.UU.	127	1,780	78	413	-	-	165	22	2,585	0.4
Venezuela	11,654	1,259	54	-	-	-	-	-	12,967	1.9
Other-Otros[2]	49,058	14,946	1,982	-	-	-	-	-	65,986	9.6
Total	386,007	251,338	38,232	3,633	-	30	363	188	679,791	

[1] Includes Belize, Bolivia, El Salvador, Guatemala and Honduras. This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye Belice, Bolivia, El Salvador, Guatemala y Honduras. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatemala, Panama, Peru and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador, Guatemala, Panamá, Perú y no identificados. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

TABLE 1-6. Estimated numbers of sets by set type and vessel size class, and estimated retained catches, in metric tons, for yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2003 are preliminary.

TABLA 1-6. Números estimados de lances, por tipo de lance y clase de arqueo de los buques, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de2003 son preliminares.

Year	Number of sets			Retained catch		
	Classes 1-5	Class 1	Total	Yellowfin	Skipjack	Bigeye
Año	Número de lances			Captura retenida		
	Clases 1-5	Clase 1	Total	Aleta amarilla	Barrilete	Patudo
Sets on fish associated with dolphins-- Lances sobre peces asociados con delfines						
1987	57	13,286	13,343	190,432	332	20
1988	49	11,160	11,209	157,173	4,898	0
1989	33	12,827	12,860	194,846	1,447	0
1990	31	10,997	11,028	179,253	867	0
1991	0	9,661	9,661	159,255	786	38
1992	26	10,398	10,424	169,350	869	0
1993	34	6,953	6,987	110,045	714	97
1994	5	7,804	7,809	125,379	516	0
1995	0	7,185	7,185	131,932	1,032	0
1996	14	7,472	7,486	137,258	729	0
1997	43	8,977	9,020	156,163	6,004	35
1998	0	10,645	10,645	151,678	2,879	66
1999	0	8,648	8,648	143,503	1,214	0
2000	2	9,235	9,237	155,212	468	0
2001	6	9,847	9,853	240,873	1,289	10
2002	0	12,433	12,433	297,147	2,153	0
2003	0	13,841	13,841	272,155	11,448	104
Sets on fish associated with floating objects--Lances sobre peces asociados con objetos flotantes						
1987	1,322	1,813	3,135	27,189	32,160	561
1988	823	2,281	3,104	23,933	35,949	569
1989	974	2,339	3,313	28,362	41,452	1,215
1990	719	2,558	3,277	34,247	34,980	3,359
1991	819	2,165	2,984	23,758	37,655	1,950
1992	868	1,763	2,631	13,057	45,556	1,154
1993	493	2,063	2,556	15,964	48,144	4,548
1994	668	2,770	3,438	17,362	47,992	27,472
1995	707	3,521	4,228	20,570	81,253	32,767
1996	1,230	4,007	5,237	31,073	74,260	48,251
1997	1,699	5,653	7,352	27,625	123,002	50,226
1998	1,198	5,481	6,679	31,271	115,370	31,332
1999	630	4,620	5,250	38,569	178,824	35,846
2000	494	3,916	4,410	43,116	123,857	67,514
2001	697	5,743	6,440	62,807	122,268	41,899
2002	778	5,775	6,553	37,159	121,891	34,541
2003	760	5,497	6,257	33,249	181,377	39,250

TABLE 1-6. (continued)
TABLA 1-6. (continuación)

Year	Number of sets			Retained catch		
	Classes 1-5	Class 1	Total	Yellowfin	Skipjack	Bigeye
Año	Número de lances			Captura retenida		
	Clases 1-5	Clase 1	Total	Aleta amarilla	Barrilete	Patudo
Sets on fish in unassociated schools-- Lances sobre peces en cardúmenes no asociados						
1987	1,823	3,981	5,804	49,399	26,303	194
1988	4,147	7,536	11,683	102,042	39,535	481
1989	2,955	5,878	8,833	60,226	46,332	256
1990	3,683	5,397	9,080	56,551	35,788	1,351
1991	3,571	3,612	7,183	52,770	22,958	1,727
1992	4,010	4,079	8,089	53,507	35,333	4,343
1993	5,739	6,267	12,006	100,974	34,865	3,424
1994	5,440	5,064	10,504	72,765	22,916	1,902
1995	6,120	4,782	10,902	69,985	50,715	4,560
1996	5,807	5,118	10,925	77,343	34,635	3,102
1997	5,334	4,693	10,027	69,658	29,510	1,354
1998	5,700	4,631	10,331	77,642	25,108	3,757
1999	5,632	6,143	11,775	111,885	84,036	4,765
2000	6,119	5,482	11,601	72,487	86,695	2,641
2001	4,481	3,037	7,518	88,818	21,331	940
2002	5,008	3,405	8,413	83,764	33,404	658
2003	7,294	5,083	12,377	93,283	66,302	1,366
Sets on all types of schools-- Lances sobre todos tipos de cardumen						
1987	3,202	19,080	22,282	267,020	58,795	775
1988	5,019	20,977	25,996	283,148	80,382	1,050
1989	3,962	21,044	25,006	283,434	89,231	1,471
1990	4,433	18,952	23,385	270,051	71,635	4,710
1991	4,390	15,438	19,828	235,783	61,399	3,715
1992	4,904	16,240	21,144	235,914	81,758	5,497
1993	6,266	15,283	21,549	226,983	83,723	8,069
1994	6,113	15,638	21,751	215,506	71,424	29,374
1995	6,827	15,488	22,315	222,487	133,000	37,327
1996	7,051	16,597	23,648	245,674	109,624	51,353
1997	7,076	19,323	26,399	253,446	158,516	51,615
1998	6,898	20,757	27,655	260,591	143,357	35,155
1999	6,262	19,411	25,673	293,957	264,074	40,611
2000	6,615	18,633	25,248	270,815	211,020	70,155
2001	5,184	18,627	23,811	392,498	144,888	42,849
2002	5,786	21,613	27,399	418,070	157,448	35,199
2003	8,054	24,421	32,475	398,687	259,127	40,720

TABLE 1-7. Types of floating objects on which sets were made. The2002 data are preliminary.
TABLA 1-7. Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2002 son preliminares.

Year	Flotsam		FADs		Unknown		Total
	Number	%	Number	%	Number	%	
Año	**Naturales**		**Plantados**		**Desconocido**		**Total**
	Número	**%**	**Número**	**%**	**Número**	**%**	
1992	1,087	61.7	556	31.5	120	6.8	1,763
1993	1,138	55.2	825	40.0	100	4.8	2,063
1994	773	27.9	1,899	68.6	98	3.5	2,770
1995	729	20.7	2,704	76.8	88	2.5	3,521
1996	537	13.4	3,447	86.0	23	0.6	4,007
1997	832	14.7	4,768	84.4	52	0.9	5,652
1998	752	13.7	4,627	84.4	102	1.9	5,481
1999	833	18.0	3,758	81.3	29	0.6	4,620
2000	488	12.5	3,381	86.3	47	1.2	3,916
2001	567	9.9	5,076	88.4	100	1.7	5,743
2002	756	13.1	4,953	85.8	66	1.1	5,775

TABLE 1-8. Catches per cubic meter of carrying capacity for the EPO purse-seine fleet, by species and vessel size group, in the EPO and in all ocean fishing areas. YFT = yellowfin; SKJ = skipjack; BET = bigeye; All = all species reported.
TABLA 1-8. Capturas por metro cúbico de capacidad de acarreo por de la flota cerquera del OPO, por especie y clase de arqueo, en el OPO y en todas las áreas oceánicas de pesca. YFT = aleta amarilla; SKJ = barrilete; BET = patudo; EPO = OPO; All = todas las especies reportadas.

Year	Species	<401 m^3		401-800 m^3		801-1100 m^3		1101-1300 m^3		1301-1500 m^3		1501-1800 m^3		1801-2100 m^3		>2100 m^3		Total	
Año	**Especie**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**
1990	YFT	1.9	1.9	1.3	1.3	1.3	1.3	2.2	2.2	2.2	2.2	1.4	1.5	0.8	0.9	0.0	0.0	1.8	1.9
	SKJ	1.9	1.9	0.7	0.7	0.3	0.3	0.4	0.5	0.2	0.4	0.3	0.5	0.1	0.2	0.0	0.0	0.5	0.5
	BET	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	All	4.9	4.9	2.4	2.4	1.9	1.9	2.6	2.7	2.4	2.6	1.7	2.0	0.9	1.1	0.0	0.0	2.5	2.6
1991	YFT	2.1	2.1	1.6	1.6	1.4	1.4	2.3	2.3	1.2	1.2	1.3	1.5	1.9	1.9	0.0	0.0	1.9	1.9
	SKJ	1.4	1.4	0.7	0.8	0.4	0.5	0.4	0.4	0.3	0.3	0.4	0.5	0.0	0.0	0.0	0.0	0.5	0.5
	BET	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	All	3.8	3.8	2.4	2.5	1.8	1.9	2.6	2.7	1.5	1.5	1.7	2.0	1.9	1.9	0.0	0.0	2.4	2.5
1992	YFT	1.4	1.4	1.5	1.5	1.6	1.6	2.5	2.5	2.0	2.0	1.1	1.2	1.0	1.0	0.0	0.0	2.0	2.0
	SKJ	1.7	1.7	1.0	1.0	0.6	0.6	0.5	0.5	0.5	0.5	0.8	0.8	0.0	0.0	0.0	0.0	0.7	0.7
	BET	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
	All	3.4	3.4	2.6	2.6	2.2	2.2	3.0	3.1	2.5	2.5	2.1	2.1	1.0	1.0	0.0	0.0	2.7	2.8
1993	YFT	2.4	2.4	1.6	1.6	1.8	1.8	1.9	1.9	2.1	2.1	1.3	1.5	1.4	1.4	0.0	0.0	1.8	1.9
	SKJ	1.6	1.6	1.0	1.0	0.7	0.7	0.4	0.5	0.7	0.7	0.9	1.1	0.0	0.0	0.0	0.0	0.7	0.7
	BET	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1
	All	4.2	4.2	2.7	2.7	2.6	2.6	2.4	2.5	2.8	2.8	2.3	2.7	1.4	1.4	0.0	0.0	2.6	2.7
1994	YFT	2.2	2.2	1.2	1.2	1.4	1.4	2.0	2.1	1.8	1.8	1.6	1.9	0.3	0.3	0.0	0.0	1.7	1.8
	SKJ	1.0	1.0	0.8	0.8	0.4	0.4	0.4	0.5	0.7	0.7	0.5	0.7	0.5	0.5	0.0	0.0	0.6	0.6
	BET	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.7	0.7	0.0	0.0	0.2	0.2
	All	3.7	3.7	2.2	2.2	2.1	2.1	2.6	2.8	2.7	2.7	2.4	3.0	1.6	1.6	0.0	0.0	2.6	2.7
1995	YFT	1.6	1.6	1.2	1.2	1.3	1.4	2.1	2.2	1.6	1.6	1.6	1.6	0.2	0.2	0.0	0.0	1.7	1.7
	SKJ	2.0	2.0	1.3	1.3	1.1	1.2	0.7	0.7	1.0	1.0	0.5	0.5	1.5	1.5	0.0	0.0	1.0	1.0
	BET	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	1.2	1.2	0.0	0.0	0.3	0.3
	All	4.3	4.3	2.8	2.8	2.8	2.8	3.1	3.1	3.0	3.0	2.5	2.5	2.9	2.9	0.0	0.0	3.1	3.1
1996	YFT	1.9	1.9	1.2	1.2	1.5	1.5	2.2	2.2	1.5	1.5	1.7	1.9	0.9	0.9	0.0	0.0	1.8	1.8
	SKJ	1.9	1.9	1.0	1.0	0.8	0.8	0.6	0.6	0.7	0.7	0.5	0.7	0.8	0.8	0.0	0.0	0.8	0.8
	BET	0.2	0.2	0.5	0.5	0.7	0.7	0.3	0.3	0.3	0.3	0.2	0.2	0.7	0.7	0.0	0.0	0.4	0.4
	All	4.4	4.4	2.9	2.9	3.0	3.1	3.1	3.1	2.5	2.5	2.4	2.8	2.3	2.3	0.0	0.0	3.0	3.1

TABLE 1-8. (continued).
TABLA 1-8. (continuación)

Year	Species	<401 m^3		401-800 m^3		801-1100 m^3		1101-1300 m^3		1301-1500 m^3		1501-1800 m^3		1801-2100 m^3		>2100 m^3		Total	
Año	**Especie**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**	**EPO**	**All**
1997	YFT	1.9	1.9	1.2	1.2	1.2	1.2	2.2	2.2	1.4	1.4	1.1	1.2	0.7	0.7	0.0	0.0	1.6	1.7
	SKJ	2.3	2.3	1.5	1.6	1.0	1.0	0.7	0.8	1.0	1.0	0.6	0.7	1.1	1.1	0.0	0.0	1.0	1.1
	BET	0.4	0.4	0.6	0.6	0.6	0.6	0.2	0.2	0.4	0.4	0.1	0.2	0.4	0.4	0.0	0.0	0.3	0.3
	All	4.8	4.8	3.4	3.4	2.8	2.8	3.1	3.2	2.8	2.8	1.9	2.1	2.2	2.2	0.0	0.0	3.0	3.1
1998	YFT	1.8	1.8	1.1	1.1	1.2	1.2	2.1	2.2	1.3	1.4	1.7	1.8	0.5	0.5	0.4	0.4	1.6	1.6
	SKJ	1.3	1.3	1.2	1.2	1.0	1.0	0.5	0.6	1.0	1.1	0.7	0.9	1.2	1.2	1.5	1.5	0.9	0.9
	BET	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.1	0.3	0.3	0.2	0.2	0.3	0.3	0.5	0.5	0.2	0.2
	All	3.5	3.5	2.6	2.6	2.4	2.4	2.8	2.8	2.6	2.8	2.6	2.9	2.1	2.1	2.5	2.5	2.7	2.7
1999	YFT	3.2	3.2	1.5	1.5	1.2	1.2	2.0	2.0	1.3	1.3	2.2	2.2	0.5	0.6	0.4	0.5	1.6	1.6
	SKJ	1.9	1.9	2.1	2.1	1.7	1.8	0.9	0.9	1.9	1.9	1.1	1.1	1.5	1.7	2.2	2.5	1.5	1.5
	BET	0.2	0.2	0.3	0.3	0.2	0.2	0.1	0.1	0.3	0.3	0.2	0.2	0.3	0.4	0.8	0.8	0.2	0.2
	All	5.4	5.4	3.9	3.9	3.2	3.3	3.0	3.1	3.5	3.5	3.5	3.5	2.3	2.6	3.5	3.8	3.3	3.4
2000	YFT	1.8	1.8	0.9	0.9	1.1	1.1	2.2	2.3	1.3	1.4	1.5	1.6	0.6	0.8	0.5	0.5	1.5	1.5
	SKJ	2.5	2.5	1.7	1.7	1.8	1.8	0.5	0.6	1.1	1.2	0.8	0.9	1.5	1.8	1.4	1.4	1.2	1.2
	BET	0.1	0.1	0.4	0.4	0.5	0.5	0.1	0.1	0.4	0.4	0.2	0.2	1.0	1.2	1.5	1.5	0.4	0.4
	All	4.5	4.5	2.9	2.9	3.4	3.4	2.9	3.0	2.8	2.9	2.6	2.7	3.2	3.8	3.3	3.5	3.1	3.2
2001	YFT	2.5	2.5	1.3	1.3	1.4	1.4	3.0	3.0	2.1	2.1	2.4	2.4	0.9	0.9	0.7	0.7	2.1	2.1
	SKJ	1.3	1.3	1.1	1.1	1.1	1.1	0.3	0.3	0.7	0.7	0.4	0.5	1.4	1.4	1.4	1.4	0.8	0.8
	BET	0.0	0.0	0.3	0.3	0.3	0.3	0.1	0.1	0.3	0.3	0.1	0.1	0.5	0.5	0.5	0.5	0.2	0.2
	All	4.0	4.0	2.7	2.7	2.8	2.9	3.4	3.4	3.1	3.1	2.9	3.0	2.8	2.8	2.5	2.5	3.1	3.1
2002	YFT	1.9	1.9	1.5	1.5	1.2	1.2	3.3	3.3	2.6	2.6	2.3	2.3	0.7	0.7	0.5	0.5	2.2	2.2
	SKJ	1.4	1.4	1.4	1.4	1.2	1.2	0.3	0.3	0.6	0.6	0.2	0.2	1.4	1.4	1.6	1.6	0.8	0.8
	BET	0.0	0.0	0.1	0.1	0.3	0.3	0.1	0.1	0.3	0.3	0.1	0.1	0.4	0.4	0.4	0.4	0.2	0.2
	All	3.5	3.5	3.1	3.1	2.7	2.7	3.7	3.7	3.6	3.6	2.6	2.6	2.5	2.5	2.6	2.6	3.2	3.2

TABLE 1-9a. Annual retained catches of yellowfin tuna by region, in metric tons. In some cases the data were converted from numbers of fish to weights in metric tons with average weight data estimated by the IATTC staff. "Other" includes China, Costa Rica, Ecuador, El Salvador, French Polynesia, Guatemala, Mexico, Nicaragua, and the USA. The data for 2002-2003 are preliminary.

TABLA 1-9a. Capturas retenidas anuales de atún aleta amarilla por región, en toneladas métricas. En algunos casos se convirtieron los datos de números de peces a peso en toneladas métricas usando datos de peso promedio estimados por el personal de la CIAT. "Otros" incluye China, Costa Rica, Ecuador, EE.UU., El Salvador, Guatemala, México, Nicaragua, y Polinesia Francesa. Los datos de 2002-2003 son preliminares.

Year	EPO							WCPO[3]	Total
	Surface[1]	Longline[2]			Other flags and gears	Subtotal	Subtotal EPO		
		Japan	Korea	Chinese Taipei					
Año	OPO							OPOC[3]	Total
	Superficie[1]	Palangre[2]			Otras banderas y artes	Subtotal	Subtotal OPO		
		Japon	Corea	Taipei Chino					
1970	155,642	12,273	*	358	*	12,632	168,273	93,826	262,099
1971	122,722	7,368	*	645	*	8,013	130,735	94,392	225,127
1972	177,128	16,013	*	847	*	16,859	193,987	106,069	300,056
1973	205,253	11,413	*	284	*	11,697	216,950	122,911	339,861
1974	210,364	6,914	*	276	*	7,190	217,554	127,255	344,809
1975	202,186	10,299	138	209	*	10,646	212,833	132,050	344,883
1976	236,234	15,036	284	145	*	15,465	251,699	145,413	397,112
1977	198,811	11,222	558	299	*	12,079	210,891	176,832	387,723
1978	179,923	9,187	585	150	648	10,571	190,493	174,505	364,998
1979	189,674	10,909	312	141	2	11,364	201,038	194,150	395,188
1980	159,432	11,549	1,243	31	0	12,823	172,254	210,075	382,329
1981	181,805	7,090	680	165	*	7,935	189,741	225,309	415,050
1982	125,184	9,826	784	82	97	10,788	135,972	219,427	355,399
1983	94,482	9,404	1,057	65	60	10,585	105,068	253,870	358,938
1984	145,060	9,134	937	44	50	10,165	155,225	248,656	403,881
1985	216,994	10,633	1,995	50	7	12,685	229,679	256,137	485,816
1986	268,314	17,770	3,250	76	73	21,168	289,482	244,546	534,028
1987	271,945	13,484	3,103	113	274	16,973	288,918	301,922	590,840
1988	288,992	12,481	1,305	34	259	14,079	303,071	259,462	562,533
1989	289,503	15,335	811	689	21	16,857	306,360	313,402	619,762
1990	273,370	29,255	3,244	630	2	33,131	306,502	350,915	657,417
1991	239,036	23,721	4,796	1,301	211	30,029	269,066	400,445	669,511
1992	239,696	15,296	2,092	227	281	17,895	257,590	414,746	672,336
1993	232,071	20,339	2,441	93	958	23,831	255,902	399,860	655,762
1994	219,261	25,983	2,309	275	903	29,470	248,731	411,031	659,762
1995	223,773	17,042	2,014	42	810	19,907	243,680	386,292	629,972
1996	250,285	12,631	2,246	48	623	15,548	265,833	327,693	593,526
1997	258,042	16,218	2,840	151	1,096	20,305	278,347	457,752	736,099
1998	265,782	10,048	2,436	95	2,273	14,852	280,634	502,960	783,594
1999	294,606	7,186	1,941	137	3,177	12,441	307,047	440,755	748,067
2000	272,163	14,924	2,628	1,418	3,128	22,098	294,470	458,169	752,639
2001	397,433	14,645	3,669	2,901	3,789	25,005	422,438	466,983	889,421
2002	421,443	8,495	1,708	*	3,440	13,643	435,086	437,984	873,070
2003	399,256	3,028[4]	*	*	628	3,656	402,912	*	402,912

1 Source: Table 1-4—Fuente: Tabla 1-4

2 Sources: published and unpublished data from the National Research Institute of Far Seas Fisheries (NRIFSF), Shimizu, Japan, Institute of Oceanography, National Taiwan University, Taipei, Taiwan, Ministry of Agriculture, People's Republic of China, and National Fisheries Research and Development Agency, Republic of Korea.

2 Fuentes: datos publicados e inéditos del Instituto Nacional de Investigación de Pesquerías de Ultramar (NRIFSF) en Shimizu (Japón), el Instituto de Oceanografía de la Universidad Nacional de Taiwan en Taipei, Ministerio de Agricultura, República Popular de China, y la Agencia Nacional de Investigación y Desarrollo Pesquero de Corea.

3 WCPO = western and central Pacific Ocean; Source: Secretariat of the Pacific Community, Ocean Fisheries Programme

3 WCPO = Océano Pacífico oeste y central; Fuente: Secretariat of the Pacific Community, Ocean Fisheries Programme

4 Jan – June 2003

* not available—no disponible

TABLE 1-9b. Annual retained catches of skipjack tuna by region, in metric tons. In some cases the data were converted from numbers of fish to weight in metric tons with average weight data estimated by the IATTC staff. "Other" includes Costa Rica, French Polynesia, Mexico, and the USA. The data for 2002-2003 are preliminary.

TABLA 1-9b. Capturas retenidas anuales de atún barrilete por región, en toneladas métricas. En algunos casos los dates fueron convertidos de número de peces a peso en toneladas con datos de peso promedio estimados por el personal de la CIAT. "Otros" incluye Costa Rica, EE.UU., México, y Polinesia Francesa. Los datos de 2002-2003 son preliminares.

Year	EPO							WCPO[3]	Total
	Surface[1]	Longline[2]			Other flags and gears	Subtotal	Subtotal EPO		
		Japan	Korea	Chinese Taipei					
Año	OPO							OPOC[3]	Total
	Superficie[1]	Palangre[2]			Otras banderas y artes	Subtotal	Subtotal OPO		
		Japon	Corea	Taipei Chino					
1970	55,973	136	*	21	*	157	56,130	242,082	298,212
1971	104,520	129	*	51	*	180	104,700	226,371	331,071
1972	33,409	224	*	6	*	230	33,639	235,756	269,395
1973	43,954	180	*	18	*	198	44,152	326,546	370,698
1974	78,803	80	*	11	*	91	78,894	355,361	434,255
1975	124,344	82	6	3	*	92	124,436	288,511	412,947
1976	126,354	102	7	18	*	127	126,481	357,899	484,380
1977	86,327	87	12	12	*	111	86,439	404,232	490,671
1978	169,858	40	10	12	*	62	169,920	450,473	620,393
1979	132,024	23	7	4	*	34	132,058	411,304	543,362
1980	130,669	21	5	*	*	26	130,696	458,419	589,115
1981	119,529	11	9	1	*	22	119,551	438,178	557,729
1982	98,551	19	9	1	*	30	98,580	491,094	589,674
1983	58,195	18	13	0	*	31	58,226	683,821	742,047
1984	60,551	24	9	*	*	33	60,584	755,538	816,122
1985	49,460	34	12	0	*	46	49,505	599,874	649,379
1986	63,553	39	21	2	*	61	63,615	756,846	820,461
1987	62,020	19	9	3	*	31	62,050	685,940	747,990
1988	85,416	12	5	6	*	23	85,439	841,586	927,025
1989	92,403	15	2	9	*	26	92,429	818,241	910,670
1990	72,580	31	6	*	*	37	72,617	891,226	963,843
1991	63,225	20	8	2	3	32	63,258	1,129,767	1,193,025
1992	83,911	17	5	*	*	22	83,933	1,022,629	1,106,562
1993	87,357	51	4	3	*	58	87,415	919,370	1,006,785
1994	74,534	55	2	8	3	68	74,602	1,013,954	1,088,556
1995	138,210	65	2	1	6	74	138,283	1,061,372	1,199,655
1996	112,118	26	5	5	24	59	112,177	1,037,340	1,149,517
1997	161,888	20	2	70	13	105	161,994	986,066	1,148,060
1998	145,115	44	3	18	31	95	145,210	1,314,239	1,459,449
1999	265,502	47	4	42	24	116	265,619	1,151,563	1,417,182
2000	210,477	23	3	0	49	75	210,552	1,250,821	1,461,373
2001	144,523	28	1	3	48	80	144,603	1,191,378	1,335,981
2002	160,394	74	1	*	88	163	160,557	1,321,939	1,482,496
2003	259,798	*	*	*	*	*	259,798	*	259,798

1 Source: Table 1-4—Fuente: Tabla 1-4

2 Sources: published and unpublished data from the National Research Institute of Far Seas Fisheries (NRIFSF), Shimizu, Japan, Institute of Oceanography, National Taiwan University, Taipei, Taiwan, Ministry of Agriculture, People's Republic of China, and National Fisheries Research and Development Agency, Republic of Korea.

2 Fuentes: datos publicados e inéditos del Instituto Nacional de Investigación de Pesquerías de Ultramar (NRIFSF) en Shimizu (Japón), el Instituto de Oceanografía de la Universidad Nacional de Taiwan en Taipei, Ministerio de Agricultura, República Popular de China, y la Agencia Nacional de Investigación y Desarrollo Pesquero de Corea.

3 WCPO = western and central Pacific Ocean; Source: Secretariat of the Pacific Community, Ocean Fisheries Programme

3 WCPO = Océano Pacífico oeste y central; Fuente: Secretariat of the Pacific Community, Ocean Fisheries Programme

* not available—no disponible

TABLE 1-9c. Annual retained catches of bigeye tuna by region, in metric tons. In some cases the data were converted from numbers of fish to weight in metric tons with average weight data estimated by the IATTC staff. "Other" includes China, Costa Rica, Ecuador, El Salvador, French Polynesia, Guatemala, Mexico, and the USA. The data for 2002-2003 are preliminary.

TABLA 1-9c. Capturas retenidas anuales de atún patudo por región, en toneladas métricas. En algunos casos se convirtieron los datos de números de peces a peso en toneladas métricas usando datos de peso promedio estimados por el personal de la CIAT "Otros" incluye China, Costa Rica, Ecuador, EE.UU., El Salvador, Guatemala, México, y Polinesia Francesa. Los datos de 2002-2003 son preliminares.

Year	EPO							WCPO[3]	Total
	Surface[1]	Longline[2]			Other flags and gears	Subtotal	Subtotal EPO		
		Japan	Korea	Chinese Taipei					
Año	OPO							OPOC[3]	Total
	Super-ficie[1]	Palangre[2]			Otras banderas y artes	Subtotal	Subtotal OPO		
		Japon	Corea	Taipei Chino					
1970	1,332	32,521	*	723	*	33,243	34,575	39,133	73,708
1971	2,566	28,871	*	933	*	29,804	32,370	39,496	71,866
1972	2,238	35,113	*	1,015	*	36,128	38,366	51,454	89,820
1973	1,979	49,731	*	1,046	*	50,776	52,755	42,032	94,787
1974	890	36,013	*	948	*	36,961	37,851	46,176	84,027
1975	3,945	40,726	432	456	*	41,614	45,559	60,384	105,943
1976	10,243	52,827	807	211	*	53,846	64,089	73,386	137,475
1977	7,051	70,024	2,352	597	*	72,972	80,024	73,483	153,507
1978	11,532	67,214	2,090	403	*	69,707	81,239	58,120	139,359
1979	7,532	54,377	694	234	*	55,306	62,838	65,862	128,700
1980	15,421	61,951	1,453	108	*	63,511	78,933	62,592	141,525
1981	10,091	49,970	2,135	640	*	52,744	62,836	53,069	115,905
1982	4,366	50,199	2,300	144	*	52,643	57,008	58,735	115,743
1983	3,260	57,185	2,000	163	*	59,348	62,608	59,585	122,193
1984	5,936	44,587	1,362	153	*	46,101	52,037	63,644	115,681
1985	4,396	61,627	3,696	126	0	65,449	69,845	68,519	138,364
1986	1,939	91,981	7,570	146	0	99,697	101,636	63,339	164,975
1987	776	87,913	7,182	606	1	95,701	96,477	80,738	177,215
1988	1,053	66,015	4,219	665	1	70,900	71,952	68,035	139,987
1989	1,470	67,514	2,199	1,246	*	70,960	72,430	75,268	147,698
1990	4,711	86,148	8,122	715	*	94,985	99,696	91,719	191,415
1991	3,740	85,011	15,090	1,265	7	101,373	105,112	78,565	183,677
1992	5,497	74,466	6,720	727	114	82,027	87,525	93,897	181,422
1993	8,069	63,190	6,688	237	195	70,310	78,379	81,779	160,158
1994	29,375	61,471	7,290	367	135	69,263	98,639	90,045	188,684
1995	37,279	49,016	6,592	68	192	55,868	93,147	82,020	175,167
1996	51,110	36,685	6,423	103	178	43,389	94,500	80,727	175,227
1997	51,627	40,571	6,797	131	363	47,862	99,488	101,396	200,884
1998	35,154	35,752	6,534	149	1,129	43,564	78,718	107,363	186,081
1999	40,674	22,224	6,021	910	961	30,116	70,790	113,168	183,958
2000	70,287	27,929	6,779	5,214	3,719	43,641	113,928	107,994	221,922
2001	42,961	37,493	10,122	7,953	6,719	62,287	105,248	106,901	212,149
2002	35,677	33,794	5,605	*	10,948	50,347	86,024	107,568	193,592
2003	40,720	10,439	*	*	34	10,473	51,193	*	51,193

1 Source: Table 1-4—Fuente: Tabla 1-4

2 Sources: published and unpublished data from the National Research Institute of Far Seas Fisheries (NRIFSF), Shimizu, Japan, Institute of Oceanography, National Taiwan University, Taipei, Taiwan, Ministry of Agriculture, People's Republic of China, and National Fisheries Research and Development Agency, Republic of Korea.

2 Fuentes: datos publicados e inéditos del Instituto Nacional de Investigación de Pesquerías de Ultramar (NRIFSF) en Shimizu (Japón), el Instituto de Oceanografía de la Universidad Nacional de Taiwan en Taipei, Ministerio de Agricultura, República Popular de China, y la Agencia Nacional de Investigación y Desarrollo Pesquero de Corea.

3 WCPO = western and central Pacific Ocean; Source: Secretariat of the Pacific Community, Ocean Fisheries Programme

3 WCPO = Océano Pacífico oeste y central; Fuente: Secretariat of the Pacific Community, Ocean Fisheries Programme

4 Jan – June 2003

* not available—no disponible

TABLE 1-9d. Annual retained catches of Pacific bluefin tuna, in metric tons.
TABLA 1-9d. Capturas retenidas anuales de atún aleta azul del Pacífico, en toneladas métricas.

Year	Eastern Pacific Ocean					Western and central Pacific Ocean[3]			Total
	Surface[1]			Longline[2]	Subtotal	Surface	Longline	Subtotal	
	Commercial	Recre-ional	Subtotal						
Año	Océano Pacífico oriental					Océano Pacífico occidental y central[3]			Total
	Superficie[1]			Palangre[2]	Subtotal	Superficie	Palangre	Subtotal	
	Comercial	Deportiva	Subtotal						
1970	3,966	15	3,966	43	4,009	7,505	1,123	8,628	12,637
1971	8,360	6	8,360	24	8,384	8,673	757	9,430	17,814
1972	13,347	12	13,347	33	13,380	7,951	724	8,675	22,055
1973	10,744	44	10,744	22	10,766	8,798	1,158	9,956	20,722
1974	5,617	47	5,617	58	5,675	14,763	3,533	18,296	23,971
1975	9,582	27	9,583	14	9,597	10,770	1,558	12,328	21,925
1976	10,645	17	10,645	13	10,658	9,186	520	9,706	20,364
1977	5,458	32	5,490	11	5,501	12,617	712	13,329	18,830
1978	5,394	8	5,402	10	5,411	21,285	1,049	22,334	27,745
1979	6,108	19	6,127	6	6,133	25,311	1,223	26,534	32,667
1980	2,933	6	2,939	0	2,939	18,372	1,170	19,542	22,481
1981	1,086	9	1,095	4	1,099	29,576	975	30,551	31,650
1982	3,145	11	3,156	10	3,166	24,095	1,056	25,151	28,317
1983	838	33	871	3	873	18,046	864	18,910	19,783
1984	858	50	907	3	910	10,562	831	11,393	12,303
1985	4,014	89	4,103	1	4,104	11,985	706	12,691	16,795
1986	5,079	12	5,091	1	5,092	14,496	319	14,815	19,907
1987	998	35	1,033	3	1,036	13,314	711	14,025	15,061
1988	1,421	5	1,426	2	1,428	7,331	349	7,680	9,108
1989	1,117	112	1.229	5	1,234	9,099	645	9,744	10,978
1990	1,511	65	1,576	12	1,588	6,294	585	6,879	8,467
1991	419	91	510	6	516	14,084	627	14,711	15,227
1992	1,928	110	2,039	20	2,058	10,221	1,037	11,258	13,316
1993	581	298	879	10	889	7,818	1,328	9,146	10,035
1994	971	91	1,062	11	1,074	10,964	1,697	12,661	13,735
1995	630	245	874	21	896	22,768	1,104	23,872	24,768
1996	8,223	36	8,259	17	8,276	10,119	1,934	12,053	20,329
1997	2,657	156	2,813	10	2,824	14,757	3,197	17,954	20,778
1998	1,826	413	2,239	21	2,260	7,357	3,170	10,527	12,787
1999	2,645	447	3,092	147	3,238	16,863	4,244	21,107	24,345
2000	3,779	344	4,123	11	4,133	17,888	3,898	21,786	25,919
2001	1,006	356	1,362	12	1,374	995	2,429	3,424	4,798
2002	1,765	351	2,116	4	2,120	*	*	*	*
2003	3,248	391	3,639	*	3,639	*	*	*	*

1. Source: Table 1-4—Fuente: Table 1-4
2. Source: U.S. NMFS and Report of the Second Meeting of the Pacific Bluefin Tuna Working Group of the Interim Scientific Committee (ISC for Tuna and Tuna-like Species in the North Pacific Ocean
2. Fuente: NMFS de EE.UU. y Informe de la Segunda Reunión del Grupo de Trabajo sobre Atún Aleta Azul del Pacífico del Interim Scientific Committee (ISC for Tuna and Tuna-like Species in the North Pacific Ocean
3. Source: ISC—Fuente: ISC
* not available—no disponible

TABLE 1-9e. Annual retained catches of North Pacific albacore by region, in metric tons. Data for1950-1969 are in Table1e of the IATTC Annual Report for 2002. The data for the western and central Pacific Ocean were obtained from the Secretariat for the Pacific Community.

TABLA 1-9e. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas. Datos para1950-1969 están en la Tabla1e del Informe Anual de la CIAT para 2002. Los datos del Océano Pacífico occidental y central provienen de la Secretaría de la Comunidad del Pacífico.

Yea r	Eastern Pacific Ocean					Western and central Pacific Ocean					Total
	Longlin e	Pole-and-line	Troll	Othe r	Subtota l	Longlin e	Pole-and-line	Troll	Other	Subtotal	
Año	**Océano Pacífico oriental**					**Océano Pacífico occidental y central**					**Total**
	Palangr e	**Cañer o**	**Curric án**	**Otro**	**Subtota l**	**Palangr e**	**Cañer o**	**Curricá n**	**Otro**	**Subtotal**	
1970	459	4,416	21,032	822	26,729	17,339	24,263	390	773	42,765	69,494
1971	320	2,076	20,526	1,17	24,098	12,963	52,952	1,746	1,210	68,871	92,969
1972	437	3,750	23,600	637	28,424	15,698	60,569	3,921	1,001	81,189	109,61
1973	710	2,236	15,653	84	18,683	16,213	68,767	1,400	1,887	88,267	106,95
1974	105	4,777	20,178	94	25,154	13,874	73,564	1,331	1,265	90,034	115,18
1975	139	3,243	18,861	650	22,893	14,139	52,152	182	554	67,027	89,920
1976	184	2,705	15,905	717	19,512	17,764	85,331	278	2,487	105,860	125,37
1977	813	1,497	9,968	537	12,815	16,554	31,934	54	1,712	50,254	63,069
1978	793	950	16,613	825	19,181	12,762	59,877	23	7,223	79,885	99,066
1979	1,409	303	4,955	74	6,741	13,321	44,662	2,347	4,108	64,438	71,179
1980	1,309	382	5,421	168	7,281	14,445	46,742	2,347	4,531	68,065	75,346
1981	2,539	748	12,039	195	15,521	17,727	27,426	798	11,287	57,238	72,759
1982	2,317	425	3,303	278	6,323	17,007	29,614	3,410	13,632	63,663	69,986
1983	1,609	607	7,751	87	10,055	14,746	21,098	1,833	7,586	45,263	55,318
1984	2,645	1,033	8,343	1,42	13,448	13,226	26,010	1,011	17,236	57,483	70,931
1985	1,345	1,533	5,308	1,17	9,364	13,592	20,679	1,163	13,667	49,101	58,465
1986	764	432	4,282	199	5,677	12,671	16,096	456	10,710	39,933	45,610
1987	1,062	130	2,300	79	3,571	13,822	19,110	570	11,396	44,898	48,469
1988	852	598	4,202	89	5,741	14,026	6,216	165	18,836	39,243	44,984
1989	944	54	1,852	187	3,037	12,786	8,629	148	19,726	41,289	44,326
1990	1,143	115	2,440	57	3,754	14,953	8,532	465	26,098	50,048	53,802
1991	1,514	0	1,783	94	3,391	15,889	7,103	201	10,697	33,890	37,281
1992	1,572	0	4,515	74	6,161	18,200	13,888	420	16,499	49,007	55,168
1993	1,683	0	4,331	25	6,039	28,972	12,797	2,417	4,054	48,240	54,279
1994	2,388	0	9,533	357	12,278	28,086	26,389	3,601	3,094	61,170	73,448
1995	1,346	80	7,267	155	8,848	30,286	20,981	2,636	2,400	56,303	65,151
1996	1,613	0	8,195	171	9,979	36,256	20,296	12,839	1,661	71,052	81,031
1997	1,276	0	6,053	1,07	8,409	44,778	32,311	11,036	3,190	91,315	99,724
1998	1,552	0	11,748	1,29	14,589	44,946	23,005	7,136	3,078	78,165	92,754
1999	2,440	23	10,791	3,77	17,025	41,751	50,406	2,172	8,250	102,579	119,60
2000	1,545	98	10,862	1,85	14,361	39,342	21,520	3,737	3,387	67,986	82,347
2001	567	18	11,537	1,72	13,852	40,342	29,707	4,770	1,851	76,670	90,522
2002	362	400	12,085	2,41	15,260	40,411	29,587	1,909	1,803	73,710	88,970

*not available—no disponible

TABLE 1-9f. Annual retained catches of South Pacific albacore by region, in metric tons. Data for1950-1969 are in Table1f of the IATTC Annual Report for 2002. The data for the western and central Pacific Ocean were obtained from the Secretariat for the Pacific Community.

TABLA 1-9f. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas. Datos para1950-1969 están en la Tabla1f del Informe Anual de la CIAT para 2002. Los datos del Océano Pacífico occidental y central provienen de la Secretaría de la Comunidad del Pacífico.

Year	Eastern Pacific Ocean			Western and central Pacific Ocean					Total
	Longline	Troll	Subtotal	Longline	Pole-and-line	Troll	Other	Subtotal	
Año	Océano Pacífico oriental			Océano Pacífico occidental y central					Total
	Palangre	Curricán	Subtotal	Palangre	Cañero	Curricán	Otro	Subtotal	
1970	3,041	*	3,041	26,614	100	50	0	26,764	29,805
1971	4,719	*	4,719	27,533	100	0	0	27,633	32,352
1972	6,953	*	6,953	28,501	122	268	0	28,891	35,844
1973	5,614	*	5,614	33,805	141	484	0	34,430	40,044
1974	3,624	*	3,624	26,634	809	898	0	28,341	31,965
1975	4,227	*	4,227	24,899	100	646	0	25,645	29,872
1976	2,110	*	2,110	22,221	100	25	0	22,346	24,456
1977	4,359	*	4,359	26,375	100	621	0	27,096	31,455
1978	12,459	*	12,459	26,825	100	1,686	0	28,611	41,070
1979	8,381	*	8,381	25,546	100	814	0	26,460	34,841
1980	4,923	*	4,923	28,689	101	1,468	0	30,258	35,181
1981	4,859	*	4,859	29,162	0	2,085	5	31,252	36,111
1982	5,470	*	5,470	24,095	1	2,434	6	26,536	32,006
1983	7,601	*	7,601	20,663	0	744	39	21,446	29,047
1984	5,012	*	5,012	17,776	2	2,773	1,589	22,140	27,152
1985	6,073	*	6,073	24,502	0	3,253	1,937	29,692	35,765
1986	5,769	74	5,843	29,069	0	1,929	1,946	32,944	38,787
1987	5,401	188	5,588	18,970	9	1,946	930	21,855	27,443
1988	9,163	1,282	10,446	23,124	0	3,014	5,283	31,421	41,867
1989	5,491	593	6,084	16,589	0	7,777	21,968	46,334	52,418
1990	5,728	1,336	7,064	17,368	245	5,639	7,538	30,790	37,854
1991	6,590	795	7,385	18,489	14	7,010	1,489	27,002	34,387
1992	6,265	1,205	7,469	14,593	11	5,373	65	20,042	27,511
1993	16,884	35	16,919	19,937	74	4,261	70	24,342	41,261
1994	10,364	415	10,779	25,172	67	6,749	89	32,077	42,856
1995	7,629	2	7,631	21,053	139	7,706	104	29,002	36,633
1996	4,608	230	4,838	18,263	30	7,137	156	25,586	30,424
1997	6,983	609	7,592	24,180	21	4,070	133	28,404	35,996
1998	11,951	177	12,128	28,714	36	6,081	85	34,916	47,044
1999	9,151	328	9,479	29,681	138	3,063	74	32,956	42,435
2000	10,050	1,075	11,125	32,792	102	4,793	139	37,826	48,951
2001	12,324	708	13,033	39,207	37	4,859	199	44,302	57,335
2002	7,848	250	8,098	36,417	7	4,227	150	40,801	48,899

*not available—no disponible

TABLE 1-10. Nominal fishing effort (E; 1000 hooks) and estimated catch (C; metric tons) of yellowfin, skipjack, bigeye, bluefin, and albacore tunas, by flag, by the principal identified longline fishing fleets operating in the EPO, 1970-2002.
TABLA 1-10. Esfuerzo de pesca nominal (E; 1000 anzuelos) y captura estimada (C; toneladas métricas) de atunes aleta amarilla, barrilete, patudo, aleta azul, y albacora, por pabellón, de las principales flotas palangreras identificadas faenando en el OPO, 1970-2002.

Year-Año	China		Chinese Taipei-Taipei Chino		French Polynesia-Polinesia Francesa		Japan-Japón		Korea-Corea		Mexico-México		Panama-Panamá		USA-EE.UU.	
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
1970	*	*	5,253	5,222	*	*	83,401	47,349	*	*	*	*	*	*	*	*
1971	*	*	8,735	8,193	*	*	66,761	37,323	*	*	*	*	*	*	*	*
1972	*	*	7,627	6,828	*	*	78,240	52,201	*	*	*	*	*	*	*	*
1973	*	*	8,010	4,524	*	*	107,227	62,723	*	*	*	*	*	*	*	*
1974	*	*	10,262	5,177	*	*	89,205	43,579	*	*	*	*	*	*	*	*
1975	*	*	3,777	1,594	*	*	86,134	51,562	2,191	601	*	*	*	*	*	*
1976	*	*	2,202	1,517	*	*	117,301	68,889	3,931	1,521	*	*	*	*	*	*
1977	*	*	12,009	7,811	*	*	132,875	83,721	10,958	4,240	*	*	*	*	*	*
1978	*	*	8,714	6,503	*	*	140,006	79,319	8,571	5,799	*	*	*	*	*	*
1979	*	*	3,138	2,293	*	*	137,769	67,931	5,021	2,066	*	*	*	*	*	*
1980	*	*	2,828	1,518	*	*	138,141	75,638	11,788	4,523	12	0	*	*	*	*
1981	*	*	6,293	3,118	*	*	131,275	59,225	19,731	5,638	16	0	*	*	*	*
1982	*	*	8,015	3,861	*	*	116,200	61,368	18,612	6,551	48	0	*	*	*	*
1983	*	*	4,690	2,235	*	*	127,176	69,563	14,675	5,543	946	49	*	*	*	*
1984	*	*	3,617	1,681	*	*	119,635	57,259	11,767	4,023	*	*	*	*	*	*
1985	*	*	3,016	1,909	*	*	106,758	74,346	19,785	9,188	183	2	*	*	*	*
1986	*	*	4,579	2,414	*	*	160,553	111,669	30,765	13,221	2,672	68	*	*	*	*
1987	*	*	12,981	5,420	*	*	188,393	104,052	29,185	11,930	4,919	273	*	*	*	*
1988	*	*	9,707	4,645	*	*	182,694	82,382	21,471	6,974	4,159	234	*	*	*	*
1989	*	*	20,344	6,043	*	*	170,373	84,960	12,657	3,416	338	9	*	*	*	*
1990	*	*	12,935	4,974	*	*	178,419	117,921	32,334	11,668	*	*	*	*	*	*
1991	*	*	17,624	5,818	*	*	200,365	112,337	58,714	20,793	*	*	*	*	43	9
1992	*	*	32,146	13,758	500	225	191,284	93,009	29,832	9,570	*	*	*	*	325	97
1993	*	*	17,729	6,444	2,605	1,346	159,955	87,973	30,769	9,625	3	2	*	*	417	83
1994	*	*	12,925	5,011	3,410	1,019	163,976	92,603	28,743	10,093	8	41	*	*	302	23
1995	*	*	2,914	1,641	3,452	810	129,598	69,432	30,433	9,366	13	7	*	*	823	144
1996	*	*	5,858	3,572	4,219	1,669	103,653	52,297	31,411	9,085	3	0	*	*	507	77
1997	*	*	8,606	5,599	5,490	2,777	96,383	59,325	26,414	9,957	*	*	*	*	462	78
1998	*	*	9,123	4,482	6,415	3,652	106,569	50,167	26,183	10,135	9	17	*	*	1,020	205
1999	*	*	22,512	7,616	9,190	3,286	80,958	32,885	31,707	8,498	17	41	*	*	1,680	401
2000	*	*	29,271	12,593	10,230	4,766	77,022	44,036	29,136	9,584	76	26	40	378	1,076	104
2001	13,056	5,014	41,920	16,602	11,200	5,297	100,824	54,050	43,145	14,281	74	13	60	866	1,440	70
2002	34,889	9,780			10,700	4,528	105,124	45,256	25,510	7,625	30	12	90	816	236	26

*not available—no disponible

TABLE 1-11. Estimates of the commercial catches, in metric tons, of billfishes in the eastern Pacific Ocean. Most of the longline-caught fish were retained, and, with the exception of swordfish and blue marlin, most of those caught by surface gear were discarded.

TABLA 1-11. Estimaciones de las capturas comerciales, en toneladas métricas, de peces picudos en el Océano Pacífico oriental. La mayoría del pescado capturado con palangre fue retenida, y, a excepción de pez espada y marlín azul, la mayoría de la captura de superficie descartada.

Year	Swordfish		Blue marlin		Black marlin		Striped marlin		Shortbill spearfish		Sailfish	
	Longline	Surface	Longline	Surface	Longline	Surface	Longline	Surface	Longline	Surface	Longline	Surface
Año	Pez espada		Marlín azul		Marlín negro		Marlín rayado		Marlín trompa corta		Pez vela	
	Palangre	Superficie	Palangre	Superficie	Palangre	Superficie	Palangre	Superficie	Palangre	Superficie	Palangre	Superficie
1970	4,151	2,639	4,112	*	651	*	11,006	*	*	*	*	*
1971	1,957	366	2,755	*	539	*	10,206	*	*	*	*	*
1972	2,304	691	2,411	*	686	*	7,097	*	*	*	*	*
1973	3,809	2,351	3,553	*	906	*	5,213	*	*	*	*	*
1974	2,177	688	2,751	*	520	*	5,353	*	*	*	*	*
1975	2,321	295	2,201	*	391	*	5,390	*	*	*	554	*
1976	3,487	308	3,240	*	252	*	6,432	*	*	*	494	*
1977	4,299	452	3,016	*	624	*	3,144	*	*	*	753	*
1978	4,103	492	3,570	*	415	*	2,494	*	*	*	878	*
1979	2,659	228	4,528	*	332	*	4,138	*	*	*	251	*
1980	3,746	320	4,016	*	334	*	4,827	*	*	*	244	*
1981	3,070	385	4,475	*	246	*	4,876	*	*	*	379	*
1982	2,604	439	4,745	*	213	*	4,711	*	*	*	1,084	*
1983	3,222	580	4,452	*	240	*	4,279	*	*	*	502	*
1984	2,705	446	5,198	*	248	*	2,662	*	*	*	345	*
1985	1,866	397	3,589	*	180	*	1,510	*	*	*	395	*
1986	2,869	785	5,255	*	297	*	2,617	*	5	*	526	*
1987	3,822	2,132	6,734	*	357	*	5,420	*	15	*	435	*
1988	3,788	4,509	5,465	*	288	*	3,652	*	13	*	465	*
1989	3,379	5,827	5,276	*	192	*	3,401	*	0	*	121	*
1990	4,493	4,956	5,290	*	223	*	3,136	*	*	*	6	*
1991	6,618	7,258	6,527	81	246	58	2,935	76	1	1	717	40
1992	6,108	6,395	6,333	59	231	95	2,890	69	1	1	1,353	41
1993	4,171	4,788	6,527	60	218	64	3,356	35	3	0.1	2,267	36
1994	3,688	4,111	9,032	80	263	118	3,295	34	143	0.3	1,687	29
1995	3,840	2,601	7,159	93	157	83	3,139	21	155	0.5	1,355	31
1996	4,047	4,158	3,485	97	121	92	2,946	22	128	0.5	740	25
1997	6,777	4,064	5,534	154	168	125	3,963	25	150	1	1,214	29
1998	6,580	4,590	4,914	148	166	113	3,318	18	205	0.4	1,383	49
1999	5,453	2,940	3,476	194	143	141	2,460	31	283	0.5	1,282	42
2000	7,053	2,975	4,016	141	129	97	1,685	17	278	0.5	1,341	58
2001	12,911	3,262	5,020	181	251	113	2,240	20	301	0.3	1,393	37
2002	11,684	3,537	3,016	*	63	*	1,467	*	276	*	293	*

*not available—no disponible

2. YELLOWFIN TUNA

An age-structured, catch-at-length analysis (A-SCALA) is used to assess yellowfin tuna in the eastern Pacific Ocean (EPO). The analysis method is described in IATTC Bulletin, Vol. 22, No. 5, and readers are referred to that report for technical details.

The stock assessment requires a substantial amount of information. Data on retained catch, discards, fishing effort, and the size compositions of the catches from several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure have also been made. The assessment for 2004 differs from that carried out in 2003 in the following ways. Catch and length-frequency data for the surface fisheries have been updated to include new data for 2003. Effort data for the surface fisheries have been updated to include new data for 2003 and revised data for 1975 to 2002. Catch data for the Japanese longline fisheries have been updated to include new data for 2002. Catch data for the longline fisheries of Chinese Taipei have been updated for 1975 to 1999 and new data added for 2000 and 2001. Catch data for the longline fisheries of the Peoples Republic of China have been included for 2001 and 2002. Catch data for the longline fisheries of the Republic of Korea have been updated for 1987 to 1997 and new data added for 1998-2002. Longline catch-at-length data for 1975-2001 were updated and new data added for 2002. Longline effort data based on neural-network standardization of catch per unit of effort have been updated to include data for 2001. Future projections are based on a new method that allows the inclusion of parameter uncertainty in the calculation of confidence intervals for future quantities

Significant levels of fishing mortality have been observed in the yellowfin tuna fishery in the EPO (Figure 2-1). These levels are highest for middle-aged yellowfin (except for the estimates for the oldest yellowfin, which is an artifact of the model). Both recruitment (Figure 2-2) and exploitation have had substantial impacts on the yellowfin biomass trajectory (Figure 2-3). Dolphin-associated fishing has had the greatest impact on the yellowfin tuna population (Figure 2-3). It appears that the yellowfin population has experienced two different productivity regimes (1975-1983 and 1984-2001), with greater recruitment during the second regime. The two recruitment regimes (Figure 2-2) correspond to two regimes in biomass (Figure 2-3), the high-recruitment regime corresponding to greater biomasses. The spawning biomass ratio (the ratio of the spawning biomass to that for the unfished stock; SBR) of yellowfin in the EPO was below the level capable of supporting the average maximum sustainable yields (AMSYs) during the low-recruitment regime, but above that level during the high-recruitment regime (Figure 2-4). The two different productivity regimes may support two different levels of AMSY and associated SBRs, and the AMSY reported here is an average for the two regimes. The current SBR is below the SBR level at AMSY (Figure 2-4). However, there is substantial uncertainty in the most recent estimate of SBR, and there is a moderate probability that the current SBR is above the level that would support the AMSY. The effort levels are estimated to be less than the levels capable of supporting the AMSY (based on the current distribution of effort among the different fisheries). However, due to the large recruitment that entered the fishery in 1998, the catch levels are greater than the corresponding values at the AMSY (Table 2-1). Because of the flat yield curve, the current effort levels are estimated to produce, under average conditions, catch that is only slightly less than AMSY. Future projections under the current effort levels and average recruitment indicate that the population will increase to an SBR level greater than the current level and slightly greater than that which will support the AMSY at the start of 2005, but will decrease below that level after that (Figure 2-5). These simulations were carried out using the average recruitment for the 1975-2002 period. If they had been carried out using the average recruitment for the 1984-2002 period it is likely that the estimates of SBR and catches would be greater.

The analysis indicates that strong cohorts entered the fishery in 1998-2000, and that these cohorts increased the population biomass during 1999-2000. However, they have now moved through the population, so the biomass decreased in 2001-2003.

The overall average weights of yellowfin tuna that are caught have consistently been much less than the critical weight (about 36.2 kg), indicating that, from the yield-per-recruit standpoint, the yellowfin in the

EPO are not harvested at the optimal size. There is substantial variability in the average weights of the yellowfin taken by the different fisheries, however. In general, the floating-object (Fisheries 1-4), unassociated (Fisheries 5 and 6), and pole-and-line (Fishery 10) fisheries capture younger, smaller fish than do the dolphin-associated (Fisheries 7-9) and longline (Fisheries 11 and 12) fisheries. The longline fisheries and the purse-seine sets in the southern area on yellowfin associated with dolphins (Fishery 9) capture older, larger yellowfin than do the coastal (Fishery 8) and northern (Fishery 7) dolphin-associated fisheries. The AMSY calculations indicate that the yield levels could be considerably increased if the fishing effort were diverted to the fisheries that catch yellowfin closest to the critical weight (longlining and purse-seine sets on yellowfin associated with dolphins, particularly in the southern area). This would also increase the SBR levels.

Under 2003 levels of effort the biomass is predicted to increase during 2004, but then decrease in the following years. SBR is predicted to be above the level that will produce AMSY at the start of 2005, but drop below that level in the future. The catch in 2004 is predicted to be much less than that for 2003. Closing the surface fisheries for six weeks is predicted to only slightly increase the biomass levels. Greater restrictions on the floating-object fishery would cause only a small increase in biomass. Closing the fishery for dolphin-associated fish would cause the greatest increase in biomass.

A sensitivity analysis was carried out to estimate the effect of a stock-recruitment relationship. The results suggest that the model with a stock-recruitment relationship fits the data slightly better than the base case. The results from the analysis with a stock-recruitment relationship are more pessimistic, suggesting that the effort level is greater than that which would produce AMSY (Table 2-1); however, the yield at this effort level is still only slightly less than AMSY. The biomass is estimated to have been less than the biomass that would give rise to AMSY for most of the modeling period, except for most of the 2000-2002 period.

The assessment results are very similar to those from the previous assessments. The major differences occur, as expected, in the most recent years. The current assessment and the 2002 and 2003 assessments estimate that the biomass increased in 2000, whereas the earlier assessments estimated a decline. In addition, SBR and the SBR required to produce AMSY have increased compared to the earlier assessments (2000 and 2001) because average recruitment has been calculated over a longer period, which includes more years from the low-recruitment regime, and due to changes in growth, fecundity, and current age-specific fishing mortality.

Summary

- The results are similar to those of the previous four assessments, except that SBR at AMSY is similar only to those of the last two assessments.
- The biomass is estimated to have declined in 2003.
- There is uncertainty about recent and future recruitment and biomass levels.
- The current SBR is less than that required to produce AMSY.
- The current fishing mortality rates are slightly less than those required to produce AMSY.
- The average weight of a yellowfin in the catch is much less than the critical weight, and increasing the average weight would substantially increase AMSY.
- There have been two different productivity regimes, and the levels of AMSY and the biomass required to produce AMSY may differ between the regimes.
- The results are sensitive to the assumption about the stock-recruitment relationship.

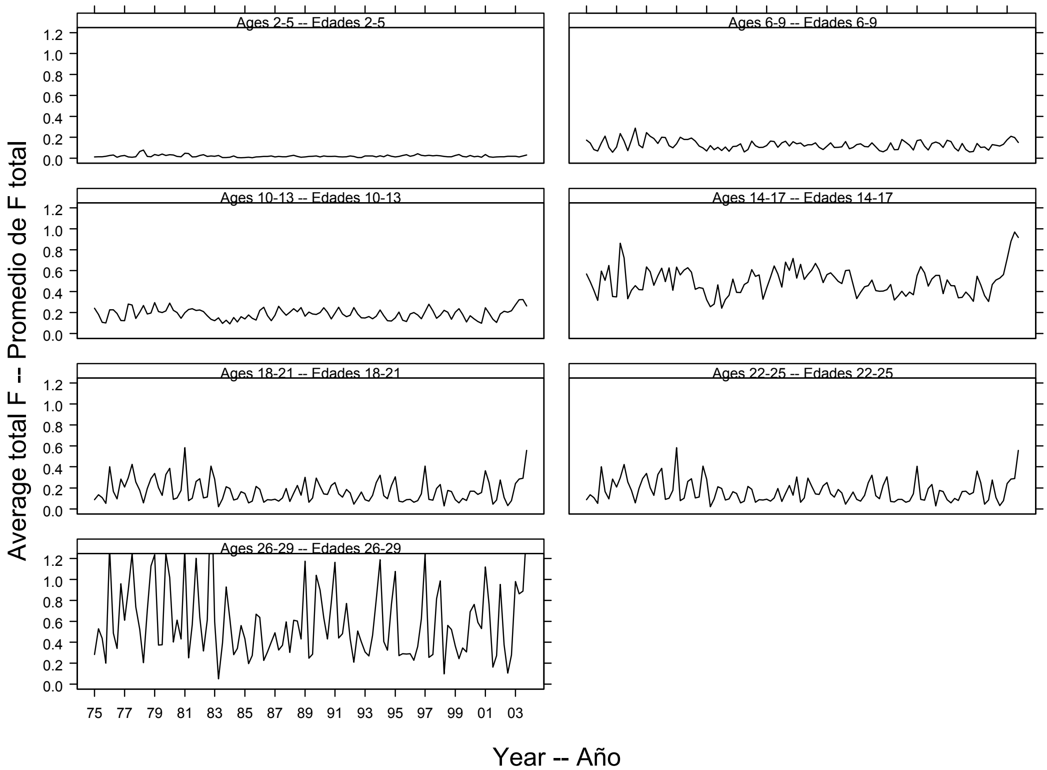


FIGURE 2-1. Time series of average total quarterly fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each panel illustrates an average of four quarterly fishing mortality vectors that affected the fish of the age range indicated in the title of each panel. For example, the trend illustrated in the upper-left panel is an average of the fishing mortalities that affected fish that were 2-5 quarters old.

FIGURA 2-1. Series de tiempo de la mortalidad por pesca trimestral total media de atún aleta amarilla reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores trimestrales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron peces de entre 2 y 5 trimestres de edad.

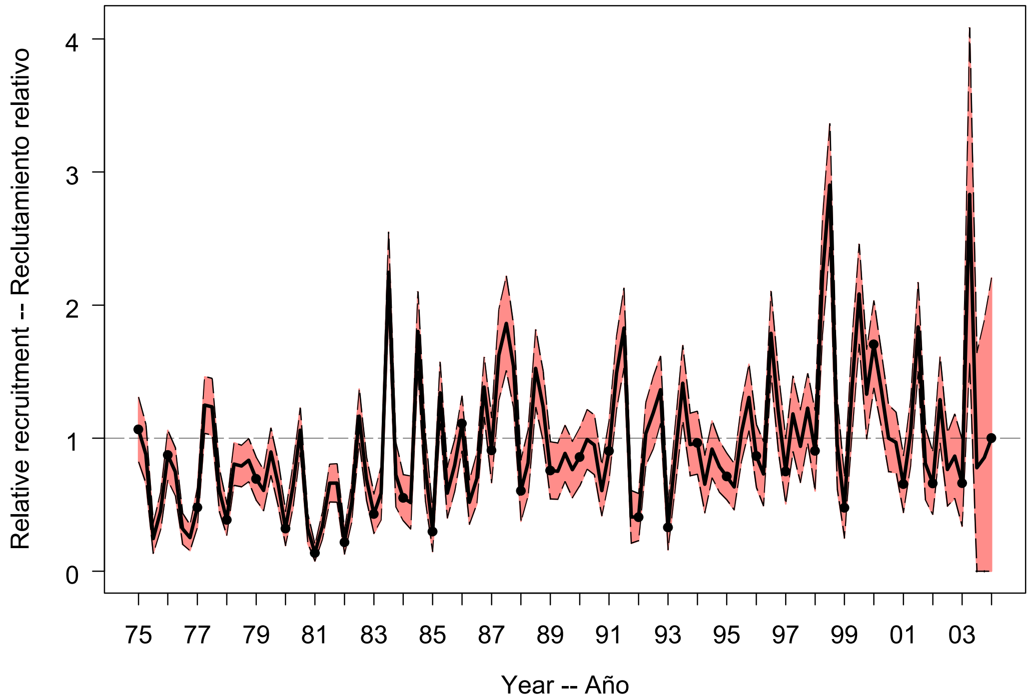


FIGURE 2-2. Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates. The labels on the time axis are drawn at the start of each year, but, since the assessment model represents time on a quarterly basis, there are four estimates of recruitment for each year.

FIGURA 2-2. Reclutamiento estimado de atún aleta amarilla a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea gruesa ilustra las estimaciones de probabilidad máxima del reclutamiento, y el área sombrada los intervalos de confianza de 95% aproximados de las estimaciones. Se dibujan las leyendas en el eje de tiempo al principio de cada año, pero, ya que el modelo de evaluación representa el tiempo por trimestres, hay cuatro estimaciones de reclutamiento para cada año.

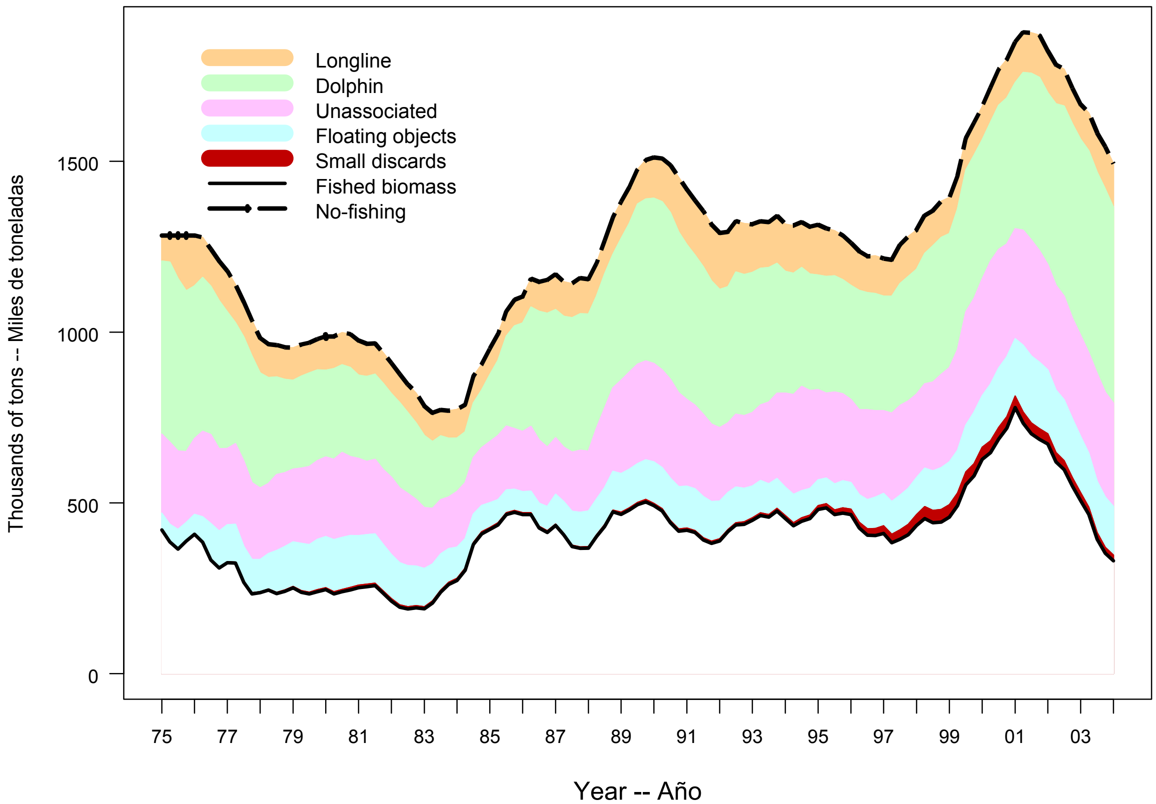


FIGURE 2-3. Biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2003 ("No-fishing") and that predicted by the stock assessment model ("Fished biomass"). The different shaded areas between the "No-fishing" and "Fished biomass" lines represent the portion of the fishery impact attributed to the different fishing methods.
FIGURA 2-3.

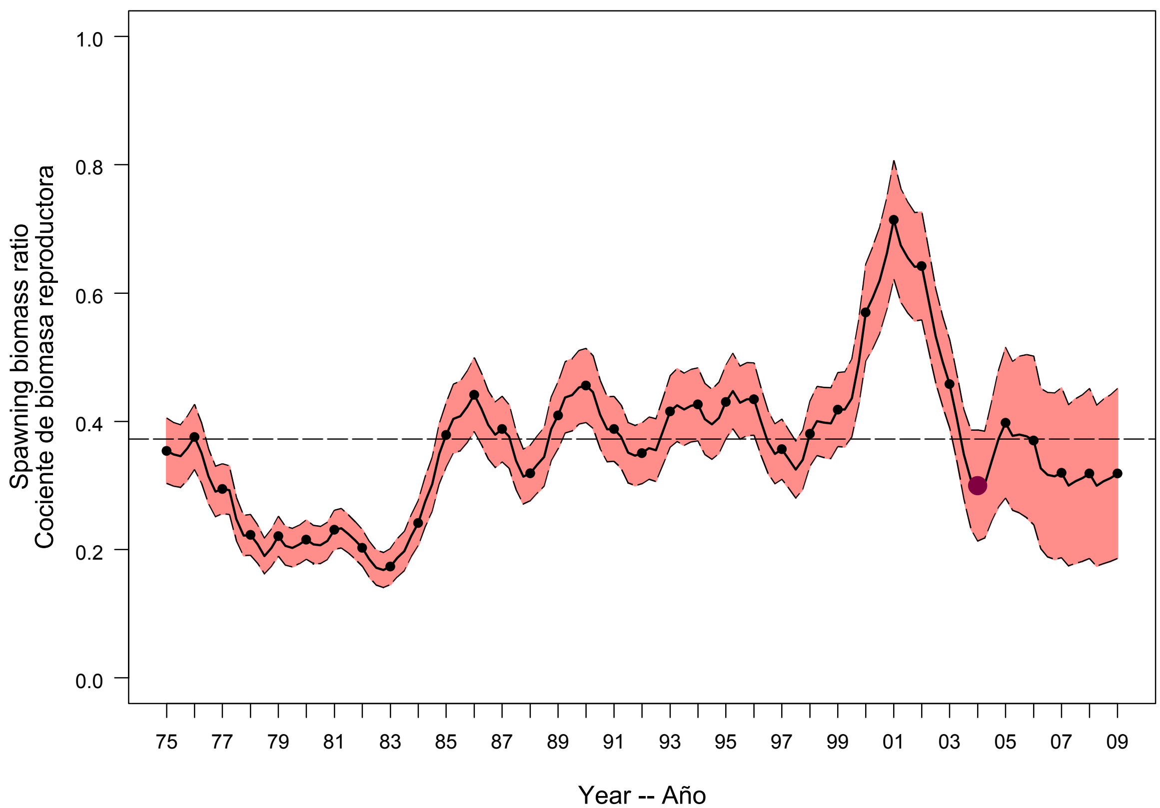


FIGURE 2-4. Spawning biomass ratios (SBRs) projected during 2003-2008 for yellowfin tuna in the EPO by the likelihood profile approximation method. The dashed horizontal line (at 0.38) identifies SBR_{AMSY}. The shaded area represents the 95% confidence limits of the estimates.

FIGURA 2-4. Cocientes de biomasa reproductora **(**SBRs) proyectados durante 2003-2008 para el atún aleta amarilla en el OPO por el método de aproximación de perfil de verosimilitud. La línea de trazos horizontal (en 0.37) identifica SBR_{RPMS}. El área sobreada representa los intervalos de confianza de 95% estimades da las estimaciones.

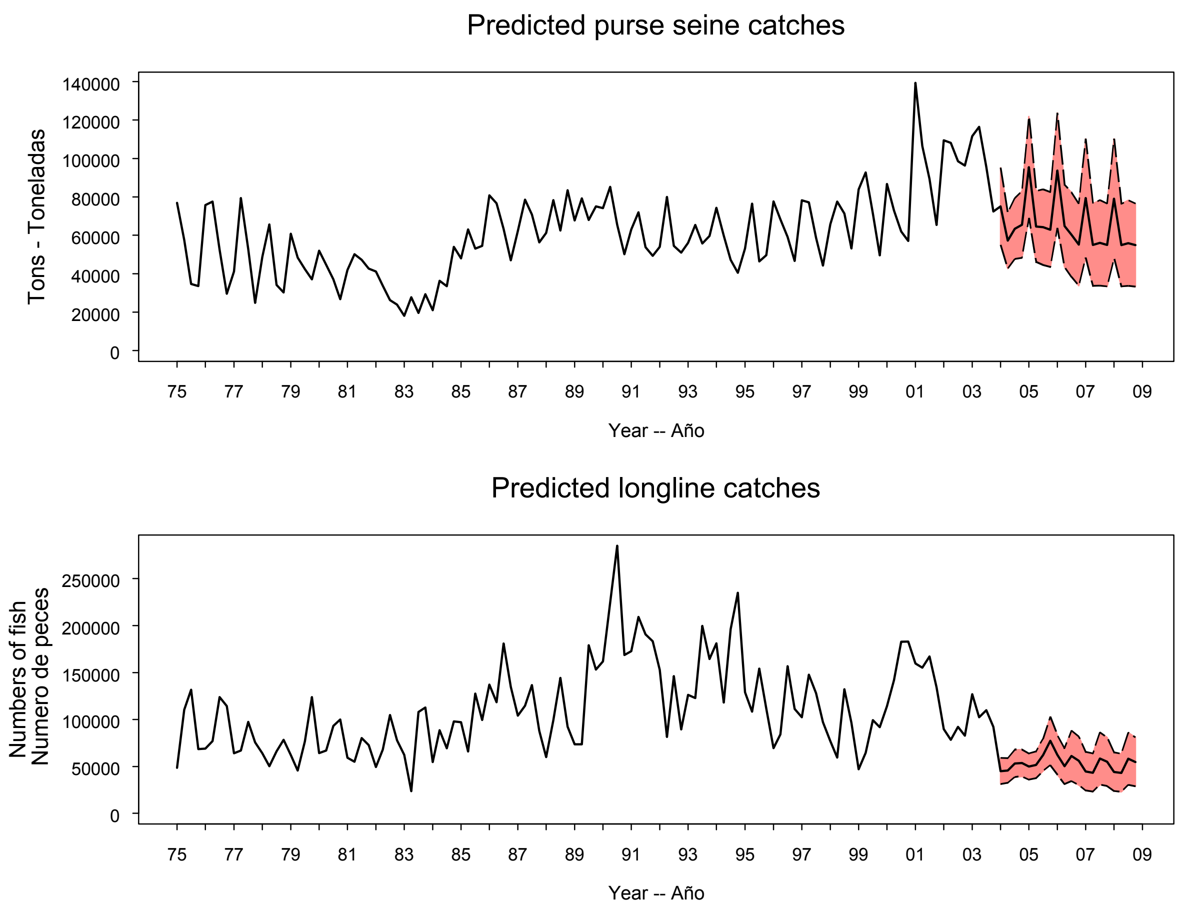


FIGURE 2-5. Simulated catches of yellowfin tuna taken by the primary surface fleet (Fisheries 1-10; upper panel) and the the longline fleet (Fisheries 11 and 12, lower panel) during 2003-2008 using the likelihood profile method. The shaded area represents the 95% confidence limits of the estimates.
FIGURA 2-5. Capturas simuladas de atún aleta amarilla por la flota primaria de superficie (Pesquerías 1-10, recuadro superior) y la flota palangrera (Pesquerías 11 y 12, recuadro inferior) durante 2003-2008, usando el método de aproximación de perfil de verosimilitud. El área sobreada representa los intervalos de confianza de 95% estimades da las estimaciones.

TABLE 2-1. AMSY and related quantities for the base case and the stock-recruitment relationship sensitivity analysis.

TABLA 2-1. RMSP y cantidades relacionadas para el caso base y el análisis de sensibilidad a la relación población-reclutamiento.

	Base case	**h = 0.75**
	Caso base	**h = 0.75**
AMSY–RMSP	284,979	308,585
B_{ms2}–B_{rm2}	420,895	571,588
S_{ms2}—S_{rm2}	6,606	9,055
C_{2002}/AMSY—C_{2002}/RMSP	1.47	1.36
B_{2003}/B_{AMSY}–B_{2003}/B_{RMSP}	0.79	0.60
S_{2003}/S_{AMSY}–S_{2003}/S_{RMSP}	0.80	0.60
$S_{AMSY}/S_{F=0}$–$S_{RMSP}/S_{F=0}$	0.38	0.42
F multiplier—Multiplicador de *F*	1.12	0.83

3. SKIPJACK TUNA

An age-structured, catch-at-length analysis (A-SCALA) is used to assess skipjack tuna (*Katsuwonus pelamis*) in the eastern Pacific Ocean (EPO). The analysis method is described in IATTC Bulletin, Vol 22, No. 5, and readers are referred to that report for technical details. This method was used for the 2001 and 2002 assessments of skipjack tuna in the EPO. New catch, effort, and length-frequency data for 2002-2003 have been included and data for previous years have been updated.

The stock assessment requires a substantial amount of information. Data on landings, discards, fishing effort, and the size compositions of the catches of several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure have also been made. The assessment is still considered preliminary because 1) it is not known whether catch per day of fishing for purse-seine fisheries is proportional to abundance, 2) it is possible that there is a population of large skipjack that is invulnerable to the fisheries, and 3) stock structure in relation to the EPO and fish in the western and central Pacific is uncertain. However, results from sensitivity analyses for this assessment are more consistent than those of previous years.

The recruitment of skipjack tuna to the fisheries in the EPO is highly variable (Figure 3.1). Fishing mortality (Figure 3.2) is estimated to be about the same or less than the rate of natural mortality. These levels of fishing mortality are supported by estimates from tagging data. Biomass fluctuates in response to variations in both recruitment and exploitation (Figure 3.3). Estimates of absolute biomass are moderately sensitive to weights given to the information about abundance in the catch and effort data for the floating-object fisheries and the monotonic selectivity assumption, but the trends in biomass are not.

The analysis indicates that a group of relatively strong cohorts entered the fishery in 2002-2003 (but not as strong as those of 1998) and that these cohorts increased the biomass and catches during 2003. There is an indication the most recent recruitments are average, which may lead to lower biomasses and catches. However, these estimates of low recruitment are based on limited information, and are therefore very uncertain.

There is considerable variation in spawning biomass ratio (ratio of the spawning biomass to that for the unfished stock; SBR) for skipjack tuna in the EPO (Figure 3.4). In 2003 the SBR was at a high level (about 0.61). Estimates based on average maximum sustainable yield (AMSY) and yield-per-recruit indicate that maximum yields are achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the fishery. However, this is uncertain because of uncertainties in the estimates of natural mortality and growth. Estimates of SBR are not sensitive to weights given to the information about abundance in the catch and effort data for the floating-object fisheries and the monotonic selectivity assumption.

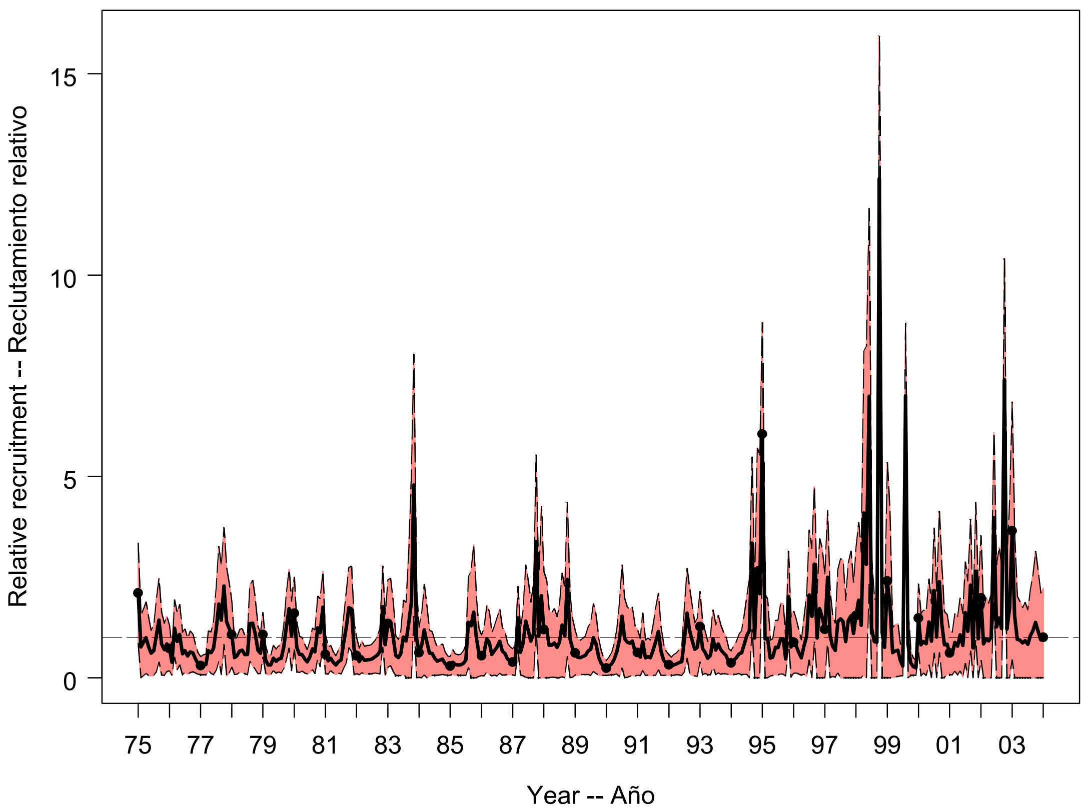


FIGURE 3-1. Estimated recruitment of skipjack tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The solid line illustrates the maximum-likelihood estimates of recruitment, and the dashed lines the 95% confidence intervals. The labels on the time axis are drawn at the start of each year, but, since the assessment model represents time on a monthly basis, there are 12 estimates of recruitment for each year.

FIGURA 3-1. Reclutamiento estimado de atún barrilete a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea sólida ilustra las estimaciones de reclutamiento de probabilidad máxima, y la lína de trazos los intervalos de confianza de 95%. Se dibujan las leyendas en el eje de tiempo al principio de cada año, pero, ya que el modelo de evaluación representa el tiempo por meses, hay 12 estimaciones de reclutamiento para cada año.

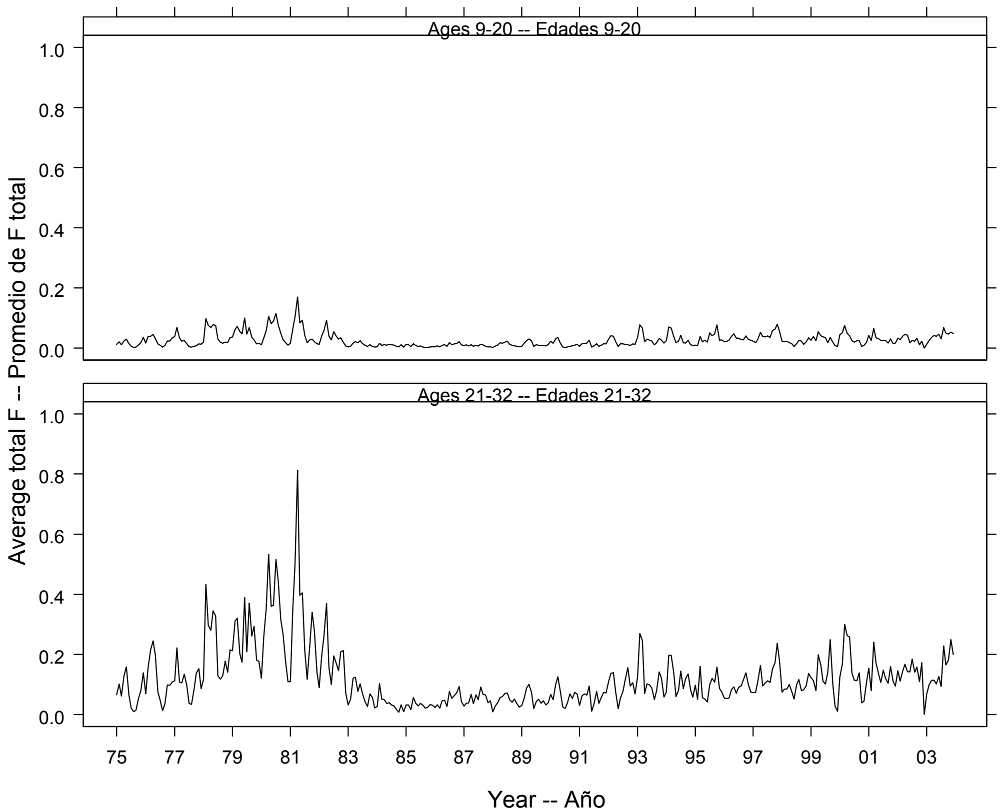


FIGURE 3-2. Time series of average total monthly fishing mortality of skipjack tuna recruited to the fisheries of the EPO. Each panel illustrates an average of 12 monthly fishing mortality vectors that affected fish of the age range indicated in the title of each panel. For example, the trend illustrated in the upper panel is an average of the fishing mortalities that affected fish that were 9-20 months old.

FIGURA 3-2. Series de tiempo de la mortalidad por pesca mensual total media de atún barrilete reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de 12 vectores mensuales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior es un promedio de las mortalidades por pesca que afectaron a los peces de entre 9 y 20 meses de edad.

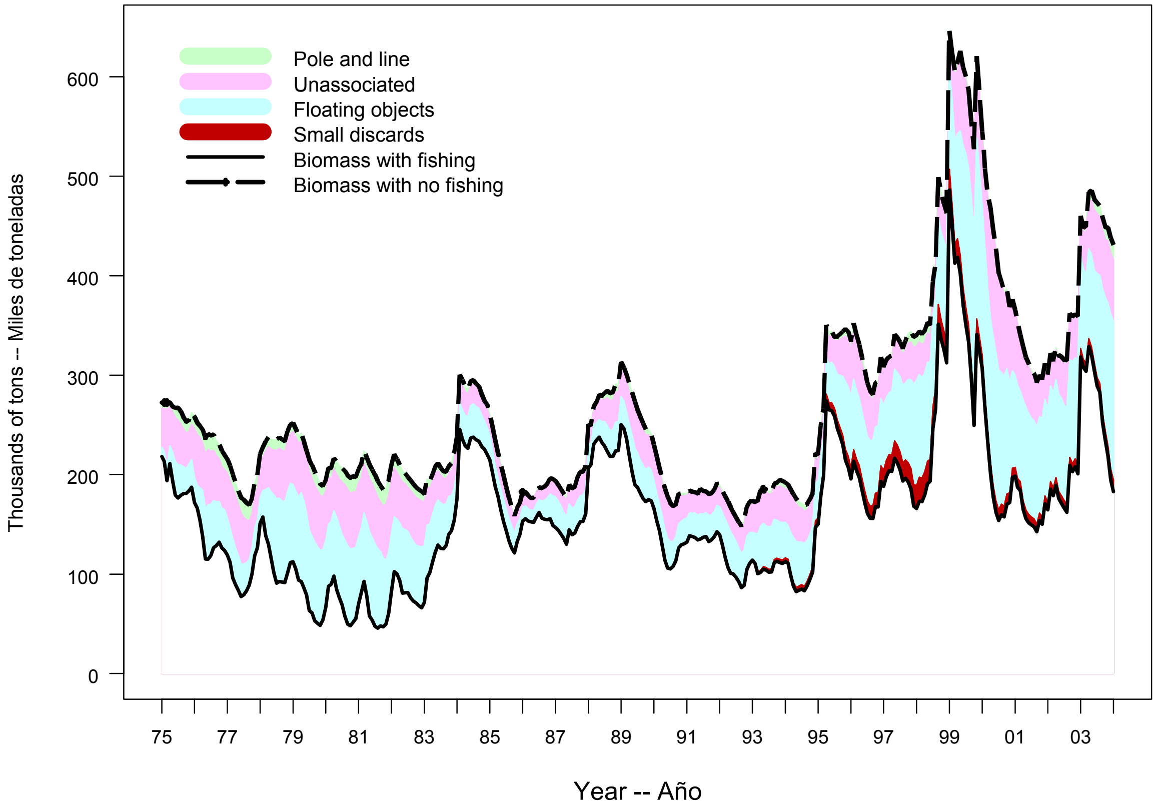


FIGURE 3-3. Biomass trajectory of a simulated population of skipjack tuna that was not exploited during 1975-2002 ("Biomass with no fishing") and that predicted by the stock assessment model ("Biomass with fishing"). The shaded areas between the two lines show the portion of the fishery impact attributed to each fishing method.

FIGURA 3-3. Trayectoria de la biomasa de una población simulada de barrilete no explotada durante 1975-2002 ("Biomasa sin pesca") y la que predice el modelo de evaluación ("Biomasa con pesca"). Las áreas sombreadas entre las dos líneas muestran la proporción del efecto de la pesqería por cada método de pesca.

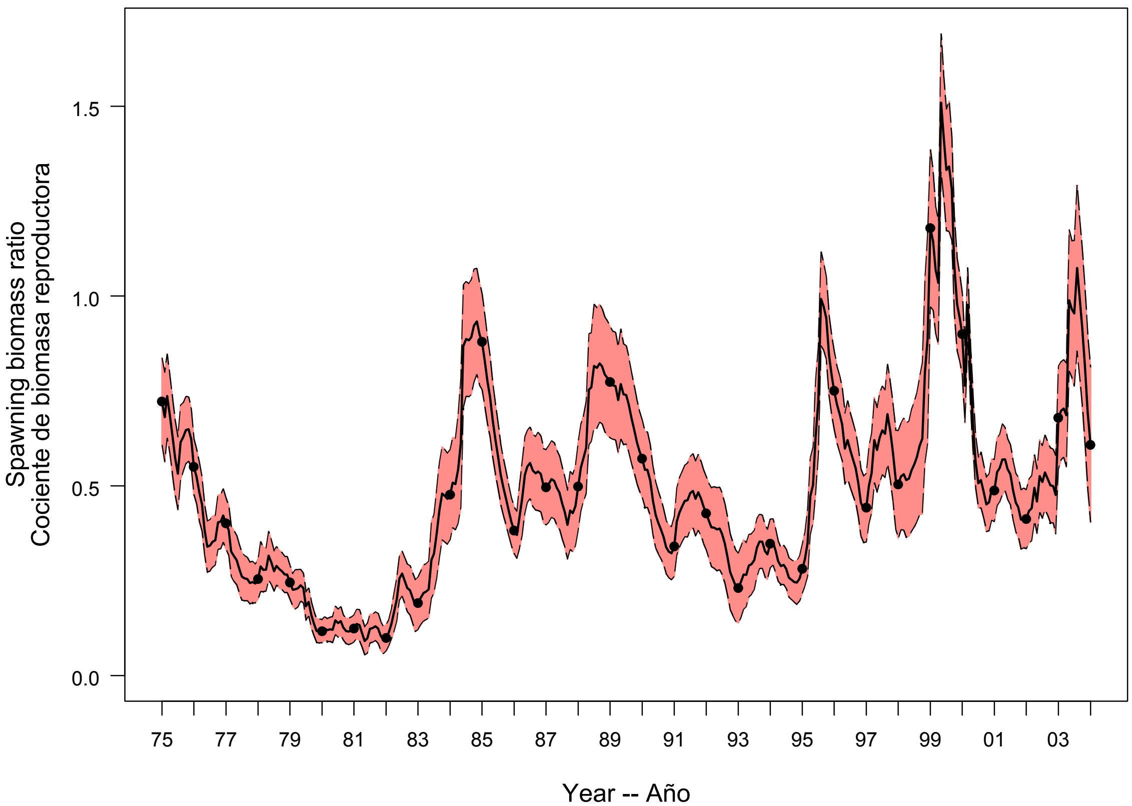


FIGURE 3-4. Estimated time series of spawning biomass ratios (SBRs) for skipjack tuna in the EPO, from the monotonic selectivity assessment.

FIGURA 3-4. Series de tiempo estimadas de los cocientes de biomasa reproductora (SBR) de atún barrilete en el OPO, de la evaluación de selectividad monotónica.

4. BIGEYE TUNA

An age-structured, catch-at-length analysis, A-SCALA, was used to assess bigeye tuna in the eastern Pacific Ocean (EPO). The analysis method is described in IATTC Bulletin, Vol 22, No. 5, and readers are referred to that report for technical details. The version of A-SCALA was similar to that used for the previous assessment.

This assessment is not much different from that for 2002. It includes revised estimates of maturity, fecundity, age-specific proportions of females in the population, and age-specific natural mortality vectors, based on updated data. Catch and length-frequency data for the surface fisheries have been updated to include new data for 2003. Effort data for the surface fisheries have been updated to include new data for 2003 and revised data for 1975 to 2002. Catch data for the Japanese longline fisheries have been updated for 1999 to 2001 and new data added for 2002. Catch data for the longline fisheries of Chinese Taipei have been updated for 1975 to 1999 and new data added for 2000 and 2001. Catch data for the longline fisheries of the Peoples Republic of China have been included for 2001 and 2002. Catch data for the longline fisheries of the Republic of Korea have been updated for 1987 to 1997 and new data added for 1998 to 2002. Longline catch-at-length data for 1975-2001 have been updated and new data added for 2002. Longline effort data based on neural-network standardization of catch per unit of effort have been updated to include data for 2001. Future projections are based on a new method that allows the inclusion of parameter uncertainty in the calculation of confidence intervals for future quantities.

Various sensitivity analyses were performed, including the incorporation of a stock-recruitment relationship, replacing the species composition estimates of purse-seine catches with the cannery estimates used in previous assessments, and increasing the levels of natural mortality assumed for bigeye tuna less the 10 quarters old.

There have been important changes in the amount of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. On average, the fishing mortality of bigeye less than about 20 quarters old has increased substantially since 1993, and that of fish more than about 24 quarters old has remained relatively constant (Figure 4-1). The increase in average fishing mortality on the younger fish was caused by the expansion of the fisheries that catch bigeye in association with floating objects. The base case assessment suggests (1) that the use of fish-aggregating devices (FADs) has substantially increased the catchability of bigeye by fisheries that catch tunas associated with floating objects, and (2) that bigeye are substantially more catchable when they are associated with floating objects in offshore areas than in inshore areas.

Recruitment of bigeye tuna to the fisheries in the EPO is variable, and the causes of the variation in recruitment have not been fully identified. Nevertheless, it appears to be related to zonal-velocity anomalies at 240 m during the time that these fish are assumed to have hatched. Over the range of spawning biomasses estimated by the base case assessment, the abundance of bigeye recruits appears to be unrelated to the spawning potential of adult females at the time of hatching.

There are two important features in the estimated time series of bigeye recruitment. First, greater-than-average recruitments occurred in 1977, 1979, 1982-1983, 1992, 1994, 1995-1997, and during the second quarters of 2001 and 2002 (Figure 4-2). The lower confidence bounds of these estimates were greater than the estimate of virgin recruitment only for 1994, 1997, 2001, and 2002. Second, aside from those two spikes in recruitment in 2001 and 2002, recruitment has been much less than average from the second quarter of 1998 to the end of 2003, and the upper confidence bounds of many of these recruitment estimates are below the virgin recruitment (Figure 4-2). Evidence for these low recruitments comes from the decreased catches per unit of effort (CPUEs) achieved by some of the floating-object fisheries, discard records collected at-sea by observers, length-frequency data, and adverse environmental conditions. The extended sequence of low recruitments is important because, in concert with high levels of fishing mortality, they are likely to produce a sequence of years in which the spawning biomass ratio (the ratio of spawning biomass to that for the unfished stock; SBR) will be considerably below the level capable of supporting the average maximum sustainable yield (AMSY).

Fishing has reduced the total biomass of bigeye present in the EPO, and it is predicted to be at its lowest level by the end of 2004 (Figure 4-3). There has been an accelerated decline in biomass since the small peak in 2000. Analsyis of the levels of fishing mortality asociated with each fishery indicates that, since the expansion of the purse-seine fishing on floating objects in the early to mid 1990s, the purse-seine fishery has had a much greater impact on the stock than has the longline fishery (Figure 4-3).

The estimates of recruitment and biomass were not sensitive to the range of alternative parameterizations of the assessment model considered or to the alternative data sources included in the assessment. However, in the current assessment, a narrower range of alternative analyses was considered.

At the beginning of 2004, the spawning biomass of bigeye tuna in the EPO was declining from a recent high level (Figure 4-4; large dot). At that time the SBR was about 0.14, about 32% less than the level that would be expected to produce the AMSY, with lower and upper confidence limits (± 2 standard deviations) of about 0.07 and 0.21. The estimate of the upper confidence bound is only slightly greater than the estimate of SBR_{AMSY} (0.20), suggesting that, at the start of 2004, the spawning biomass of bigeye in the EPO was less than the level capable of producing the AMSY. The dramatic change from being above the SBR_{AMSY} level to below it has been predicted by the past three assessments.

Estimates of the average SBR projected to occur during 2004-2014 indicate that the SBR is likely to reach an historic low level in 2007-2008, and remain below the level corresponding to the AMSY for many years unless fishing mortality is greatly reduced or recruitment is greater than average levels for a number of years (Figure 4-4). This decline is likely to occur because of the recent weak cohorts and the high estimated levels of fishing mortality.

The average weight of fish in the catch of all fisheries combined has been below the critical weight (about 49.8 kg) since 1993, suggesting that the recent age-specific pattern of fishing mortality is not satisfactory from a yield-per-recruit perspective. The average weight of purse-seine-caught fish is currently about 10 kg, while the average weight of longline-caught fish is about 60 kg.

Recent catches are estimated to have been about 26% above the AMSY level (Table 4-1). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort that is estimated to produce AMSY is about 62% of the current level of effort. Decreasing the effort to 62% of its present level would increase the long-term average yield by about 8% and would increase the spawning potential of the stock by about 156%. The AMSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery that operates south of 15°N because it catches larger individuals which are close to the critical size.

All analyses considered suggest that at the start of 2004 the spawning biomass was below the level that would be present if the stock were producing the AMSY (Table 4-1). AMSY and the fishing mortality (*F*) multiplier are sensitive to how the assessment model is parameterized, the data that are included in the assessment, and the periods assumed to represent average fishing mortality, but under all scenarios considered, fishing mortality is well above the level that will produce the AMSY.

Presently the purse-seine fishery on floating objects has the greatest impact on the bigeye tuna stock. Nevertheless, restrictions that apply only to a single fishery (*e.g.* longline or purse-seine), particularly longline fisheries, are predicted to be insufficient to allow the stock to rebuild to levels that will 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. Simulations suggest that the restrictions inmposed by the 2003 Resolution on the Conservation of Tuna in the Eastern Pacific Ocean are not sufficient to rebuild the stock.

The sensitivity analysis indicates that, if fishing mortality rates continue at their recent (2002 and 2003) levels, longline catches and SBR will decrease to extremely low levels. As the base case does not include a stock-recruitment relationship, recruitment would not decline, so purse-seine catches are predicted to stay decline only slightly from recent levels (Figure 4-5).

Summary:

- Almost all cohorts since 1998 have been below average.
- As a consequence, total biomass and spawning biomass will decrease in the future below the lowest levels observed during the period modelled (1975-2004).
- The current status and future projections are considerably more pessimistic if a stock-recruitment relationship (h = 0.75) exists.
- Under all scenarios considered, fishing mortality levels are greater than those necessary to obtain the AMSY.
- These conclusions are robust to the alternative model and data formulations considered.

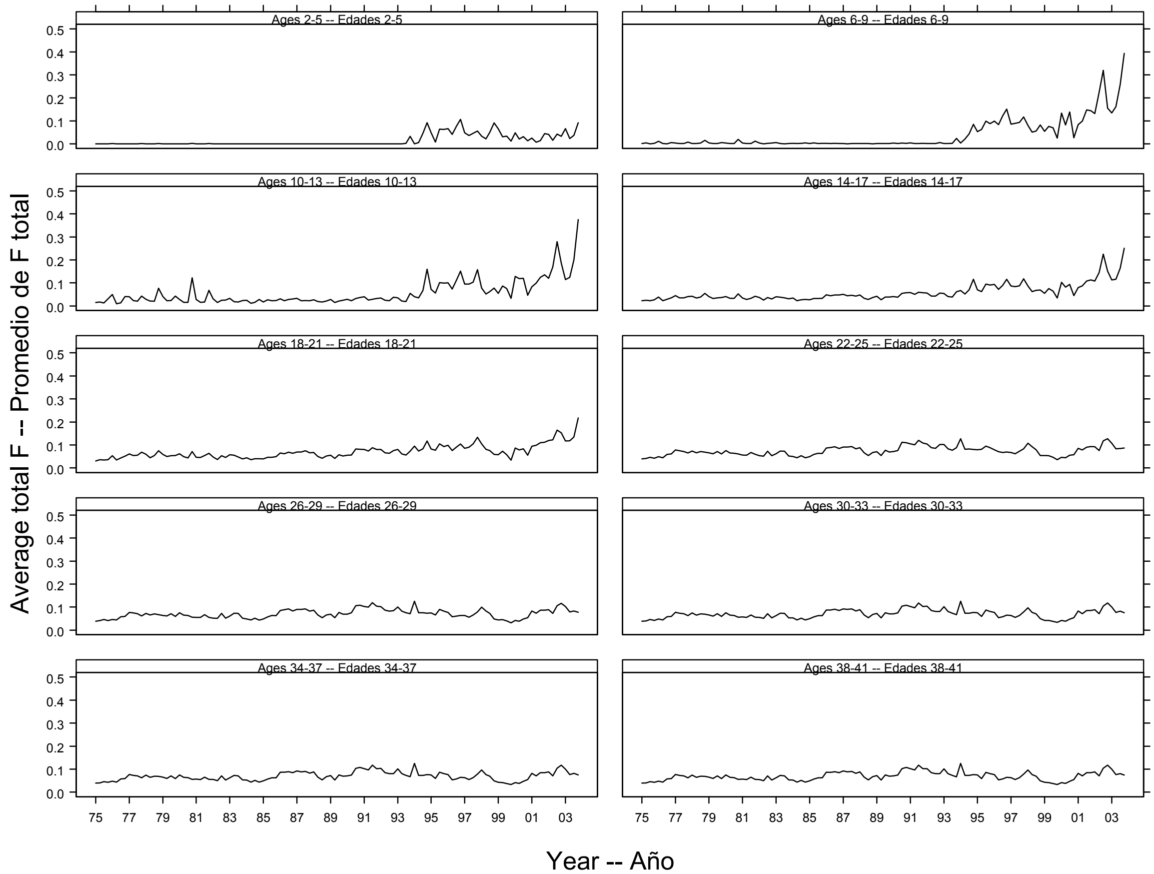


FIGURE 4-1. Time series of average total quarterly fishing mortality on bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four quarterly fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated in the upper-left panel is an average of the fishing mortalities that affected fish that were 2-5 quarters old.
FIGURA 4-1. Series de tiempo de la mortalidad por pesca trimestral total media de atún patudo reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores trimestrales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron a peces de entre 2 y 5 trimestres de edad.

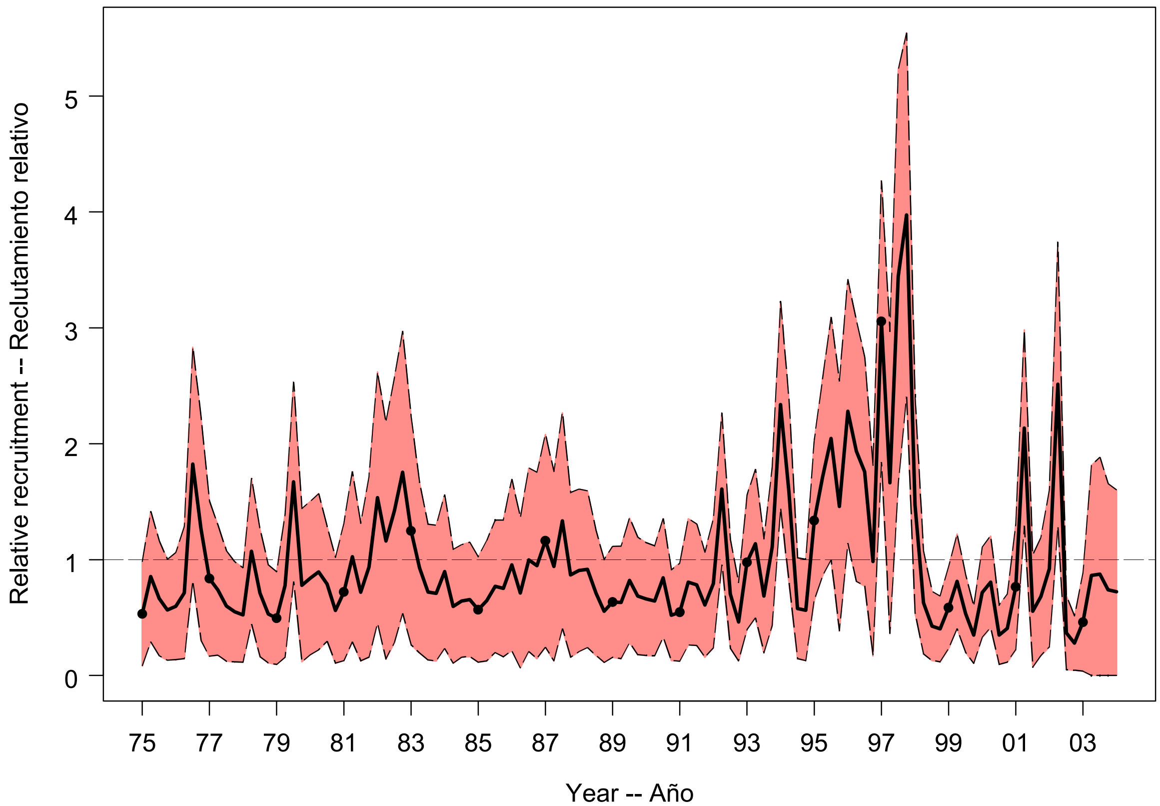


FIGURE 4-2. Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the thin lines are confidence intervals (±2 standard deviations) around those estimates. The labels on the time axis are drawn at the start of each year, but, since the assessment model represents time on a quarterly basis, there are four estimates of recruitment for each year.

FIGURA 4-2. Reclutamiento estimado de atún patudo a las pesquerías del OPO. Se escalan las estimaciones para que la estimación de reclutamiento virgen equivalga a 1,0. La línea gruesa ilustra las estimaciones de reclutamiento de verosimilitud máxima, y las líneas delgadas representan los intervalos de confianza (±2 desviaciones estándar) alrededor de esas estimaciones. Se dibujan las leyendas en el eje de tiempo al principio de cada año, pero, ya que el modelo de evaluación representa el tiempo por trimestres, hay cuatro estimaciones de reclutamiento para cada año.

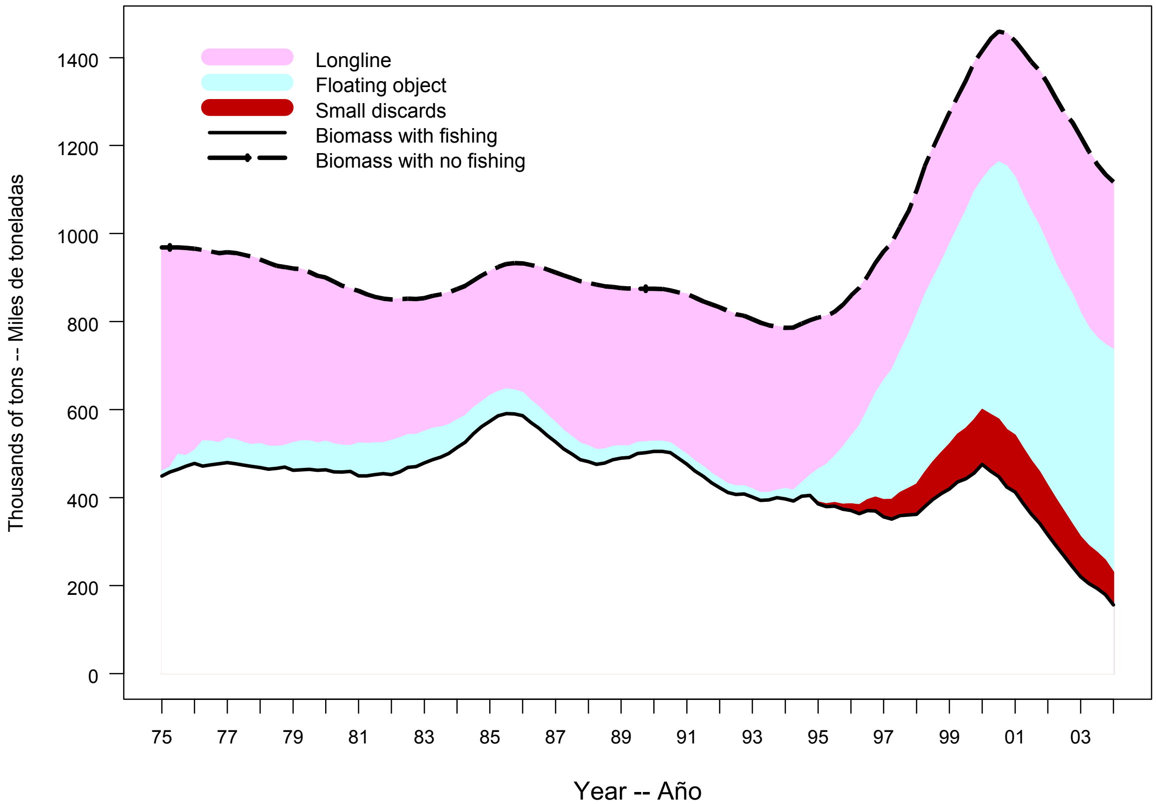


FIGURE 4-3. Biomass trajectory of a simulated population of bigeye tuna that was not exploited through December 2003 ("Biomass with no fishing") and that predicted by the stock assessment model ("Biomass with fishing"). The shaded regions between the two lines indicate the contribution of each group of fishing gears to the depletion of the stock.
FIGURA 4-3.

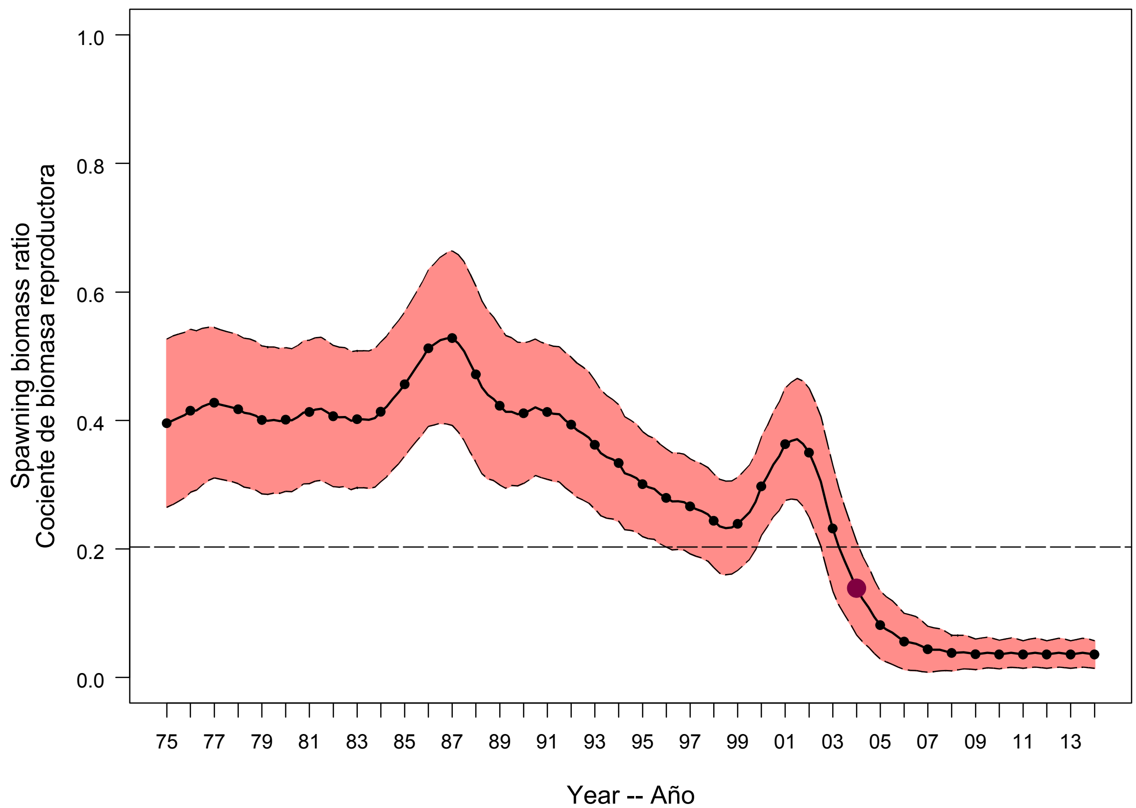


FIGURE 4-4. Estimated time series of spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.20) identifies the SBR at AMSY. The solid lines illustrate the maximum likelihood estimates, and the dashed lines are confidence intervals (±2 standard deviations) around those estimates. The estimates after 2004 (the large point) indicate the SBR predicted to occur if effort continues at the average of that observed in 2003, catchability (with effort deviates) continues at the average for 2001 and 2002, and average environmental conditions occur during the next 10 years.
FIGURA 4-4. Serie de tiempo estimada de los cocientes de biomasa reproductora (SBR) para el atún patudo en el OPO. La línea de trazos horizontal (en aproximadamente 0.20) identifica el SBR en RMSP. Las líneas sólidas ilustran las estimaciones de verosimilitud máxima, y las líneas de trazos representan los intervalos de confianza (±2 desviaciones estándar) alrededor de esas estimaciones.

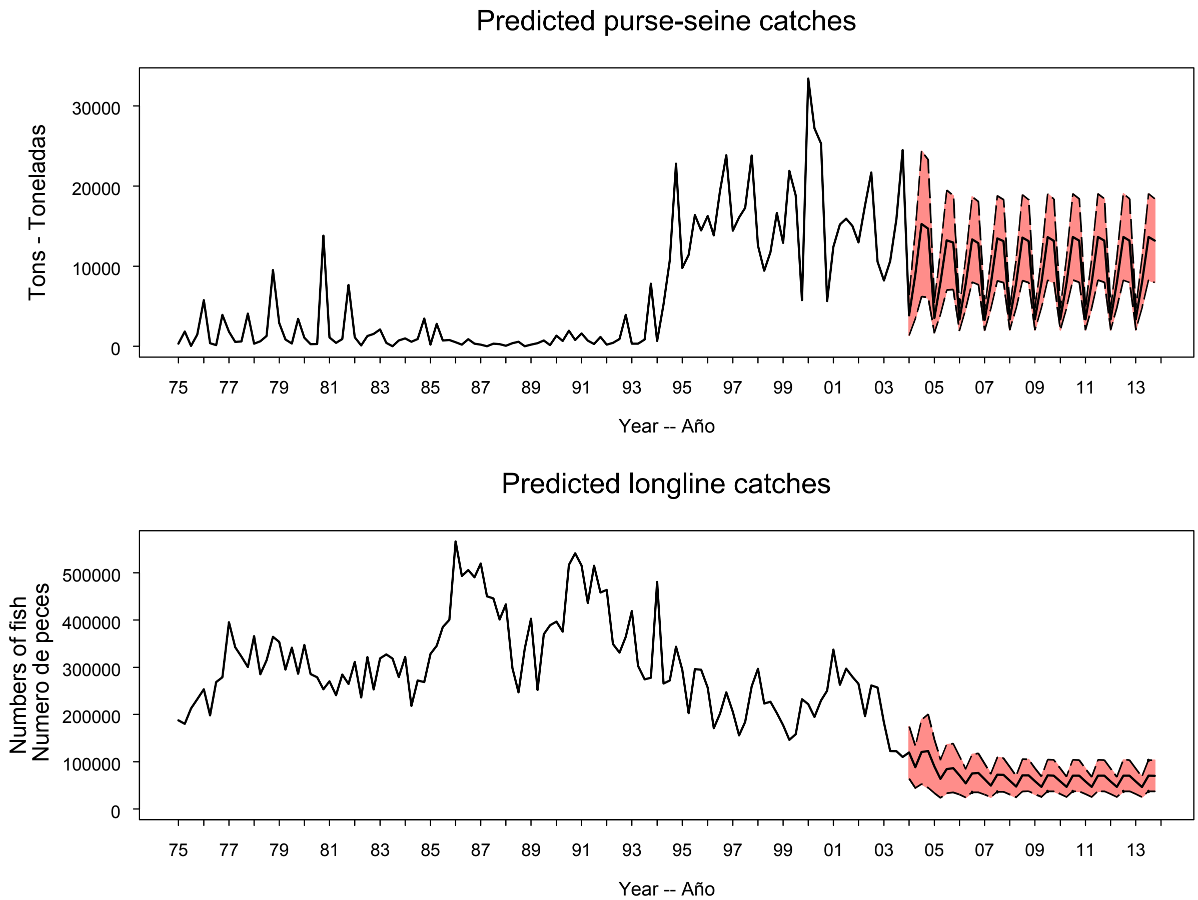


FIGURE 4-5. Predicted catches of bigeye for the surface (Fisheries 2, 3, 4, 5, and 7) and longline (Fisheries 8 and 9) fisheries based on average effort for 2003 and average catchability for 2001 and 2002. Predictions were undertaken using the likelihood profile method. The shaded areas represent 95% confidence intervals for the predictions of future catches. Note that the vertical scales of the panels are different.

FIGURA 4-5. Capturas predichas de atún patudo para las pesquerías de superficie (Pesquerías 2, 3, 4, 5, y 7) y palangreras (Pesquerías 8 y 9), basadas en el esfuerzo promedio de2003 y la capturabilidad promedio de 2001 y 2002. Se realizaron las predicciones con el método de perfil de verosimilitud. Las zonas sombreadas representan intervalos de confianza de 95% para las predicciones de capturas futuras. Nótese que las escalas verticales de los recuadross son diferentes.

TABLE 4-1. Estimates of the AMSY and its associated quantities for the base case and sensitivity analyses. All analyses are based on average fishing mortality for 2001 and 2002. B_{recent} and B_{AMSY} are defined as the biomass of bigeye 1+ years old at the start of 2004 and at AMSY, respectively, and S_{recent} and S_{AMSY} are defined in terms of female spawning biomass. C_{recent} is the estimated total catch in 2003.

TABLA 4-1. Estimaciones del RMSP y sus valores asociados para el caso base y análisis de sensibilidad. Todos los análisis se basan en la mortalidad por pesca media de 2000 y 2001. Se definen B_{recent} y B_{RMSP} como la biomasa de patuda de edad 1+ años al principio de 2003 y en RMSP, respectivamente, y S_{recent} y S_{RMSP} como índices de biomasa de hembras reproductora. C_{recent} es la captura total estimada en 2003.

	Base case	**Steepness = 0.75**	**Cannery estimates of purse-seine catch**	**Increased natural mortality of juveniles**
	Caso base	**Inclinación = 0.75**	**Estimaciones de enlatadoras de la captura cerquera**	
AMSY—RMSP	77,747	62,849	76,113	69,910
B_{AMSY}—B_{RMSP}	274,683	361,770	264,732	239,050
S_{AMSY}—S_{RMSP}	41,588	64,090	39,877	34,924
B_{AMSY}/B_0—B_{RMSP}/B_0	0.28	0.36	0.30	0.28
S_{AMSY}/S_0—S_{RMSP}/S_0	0.20	0.30	0.22	0.20
C_{recent}/AMSY—C_{recent}/RMSP	1.26	1.56	1.16	1.41
B_{recent}/B_{AMSY}—B_{recent}/B_{RMSP}	0.57	0.42	0.77	0.69
S_{recent}/S_{AMSY}—S_{recent}/S_{RMSP}	0.68	0.43	0.80	0.80
F multiplier—Multiplicador de F	0.62	0.38	0.80	0.65

5. PACIFIC BLUEFIN TUNA

Tagging studies have shown that there is exchange of Pacific bluefin, *Thunnus orientalis*, between the eastern and western Pacific Ocean. Larval, postlarval, and early juvenile bluefin have been caught in the western Pacific Ocean (WPO), but not the eastern Pacific Ocean (EPO), so it is likely that there is a single stock of bluefin in the Pacific Ocean.

Most of the catches of bluefin in the EPO are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 33°N. In recent years a considerable portion of the purse-seine catch of bluefin has been transported to holding pens, where the fish are held for fattening and later sale as sashimi-grade fish. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

Bluefin are exploited by various gears in the WPO from Chinese Taipei to Hokkaido. Age-0 fish about 15 to 30 cm in length are caught by trolling during July-October south of Shikoku Island and south of Shizuoka Prefecture. During November-April age-0 fish about 35 to 60 cm in length are taken by trolling south and west of Kyushu Island. Age-1 and older fish are caught by purse seining, mostly during May-September, between about 30°-42°N and 140°-152°E. Bluefin of various sizes are also caught by traps, gillnets, and other gear, especially in the Sea of Japan. Small amounts of bluefin are also caught near the southeastern coast of Japan by longlining.

The high-seas longline fisheries are directed mainly at tropical tunas, albacore, and billfishes, but small amounts of Pacific bluefin are caught by these fisheries. Small amounts of bluefin are also caught by Japanese pole-and-line vessels on the high seas.

Tagging studies, conducted with conventional and archival tags, have revealed a great deal of information about the life history of bluefin. As stated above, it appears that spawning occurs only in the WPO. Some fish apparently remain their entire lives in the WPO, while others migrate to the EPO. These migrations begin mostly, or perhaps entirely, during the first and second years of life. The first- and second-year migrants are exposed to various fisheries before beginning their journey to the EPO. The migrants, after crossing the ocean, are exposed to commercial and recreational fisheries off California and Baja California. Eventually, the survivors return to the WPO.

Bluefin are most often found in the EPO in waters where the sea-surface temperatures (SSTs) are between 17° and 23°C. Fish 15 to 31 cm in length are found in the WPO in waters where the SSTs are between 24° and 29°C. The survival of larval and early juvenile bluefin is undoubtedly strongly influenced by the environment. Conditions in the WPO probably influence the portions of the juvenile fish there that move to the EPO, and also the timing of these movements. Likewise, conditions in the EPO probably influence the timing of the return of the juvenile fish to the WPO.

Various indices of abundance of bluefin in the EPO have been calculated, but none of these is entirely satisfactory. The IATTC has calculated "habitat" and "bluefin-vessel" indices for the EPO routinely for several years.

A preliminary cohort analysis has indicated that the biomass of the spawning stock was relatively high during the 1960s, decreased during the 1970s and 1980s, and then increased during the 1990s. The recruitment was estimated to be highly variable, with four or five strong cohorts produced during the 1960-1998 period.

The total catches of bluefin have fluctuated considerably during the last 50 years (Figure 5-1). The presence of consecutive years of above-average catches (mid-1950s to mid-1960s) and below-average catches (early 1980s to early 1990s) could be due to consecutive years of above-average and below-average recruitment. The results of yield-per-recruit and cohort analyses indicate that greater catches could be obtained if the catches of age-0 and age-1 fish were reduced or eliminated.

Spawner-recruit analyses do not indicate that the recruitment of Pacific bluefin could be increased by permitting more fish to spawn.

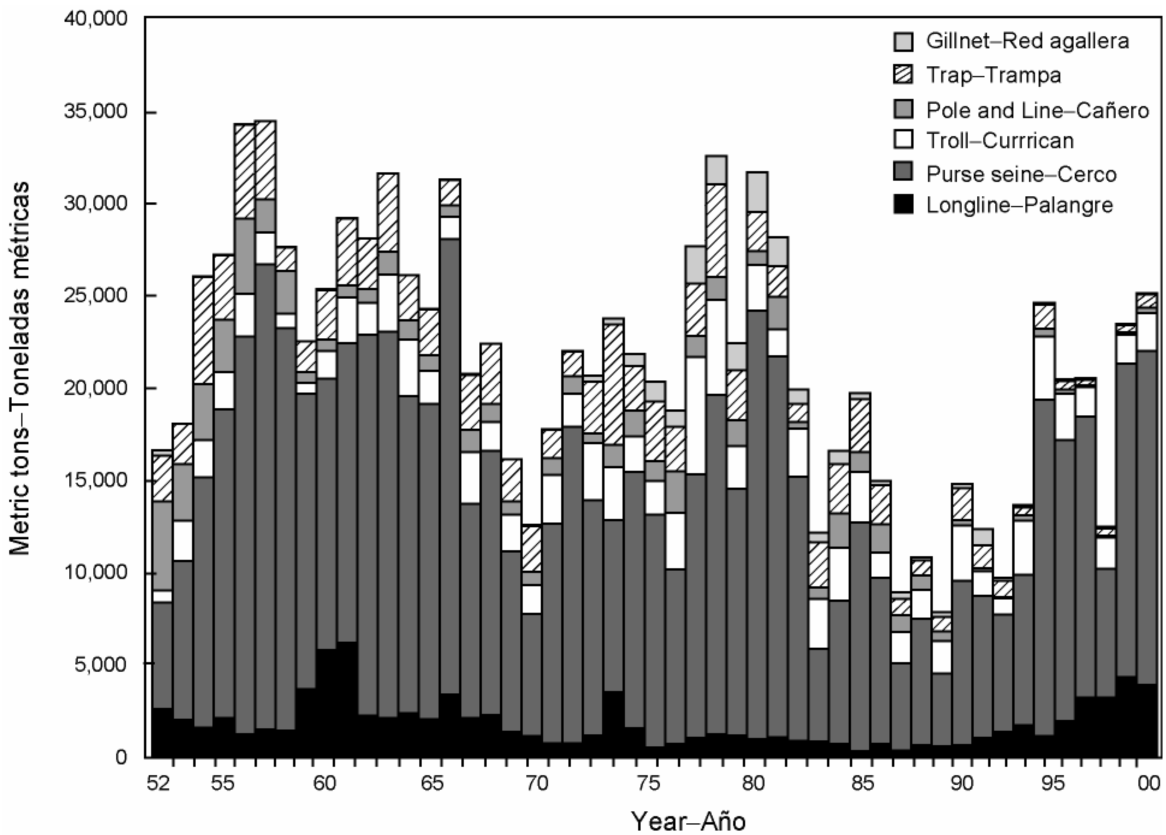


FIGURE 5-1. Retained catches of Pacific bluefin, 1952-2000.
FIGURA 5-1. Capturas retenidas de aleta azul del Pacífico, 1952-2000.

6. ALBACORE TUNA

Most scientists who have studied albacore, *Thunnus alalunga*, in the Pacific Ocean have concluded that there are two stocks, one occurring in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longliners in most of the North and South Pacific, but not often between about 10°N and 5°S, by trollers in the eastern and central North Pacific and the central South Pacific, and by pole-and-line vessels in the western North Pacific. In the North Pacific about 55% of the fish are taken in surface fisheries that catch smaller albacore, whereas only about 20% of the albacore caught in the South Pacific are taken by surface gear. Total catches of albacore from the North Pacific peaked in the early 1970s at over 100,000 t per year, and then declined. Catches recovered during the 1990s, and reached an all-time high of 127,800 t in 1999 (Figure 6-1a). In the South Pacific, catches have ranged between about 25,000 and 55,000 t during the 1980s and 1990s (Figure 6-1b).

The juveniles and adults are caught mostly in the Kuroshio Current, the North Pacific Transition Zone, and the California Current in the North Pacific and the Subtropical Convergence Zone in the South Pacific, but spawning occurs in tropical and subtropical waters.

There appear to be two subgroups of albacore in the North Pacific Ocean. The fish of the northern subgroup are found mostly north of 40°N when they are in the EPO. There is considerable exchange of fish of this subgroup between the troll fishery of the EPO and the pole-and-line and longline fisheries of the western Pacific Ocean. The fish of the southern subgroup occur mostly south of 40°N in the EPO, and relatively few of them are caught in the western Pacific. Fish that were tagged in offshore waters of the EPO and recaptured in the coastal fishery of the EPO exhibited different movements, depending on the latitude of release. Most of the recaptures of those released north of 35°N were made north of 40°N, and most of the recaptures of those released south of 35°N were made south of 40°N.

Much less is known about the movements of albacore in the South Pacific Ocean. The juveniles move southward from the tropics when they are about 35 cm long, and then eastward along the Subtropical Convergence Zone to about 130°W. When the fish approach maturity they return to the tropics, where they spawn. Recoveries of tagged fish released in areas east of 155°W were usually made at locations to the east and north of the release site, whereas those of fish released west of 155°W were usually made at locations to the west and north of the release site.

New age-structured stock assessments were presented for the North and South Pacific stocks of albacore in 2002. The South Pacific assessment, carried out with MULTIFAN-CL by the Secretariat for the Pacific Community, incorporated catch and effort, length-frequency, and tagging data. The stock was estimated to be well above the level that would produce the average maximum sustainable yield (AMSY), the current catches of around 40,000 t being much less than the estimated AMSY of 117,000 t. Although the recent recruitments are estimated to be slightly below average, there appears to be no need to restrict the fisheries for albacore in the South Pacific Ocean.

Virtual population analyses of the North Pacific stock of albacore were carried out during the 18th North Pacific albacore workshop. The estimated current biomass, 510,000 t, is almost 40% greater than that estimated for 1975, the first year of the period modeled. The estimated recruitments of the 1990s were greater than those of the 1980s, and the catches per unit effort for most of the surface fisheries have increased in recent years. The fishing mortality for juvenile fish is estimated to be relatively high. Projections, under different assumptions of future recruitment, suggest that the biomass will decline if the current levels of fishing mortality persist. F_{AMSY}, the fishing mortality corresponding to the AMSY, was not estimated, but a proxy for it suggested that the stock is currently being fished at a $F_{20\%}$ level. In the near future the North Pacific stock of albacore will be analyzed with MULTIFAN-CL, using data for years prior to 1975, in addition to those for more recent years.

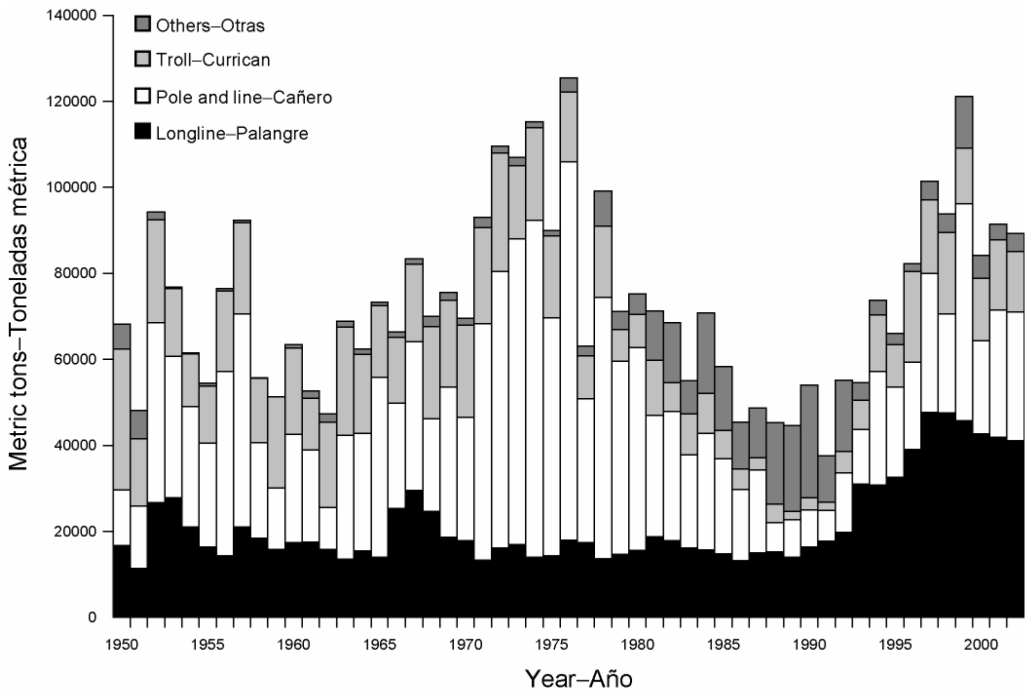


FIGURE 6-1a. Catches of North Pacific albacore, 1950-2002

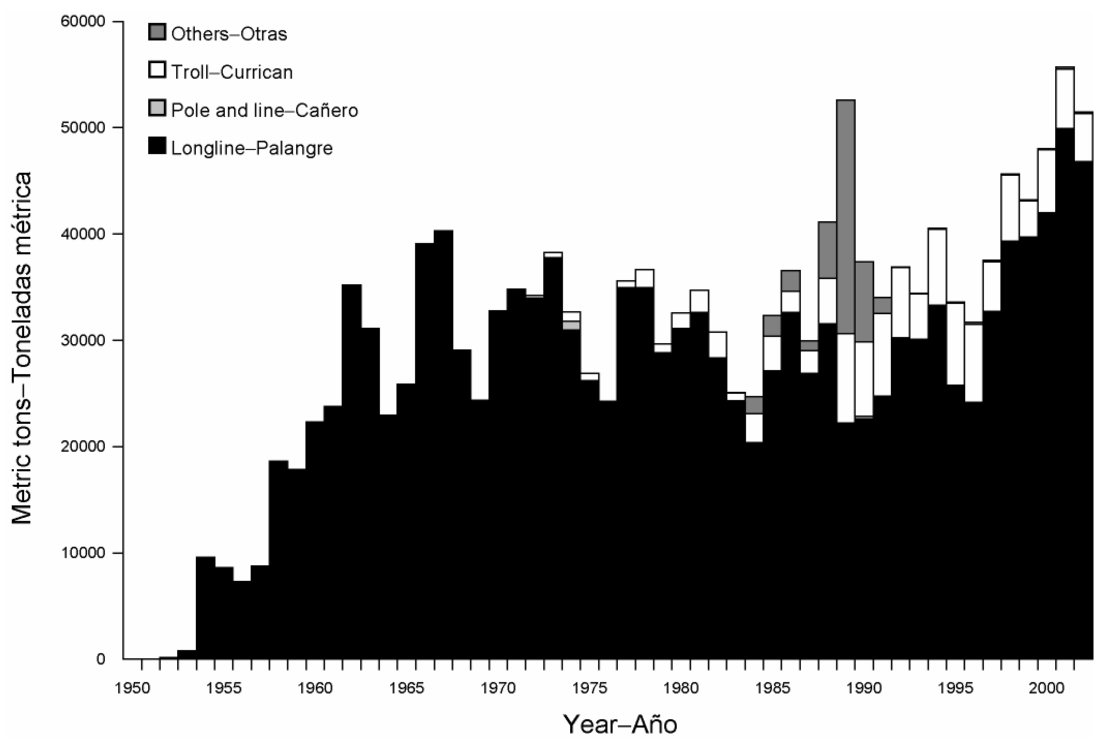


FIGURE 6-1b. Catches of South Pacific albacore, 1950-2002.

7. SWORDFISH

Swordfish, *Xiphias gladius*, occur throughout the Pacific Ocean between about 50°N and 50°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations (Figure 7-1). Lesser amounts are taken by gillnet and harpoon fisheries. They are seldom caught by recreational fishermen. During the most recent three-year period the greatest catches in the EPO have been taken by vessels of Spain, Chile, and Japan, which together harvested about 72 percent of the total swordfish catch taken in the fishery. Of these three, the fisheries of Spain and Chile target swordfish, while swordfish are taken in the Japanese fishery that predominately targets bigeye tuna.

Swordfish reach maturity at about 5 to 6 years of age, when they are about 150 to 170 cm in length. They probably spawn more than once per season. Unequal sex ratios occur frequently. For fish greater than 170 cm in length, the proportion of females increases with increasing length.

Only fragmentary data are available on the movements of swordfish. They tend to inhabit waters further below the surface during the day than at night.

Swordfish tend to inhabit frontal zones. Several of these occur in the eastern Pacific Ocean (EPO), including areas off California and Baja California, off Ecuador, Peru, and Chile, and in the equatorial Pacific. Swordfish tolerate temperatures of about 5° to 27°C, but their optimum range is about 18° to 22°C. Swordfish larvae have been found only at temperatures exceeding 24°C.

There may be two stocks of swordfish in the EPO. If there are, one has its center of distribution in the southeastern Pacific Ocean, and the other its center off California and Baja California. As well, there may be movement of a northwestern Pacific stock of swordfish into the EPO at various times. Results of genetic studies specifically undertaken to help resolve the question of stock structure are expected to be completed within the next few months.

Production modeling indicates that the catches per unit of effort (CPUEs) of swordfish, although they have declined and then increased recently, are still greater than the CPUEs that correspond to the average maximum sustainable yield. This conclusion is tentative, due primarily to the current uncertainty regarding stock structure. Analyses of standardized CPUEs for northern and southern stocks gives no indication of declining abundances in the regions, which would indicate that to date there seemingly has been little or no impact by fisheries on these stocks. Average annual catch for the 5-year period 1998 to 2002 for the northern region has been about 4,800 metric tons (t), and for the southern region about 9,100 t. It should be noted, however, that catches in the southern region have doubled during this period, reaching 13,300 t in 2002, which exceeded the previously recorded high catch of 12,400 t reported in 1991. At some point it would be a normal expectation that high levels of catch over a period of time will result in reductions in CPUE.

Results of preliminary modeling with MULTIFAN-CL of a North Pacific swordfish stock in areas north of 10°N indicate that in recent years the biomass level has been stable and well above 50% of the unexploited levels of stock biomass, implying that swordfish are not overexploited at current levels of fishing effort.

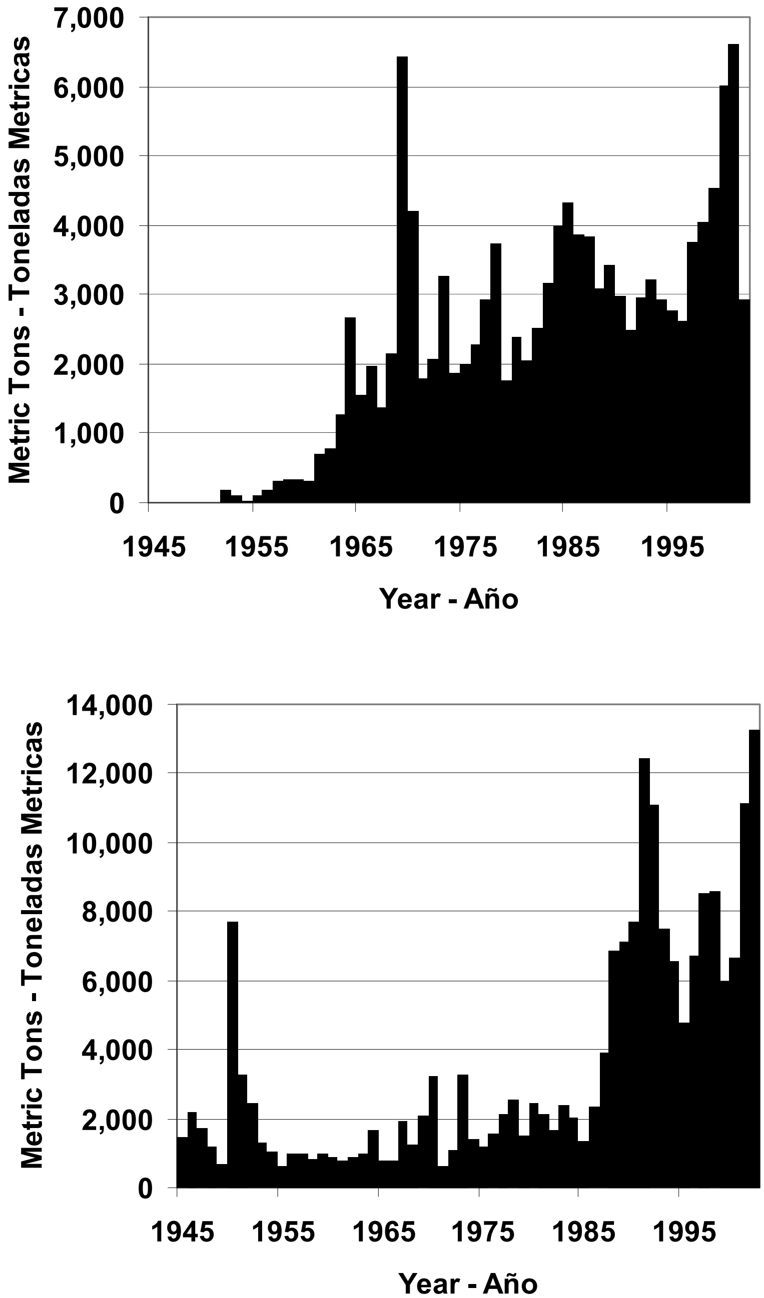


FIGURE 7-1. Retained catches of swordfish in the northern (upper panel) and southern (lower panel) region of the eastern Pacific Ocean, 1945-2002.
FIGURA 7-1. Capturas retenidas de pez espada en el Océano Pacífico oriental, 1945-2002.

8. BLUE MARLIN

The best knowledge currently available indicates that blue marlin, *Makaira nigricans*, constitutes a single world-wide species and that there is a single stock of blue marlin in the Pacific Ocean. For this reason, statistics on catches (Figure 8-1) are compiled, and analyses of stock status are made, for the entire Pacific Ocean, even though it is important to know how catches in the eastern Pacific Ocean (Figure 8-2) vary over time.

Blue marlin are taken by longline vessels of many nations that fish for tunas and billfishes between about 50°N and 50°S. Lesser amounts are taken by recreational fisheries and by various commercial surface fisheries.

Small numbers of blue marlin have been tagged, mostly by recreational fishermen, with conventional tags. A few of these fish have been recaptured long distances from the locations of release. In addition, blue marlin have been tagged with acoustic tags and their activities monitored for short periods.

Blue marlin usually inhabit regions where the sea-surface temperatures (SSTs) are greater than 24°C, and they spend about 90% of their time at depths in which the temperatures are within 1° to 2° of the SSTs.

The Deriso-Schnute delay-difference population dynamics model, a form of production model, was used to assess the status of the blue marlin stock in the Pacific Ocean. Data for the estimated annual total retained catches for 1951-1997 and standardized catch rates developed from catch and nominal fishing effort data for the Japanese longline fishery for 1955-1997 were used. It was concluded that the levels of biomass and fishing effort were near those required to maintain the average maximum sustainable yield (AMSY).

A more recent analysis, using MULTIFAN-CL, was conducted to assess the blue marlin stocks in the Pacific Ocean and to evaluate the efficacy of habitat-based standardization of longline effort. There is considerable uncertainty regarding the levels of fishing effort that would produce the AMSY. However, it was determined that blue marlin in the Pacific Ocean are close to fully exploited, *i.e*. that the population is near the top of the yield curve. It was also found that standardization of effort, using a habitat-based model, allowed estimation of parameters within reasonable bounds and with reduced confidence intervals about the estimates.

The fisheries in the EPO have historically captured on the range of 10 to 18 percent of the total harvest of blue marlin from the Pacific Ocean, with captures in the most recent 5-year period averaging about 10 percent of the total harvest.

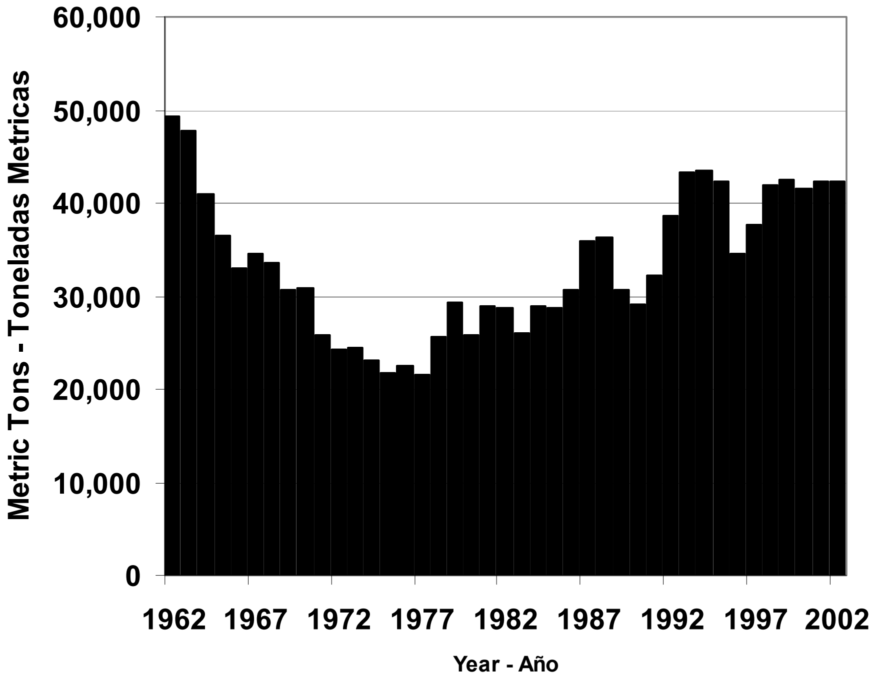


FIGURE 8-1. Retained catches of blue marlin in the Pacific Ocean, 1952-1998.
FIGURA 8-1. Capturas retenidas de marlín azul en el Océano Pacífico, 1952-1998.

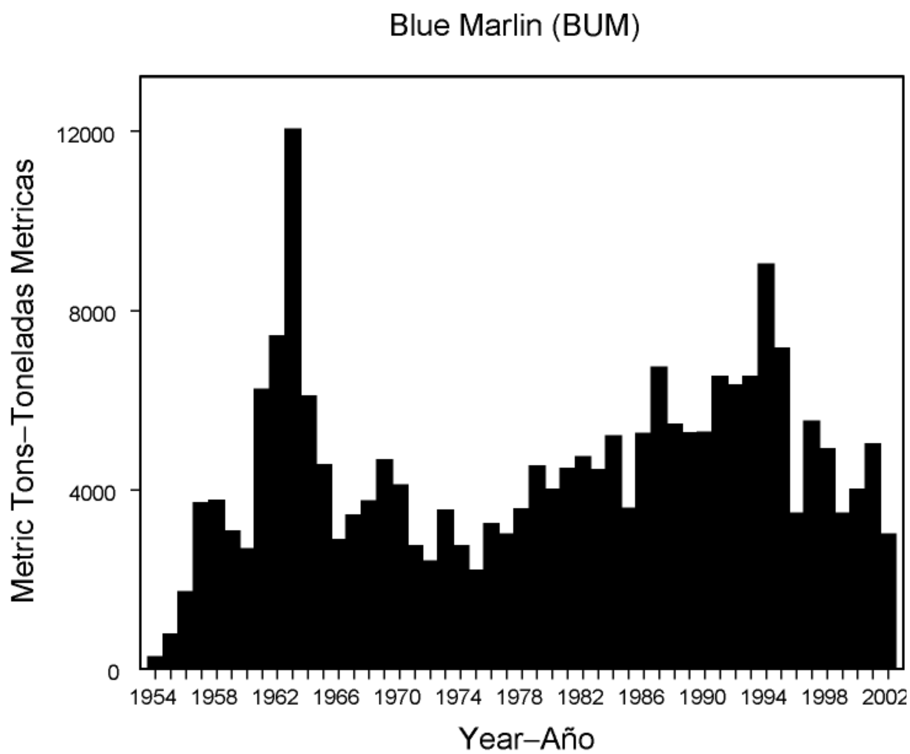


FIGURE 8-2 Retained catches of blue marlin in the eastern Pacific Ocean, 1954-2002.
FIGURA 8-2. Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1954-2002.

9. STRIPED MARLIN

Striped marlin, *Tetrapturus audax*, occur throughout the Pacific Ocean between about 45°N and 45°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are caught by recreational, gillnet, and other fisheries. During recent years the greatest catches (Figure 9-1) in the eastern Pacific Ocean (EPO) have been taken by fisheries of Costa Rica, Japan, and the Republic of Korea.

Striped marlin reach maturity when they are about 140 cm long, and spawning occurs in widely-scattered areas of the Pacific Ocean.

The stock structure of striped marlin in the Pacific Ocean is not well known. There are indications that there is only limited exchange of striped marlin between the EPO and the central and western Pacific Ocean, so it is considered in this report that examinations of local depletions and independent assessments of the striped marlin of the EPO are meaningful. An analysis of trends in catch rates in subareas suggest that the fish in the EPO consist of one stock. Genetic studies have suggested that there are separate populations in the eastern and western South Pacific and that there may be a separate populations with centers of distribution in the regions proximate to Hawaii in the north-central Pacific and to Ecuador and to Mexico in the EPO. However, preliminary results of more recent analyses suggest that the fish in the Ecuador and Mexico region are from a single population.

Few tagging data are available for striped marlin. Most recaptures of tagged fish released off the tip of the Baja California peninsula have been made in the general area of release, but some have been recaptured around the Revillagigedo Islands, a few around Hawaii, and one near Norfolk Island.

Such being the case, the conclusions reached for a single-stock model, chosen on the basis of trends in catch rates, should be considered tentative, and efforts should be undertaken to resolve the question of stock structure of striped marlin in the EPO. To this end a collaborative study to investigate the stock structure and status of striped marlin in the Pacific has been undertaken.

Standardized catch rates were obtained from a general linear model and from the statistical habitat-based standardization method. Analyses of stock status made using two production models, taking into account the time period when billfish were targeted by longline fishing in the EPO, were considered the most plausible. A Pella-Tomlinson model yielded estimates of the average maximum sustained yield (AMSY) in the range of 3,700 to 4,100 t, with a current biomass to be about 47% of the unfished biomass. The current biomass is estimated to be greater than the biomass that would produce the AMSY. An analysis, using the Deriso-Schnute delay–difference model, yielded estimates of AMSY in the range of 8,700 to 9,200 t, with current biomass greater than the biomass needed to produce the AMSY and about 70% of the size of the unexploited biomass.

Landings and standardized fishing effort for striped marlin decreased in the EPO from 1990-1991 through 1998, and this decline has continued, with annual catch during 2000 to 2002 between about 1,500 and 2,200 t, levels which are well below estimated AMSY harvest levels. This may result in a continued increase in the biomass of the stock in the EPO.

The stock(s) of striped marlin stocks in the EPO are apparently in good condition, with current and near-term anticipated fishing effort less than that required to produce the AMSY.

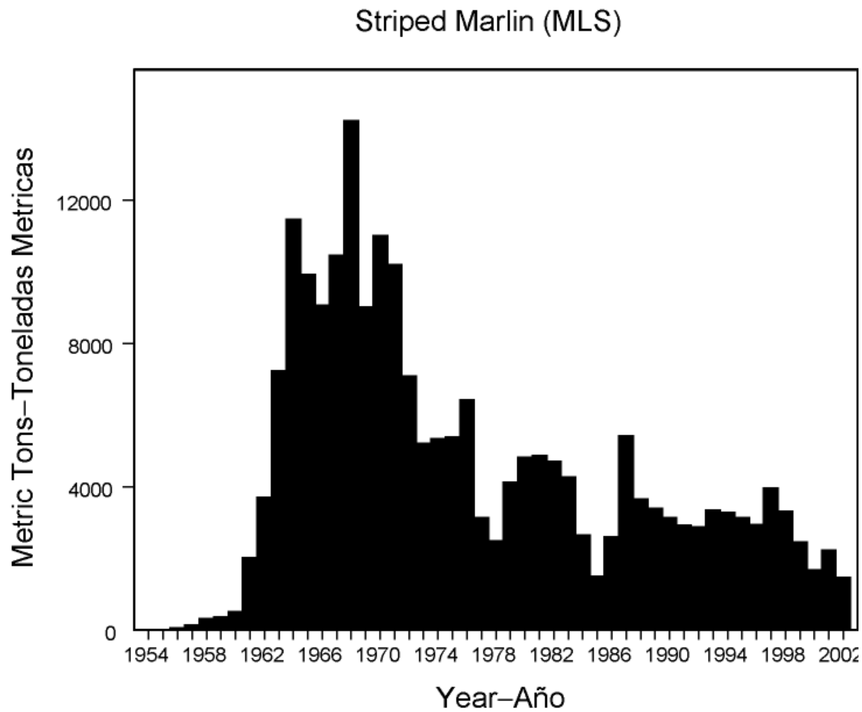


FIGURE 9.1. Retained catches of striped marlin in the eastern Pacific Ocean, 1954-2002.
FIGURA 9.1. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1954-2002.

10. ECOSYSTEM CONSIDERATIONS

1. INTRODUCTION

The FAO Code of Conduct for Responsible Fisheries provides that management of fisheries should ensure the conservation not only of target species, but also of the other species belonging to the same ecosystem. In 2001, the Reykjavik Declaration on Responsible Fisheries in the Ecosystem elaborated this standard with a commitment to incorporate ecosystem considerations into fisheries management.

The IATTC has taken account of ecosystem issues in many of its decisions, but until recently has not focused its attention on the entire ecosystem in which the target species, the tunas and billfishes, reside. This section provides a coherent view, summarizing what is known about the direct impact of the fisheries upon various species and species groups of the ecosystem, and reviews what is known about the environment and about other species that are not directly impacted by the fisheries. The purpose is to provide the Commission the opportunity to consider the ecosystem as a whole as part of its consideration of the status of the tuna and billfish stocks and management measures.

This review does not suggest objectives for the incorporation of ecosystem considerations into the management of tuna or billfish fisheries or any new management measures. Rather, its prime purpose is to offer the Commission the opportunity to ensure that ecosystem considerations are clearly part of its agenda.

It is important to remember that the view that we have of the ecosystem is based on the recent past; we have no information about the ecosystem before exploitation began. Also, the environment is subject to change on a variety of time scales, including the well-known El Niño fluctuations and more recently recognized longer-term changes, such as the Pacific Decadal Oscillation and other climate changes.

In addition to reporting the catches of the principal species of tunas and billfishes, the staff has reported the bycatches of other species that are normally discarded. In this report these bycatches are presented in the context of the effect of the fishery on the ecosystem. Unfortunately, information for the entire fishery is not available. Relatively good information is available for the tunas and billfishes. The information is comprehensive for large (Class-6) purse seiners that carry observers under the Agreement on the International Dolphin Conservation Program (AIDCP), and information on retained catches is also reported for other purse seiners, pole-and-line vessels, and much of the longline fleet. Some information is available on sharks that are retained by parts of the longline fleet. Information on bycatches and discards is also available for Class-6 and for some smaller purse seiners. There is little information available on bycatches and discards for other fishing vessels.

2. ANALYSIS OF THE IMPACT OF CATCHES

2.1. Single-species assessments

This section provides a summary of current information on the effect of the tuna fisheries on stocks of single species in the eastern Pacific Ocean (EPO). It focuses on the current biomass of each stock considered, compared to what it might have been in the absence of a fishery. The intention is to show how the fishery may have altered the components of the ecosystem, rather than the detailed assessments, which can be found in other sections of this report and in other Commission documents. The section below frequently refers to comparisons with the unexploited stock size. There are no direct measurements of the unexploited stock size, and, in any case, it would have varied from year to year. The term normally means the stock size that would be produced in the absence of a fishery with the average recruitment observed during the period in which the stock was assessed.

2.1.1. Tunas

2.1.1a. Yellowfin

Since 1984 the yellowfin stock has been at or above the level that would provide the average maximum sustainable yield, except for the most recent year (2003). To meet this objective, the spawning stock size must be kept above 38% of its unexploited size with the current mix of fishing methods. One estimate of the effect of this reduced stock size is that the predation by yellowfin on other parts of the ecosystem is reduced to about 30% of what it was in the absence of a fishery.

2.1.1b. Skipjack

Skipjack assessments are far less certain than those for yellowfin and bigeye, in part because the fishery does not appear to be having much impact on the stock. However, it appears that fluctuations in recruitment cause large variations in stock size. In 2003, the biomass was estimated to be about 60% of what it would have been in the absence of a fishery and under average conditions.

2.1.1c. Bigeye

Up to 1993 bigeye were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 46% of its unexploited size. After 1993, purse seining for tunas associated with fish-aggregating devices (FADs) took significant quantities of small and medium-sized bigeye. Currently, after several years of poor recruitment and excessive levels of fishing mortality, the stock size is estimated to be at about 15% of its unexploited size. The biomass estimated for 2004 is the lowest since 1975, the first year included in the model.

2.1.1d. Albacore

It is generally considered that there are two stocks of albacore in the Pacific Ocean, one in the North Pacific and the other in the South Pacific. The South Pacific stock is thought to be at about 90% of its unexploited size, while that of the North Pacific appears to be at about 30% of its unexploited size.

2.1.2. Billfishes

2.1.2a. Swordfish

The variations in swordfish standardized catch per unit of effort in the northern and southern EPO show no trend, suggesting that catches to date have not affected the stocks significantly, though recent catches have been near record levels.

2.1.2b. Blue marlin

Recent stock assessments of blue marlin suggest that the current stock size is between 50% and 90% of the unexploited stock size.

2.1.2c. Striped marlin

A recent stock assessment of striped marlin suggests that the current stock size is about 50 to 70% of the unexploited stock size.

2.1.2d. Black marlin, sailfish, and shortbill spearfish

No recent formal stock assessments have been made for these species, although there are some data presented in the IATTC Bulletin series published jointly by scientists of the National Research Institute of Far Seas Fisheries of Japan and the IATTC that show trends in catches, effort, and catches per unit of effort.

2.2. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis* and, to a lesser extent, *D. capensis*) frequently associate with yellowfin tuna in the size range of about 10 to 40 kg in the EPO. Purse-seine fishermen have found that their catches of yellowfin in the EPO can be maximized by searching for herds of dolphins or flocks of seabirds, setting their nets around the dolphins and tunas, and releasing the dolphins while retaining the tunas. The incidental mortality of dolphins in this operation was high during the early years of the fishery, but after the late 1980s it decreased precipitously. Table 10-1 shows the mortalities of dolphins in the fishery in 2003 and published estimates of the abundances of the various stocks.

Studies of the association of tunas with dolphins have been an important component of the staff's long-term approach to understanding key interactions of the ecosystem. The extent to which yellowfin tuna and dolphins compete for resources, or whether either or both of them benefits from the interaction, remain critical pieces of information, given the large biomasses of both groups and their high rates of prey consumption. Populations of dolphins involved in the purse-seine fishery were reduced from their unexploited levels during the 1960s and 1970s, but are now growing slowly and are expected to continue to do so.

During 2003, scientists of the U.S. National Marine Fisheries Service (NMFS) conducted the latest in a series of research cruises under the *Stenella* Abundance Research Project (STAR). The primary objective of the multi-year study is to investigate trends in population size of the dolphins that have been taken as incidental catch by the purse-seine fishery in the EPO. During STAR 2003, data on cetacean distribution, school size, and school composition were collected aboard two NOAA research vessels, *David Starr Jordan* and *McArthur II*, to estimate dolphin abundance. These data are currently being analyzed.

Scientists of the NMFS have made estimates of the abundances of several other species of marine mammals from research vessels between 1986 and 2000 in the EPO. Of the species not significantly impacted by the tuna fishery, short-finned pilot whales and three stocks of common dolphins showed increasing trends in abundance during that 15-year period. The apparent increased abundance of these mammals may have caused a decrease in the carrying capacity of the EPO for other predators that overlap in diet, including spotted dolphins. Bryde's whales also increased in estimated abundance, but there is very little diet overlap between these baleen whales and the upper-level predators impacted by the fisheries. Striped dolphins showed no clear trend in estimated abundance over time, and the estimates of abundance of sperm whales tended to decrease in recent years. The STAR 2003 cruises will provide further estimates of abundance of these mammals.

2.3. Sea turtles

Sea turtles are occasionally caught in purse seines in the tuna fishery in the EPO. Most interactions occur when the turtles associate with floating objects (for the most part fish-aggregating devices (FADs)), and are captured when the object is encircled; in other cases, the net, set around an unassociated school of tunas or a school associated with dolphins, may capture sea turtles that happen to be at that location. Olive Ridley turtles are, by far, the species of sea turtle taken most often by purse seiners. They are followed by the black or green sea turtle, and, very occasionally, by loggerhead and hawksbill turtles. Only one leatherback mortality has been recorded during the nine years that IATTC observers have been recording this information. Some of the turtles are unidentified because they were too far from the vessel or it was too dark for the observer to identify them. Sea turtles, at times, become entangled in the webbing under FADs and drown. In a few cases, they are lifted out of the water by the fishing gear while still entangled, and may fall from the net at some height and be injured, or may be passed through the power block. The estimated average annual mortalities of turtles caused by Class-6 purse-seine vessels during 1993-2003 were as follows:

	Set type		
	Floating object	Unassociated	Dolphin
Olive Ridley	47.8	18.3	10.7
Black or eastern Pacific green	5.8	3.9	0.7
Loggerhead	0.6	1.2	0.1
Hawksbill	0.6	0.2	0.2
Leatherback	0.1	0.0	0.0
Unidentified	22.0	10.3	4.4
Total	76.8	33.8	16.1
Average number of sets	4,479	4,941	9,320

The mortalities of sea turtles due to purse seining for tunas are probably less than those due to other types of human activity, which include exploitation of eggs and adults, beach development, pollution, entanglement in and ingestion of marine debris, and impacts of other fisheries.

Sea turtles also get caught on longlines when they take the bait on a hook, or are snagged accidentally by a hook or line while swimming or when the gear is being retrieved. Estimates of incidental mortality of turtles due to longline and gillnet fishing are few. Japan reported that 166 leatherback and 6000 other turtle species, mostly olive Ridley, were incidentally caught by Japan's longline fishery in the eastern Pacific during 2000. Of these, 25 and 3000, respectively, were dead. Based on information from other parts of the world, the mortality rates due to longlining may be greater than those due to purse seining, particularly for shallow longlines. About 23 million of the 200 million hooks set each year in the EPO by distant-water longline vessels target swordfish with shallow longlines. In addition, there is a sizeable fleet of local longline vessels that fish for tunas and billfishes in the EPO.

The populations of olive Ridley, black, and loggerhead turtles of the EPO are designated as threatened, and those of the leatherback turtle as endangered, by the Convention on International Trade in Endangered Species of Wild Flora and Fauna. The lack of comprehensive information concerning the impact of the fishery on turtles is a serious weakness in understanding the effects of the fisheries for tunas and billfishes on the offshore pelagic ecosystem of the EPO.

2.4. Sharks and other large fishes

Sharks and other large fishes are taken by both purse-seine and longline vessels. The IATTC staff carried out a preliminary analysis of the relative abundance of silky sharks, the most commonly-caught species of shark in the purse-seine fishery. Preliminary estimates of relative abundance for the equatorial region, between about 8°N and 10°S, show a decreasing trend over time. It is not known whether this decreasing trend is due to the fishery, changes in the environment (perhaps associated with the 1997-1998 El Niño), or other processes.

The average annual discards (in numbers) of sharks and other large fishes during 1993-2003 (other than those discussed above) by Class-6 purse-seine vessels are as follows:

	Set type		
	Floating object	Unassociated	Dolphin
Dorado	523,537	10,349	328
Wahoo	259,204	1,067	378
Rainbow runner and yellowtail	101,921	18,298	1,206
Sharks	37,011	6,957	3,930
Rays	239	3,250	796
Unidentified billfishes[1]	120	23	63
Other large fishes	16,525	20,091	26

1. The catches of the identified billfishes by surface gear, most of which are discarded, are shown in Table 1-10.

There are no stock assessments available for these species in the EPO, and hence the impact of the bycatches on the stocks is unknown.

The catch rates of other species in the purse-seine fishery are different for each type of set. With a few exceptions, the bycatch rates are greatest in sets on floating objects, followed by unassociated sets and, at a much lower level, dolphin sets. Dolphin bycatch rates are greatest for dolphin sets, followed by unassociated sets and, at a much lower level, floating-object sets. The bycatch rates of sailfish, manta rays, and stingrays are greatest in unassociated sets, followed by dolphin sets and then floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch figures. Table 1-6) shows the estimated numbers of sets during 1987-2003 by purse-seine vessels in the EPO.

2.5 Seabirds

Seabirds associate with subsurface predators such as fishes (especially tunas) and marine mammals. Subsurface predators often drive prey to the surface to trap them against the air-water interface, where the prey become available to the birds. Most species of seabirds take prey within a half meter of the sea surface or in the air (flyingfishes and flying squid). In addition to driving the prey to the surface, subsurface predators make prey available to the birds by injuring or disorienting the prey and by leaving scraps after feeding on large prey.

According to the *Report of the Scientific Research Program* under the U.S. International Dolphin Conservation Program Act, prepared by the NMFS in September 2002, there were no significant temporal trends in abundance estimates over the 1986-2000 period for any species of seabird, except the Tahiti petrel, in the tropical EPO.

2.6. Forage

The forage taxa occupying the middle trophic levels in the EPO are obviously an important component of the ecosystem, providing a link between primary production at the base of the food web and the upper-trophic-level predators such as the tunas and billfishes. The indirect effects of environmental variability are transmitted to the upper trophic levels through the forage taxa. Very little is known, however, about fluctuations in abundance of the large variety of prey species in the EPO. Scientists from the NMFS have recorded data on the distributions and abundances of common prey groups, including lanternfishes, flyingfishes, and some squids, in the tropical EPO during 1986-1990 and 1998-2000. Mean abundance estimates of all fish taxa, and to a lesser extent for squids, increased from 1986 through 1990. Estimates were low again in 1998, and then increased through 2000. Their interpretation of this pattern was that El Niño events in 1986-1987 and 1997-1998 had negative effects on these prey populations. More data on these taxa were collected during the STAR 2003 cruises by scientists of the NMFS.

Small fishes, many of which are forage for the larger predators, are incidentally caught by purse-seine vessels in the EPO. Frigate and bullet tunas (*Auxis* spp.) are a common prey of many of the animals that occupy the upper trophic levels in the tropical EPO. In the tropical EPO ecosystem model (see Section 5), *Auxis* spp. comprise 10% or more of the diet of eight predator categories. Small quantities are captured by purse-seine vessels and by local artisanal fisheries in some coastal regions of Central and South America. The vast majority of *Auxis* spp. captured by tuna purse-seine vessels is discarded at sea. The estimated annual discards of small fishes on fishing trips of Class-6 purse-seine vessels with observers onboard in the EPO during 1993-2003 were as follows:

		Set type		
	Units	**Floating object**	**Unassociated**	**Dolphin**
Triggerfishes and filefishes	numbers	719,287	5,102	3,453
Other small fishes	numbers	664,047	58,424	26,558
Frigate and bullet tunas (*Auxis* spp.)	metric tons	1,284.4	235.3	40.8

3. PHYSICAL ENVIRONMENT

Environmental conditions affect the target populations, all other components of the ecosystem, and the operations of the fishermen. Very few ocean areas of the world show changes as dramatic as those that take place in the EPO during El Niño events. In addition, many less dramatic events are constantly taking place. In broad terms, water temperature controls the horizontal and vertical distributions of the tunas and billfishes. The drift of floating objects, with their associated communities, depends on the currents. Currents also transport eggs and larvae, determining their location and their patchiness. Fronts change the productive conditions, and in some cases create areas of attraction for tunas and billfishes. Upwelling brings nutrients from the deeper layers to the surface, and the Humboldt Current, off the Pacific coast of northern South America, is one of the most productive ocean areas of the world. Turbulence, at a very small scale, has a significant impact on the survival of fish larvae. Along the coastline, the contributions of organic matter, fresh water, nutrients, and debris that rivers bring to the ocean are quite significant, creating special conditions that in some cases result in high productivity and areas that are favorable for the development of the early life stages of many species. Topographic features, such as islands and seamounts, change oceanographic conditions around them, and many constitute rich habitats. Some species are permanent residents in these locations; others use them as stages in longer migrations.

El Niño events change not only water temperature, but also current speed and direction, upwelling intensity, precipitation patterns, and many other components of the environment. Longer-term inter-decadal changes were first described for the North Pacific a few years ago, but more recent observations show that there are also changes with a periodicity of decades that affect the EPO. One such shift may have happened in 1976-1978, and 1998 may have been another pivotal year. The recruitment of yellowfin to the fishery was apparently considerably greater during 1985-1999 than during 1975-1984. Because the productivity in the system can change dramatically under different regimes, their effect on all components of the ecosystem is very important. These changes increase the uncertainty about the parameters used to model the target stocks (*i.e.* the carrying capacity is not the same; recruitment, growth and mortality may respond to the changes, *etc*.), the trends observed for all populations, and even the fishing operations (*e.g.* changes in current speeds, depth of the thermocline, *etc*.).

This list, although by no means complete, shows the diversity and complexity of the ways in which the environment affects the target species and the rest of the ecosystem. It is, of course, not possible or necessary for the staff to address more than a small fraction of these. However, use is made of the results of work by national and international research groups that are investigating these factors.

4. AGGREGATE INDICATORS

Recognition of the consequences of fishing for marine ecosystems has stimulated much research in recent years. Researchers ask how the use of performance measures and reference points might be expanded to help meet the objectives of ecosystem-based fisheries management. Whereas reference points to date have been used primarily for single-species management of target species, applying performance measures and reference points to non-target species is believed to be a tractable first step. Current examples include incidental take limits for dolphins in the EPO purse-seine fishery under the AIDCP. Another area of interest is whether useful performance indicators based on ecosystem-level properties might be developed. Several ecosystem metrics or indicators, including community size structure, diversity indices, species richness and evenness, overlap indices, catch trophic spectra, relative abundance of an indicator species or group, and numerous environmental indicators, have been proposed. Whereas there is general agreement that multiple system-level indicators should be used, there is concern over whether there is sufficient practical knowledge of the dynamics of such metrics and whether a theoretical basis for identifying precautionary or limit reference points based on ecosystem emergent properties exists. Ecosystem-level metrics are not yet commonly used for managing fisheries.

Food web diagrams are useful for representing the structure and flows of ecosystems. A simplified food-web diagram, with approximate trophic levels (TLs), of the pelagic tropical EPO is shown in Figure 10-1.

Toothed whales (average TL 5.2), large squid predators (large bigeye tuna and swordfish, average TL 5.2) and sharks (average TL 5.0) are top-level predators. Other tunas, large piscivores, dolphins, and seabirds occupy slightly lower TLs. Smaller epipelagic fishes (*e.g. Auxis* spp. and flyingfishes), cephalopods, and mesopelagic fishes are the principal forage of many of the upper-level predators in the ecosystem. Small fishes and crustaceans prey on two zooplankton groups, and the herbivorous microzooplankton (TL = 2) feed on the producers (TL = 1), phytoplankton and bacteria.

In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as the ecosystem's apex predators. Over time, fishing can cause the overall size composition of the catch to decline. The mean trophic level of the organisms taken by a fishery is a potentially useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. There has been increasing attention to analyzing the mean TL of fisheries catches and discards since a study demonstrated that the mean TL of the fishes and invertebrates landed globally, according to FAO landings statistics, had declined from 1950 to 1994. Given the potential utility of this approach, TLs were estimated for a time series of catches and discards by year from 1993 to 2003 for three fishing modes of the purse-seine fishery in the EPO. The estimates were made by applying the TLs from the EPO ecosystem model (see Section 5), weighted by the catch data by fishery and year for all model groups from the IATTC tuna, bycatch, and discards databases. The TLs of the summed catches of all surface fisheries were fairly constant from year to year (Figure 10-2: average for surface gear). The TL of the floating-object sets varied more than those of the other fisheries, due to the interannual variability in the sizes of the tunas caught and the species compositions of the bycatches in those sets.

TLs were also estimated separately for the time series of retained and discarded catches by year for the surface fisheries from 1993 to 2003 (Figure 10-3). The TLs of the landings were quite stable from year to year, and the TLs of the discarded catches varied considerably. The greatest variation occurred for sets on unassociated fish.

5. ECOSYSTEM MODELING

It is clear that the different components of an ecosystem interact. The best way to describe the relationships and explore their effects is through ecosystem modeling. Our understanding of this complex maze of connections is at an early stage, and, consequently, the current ecosystem models are most useful as descriptive devices for exploring the effects of a mix of hypotheses and established connections among the ecosystem components. Ecosystem models must be compromises between simplistic representations on the one hand and unmanageable complexity on the other.

The IATTC staff has developed a model of the pelagic ecosystem in the tropical EPO (IATTC Bulletin, Vol. 22, No. 3) to explore how fishing and climate variation might affect the animals at middle and upper trophic levels. The ecosystem model has 38 components, including the principal exploited species (*e.g.* tunas), functional groups (*e.g.* sharks and flyingfishes), and sensitive species (*e.g.* sea turtles). Some taxa are further separated into size categories (*e.g.* large and small marlins). The model has finer taxonomic resolution at the upper trophic levels, but most of the system's biomass is contained in the middle and lower trophic levels. Fisheries landings and discards were estimated for five fishing "gears," pole-and-line, longline, dolphin sets by purse seiners, floating-object sets by purse seiners, and sets on unassociated schools by purse seiners. The model focuses on the pelagic regions; localized, coastal ecosystems are not adequately described by the model.

Most of the information describing inter-specific interactions in the model comes from a joint IATTC-NMFS project, which included studies of the food habits of co-occurring yellowfin, skipjack, and bigeye tuna, dolphins, pelagic sharks, billfishes, dorado, wahoo, rainbow runner, and others. The impetus of the project was to contribute to the understanding of the tuna-dolphin association, so a community-level sampling design was adopted.

The ecosystem model has been used to evaluate the possible effects of variability in bottom-up forcing by the environment on the middle and upper trophic levels of the pelagic ecosystem. Predetermined time series of producer biomasses were put into the model as a proxy for changes in primary production that have been documented during El Niño and La Niña events, and the dynamics of the remaining components of the ecosystem were simulated. The model was also used to evaluate the relative contributions of fishing and the environment in shaping ecosystem structure in the tropical pelagic EPO. This was done by using the model to predict which components of the ecosystem might be susceptible to top-down effects of fishing, given the apparent importance of environmental variability in structuring the ecosystem. In general, animals with relatively low turnover rates were influenced more by fishing than by the environment, and animals with relatively high turnover rates more by the environment than by fishing.

6. OTHER ECOSYSTEM STUDIES IN PROGRESS

A study entitled "Trophic structure and tuna movement in the equatorial Pacific pelagic ecosystem," funded primarily by the Pelagic Fisheries Research Program (PFRP) of the University of Hawaii, was initiated during 2003. The project was also funded by the IATTC; the Centro Interdisciplinario de Ciencias Marinas (CICIMAR) of the Instituto Politénico Nacional, La Paz, Mexico; and the Secretariat of the Pacific Community, Nouméa, New Caledonia. Scientists from these four agencies will compare the pelagic food web in the EPO with that of the more oligotrophic western Pacific. The main objectives of the study are: 1) to define the trophic structure of the pelagic ecosystems in the western, central, and eastern parts of the tropical Pacific Ocean, 2) to establish a stable C and N isotope-derived (upwelling-related) biogeography of the pelagic tropical Pacific ecosystems, and 3) to characterize large-scale tuna movements related to upwelling regions along the equator. This study will also provide important information on the trophic position of the forage fishes and cephalopods in the tropical EPO, which is not currently available. Results will be incorporated in ecosystem models to help define the ecosystem linkages leading to tuna production and the effect of climate variability on fisheries production.

7. ACTIONS BY THE IATTC AND AIDCP ADDRESSING ECOSYSTEM CONSIDERATIONS

Both the IATTC and AIDCP have objectives that address the incorporation of ecosystem considerations into the management of the tuna fisheries in the EPO. Actions taken in the past include:

7.1. Dolphins

a. For many years, the impact of the fishery on the dolphin populations has been assessed, and programs to reduce or eliminate that impact have met with considerable success.

b. Studies to determine why tunas associate with dolphins have been carried out.

c. The incidental mortality of each stock of dolphins has been limited to levels that are insignificant compared to stock sizes.

7.2. Sea turtles

a. A data base on all sea turtle sightings, captures, and mortalities reported by observers has been compiled.

b. A Recommendation on Sea Turtles was adopted at the fourth meeting of the Working Group on Bycatch in January 2004. It recommends that all nations in which vessels that fish in the EPO are registered provide the IATTC with information on interactions with sea turtles in the EPO, including both incidental and direct catches and other impacts on sea turtle populations. It also recommends that the IATTC "explore the development of a three-year program that could include mitigation of sea turtle bycatch, biological research on sea turtles, improvement of fishing gears, industry education and other techniques to improve sea turtle conservation."

c. A resolution on releasing and handling of sea turtles captured in purse seines has been adopted.

d. A resolution on netting attached underwater to FADs has been adopted.

e. A resolution prohibiting disposing of plastic containers and other debris at sea has been adopted.

7.3. Other species

a. A resolution on live release of sharks, rays, billfishes, dorado, and other non-target species has been adopted.

b. A resolution directing the IATTC staff to seek funds for reduction of incidental mortality of juvenile tunas, for developing techniques and equipment to facilitate release of billfishes, sharks, and rays from the deck or the net, and to carry out experiments to determine the survival rates of released billfishes, sharks, and rays has been adopted.

7.4. All species

a. Data on the bycatches by Class-6 purse-seine vessels have been collected, and plans have been made to expand the activity to smaller vessels and other gears.

b. Data on the spatial distributions of the bycatches and the bycatch/catch ratios have been collected for analyses of policy options to reduce bycatches.

c. Information to evaluate measures to reduce the bycatches, such as closures, effort limits, *etc*., has been collected.

d. Assessments of habitat preferences and the effect of environmental changes have been made.

8. FUTURE DEVELOPMENTS FOR ECOSYSTEM ANALYSES

It is unlikely, in the near future at least, that there will be stock assessments for most of the bycatch species. In lieu of formal assessments, it may be possible to develop indices to assess trends in the status of these species. The IATTC staff's experience with dolphins suggests that the task is not trivial if relatively high precision is required.

An array of measures has been proposed to study changes in ecosystem properties. This could include studies of average trophic level, size spectra, dominance, diversity, *etc*., to describe the ecosystem in an aggregate way.

The distributions of the fisheries for tunas and billfishes in the EPO are such that several regions with different ecological characteristics may be included. Within them, water masses, oceanographic or topographic features, influences from the continent, *etc*., may generate heterogeneity that affects the distributions of the different species and their relative abundances in the catches. It would be desirable to increase our understanding of these ecological strata so that they can be used in our analyses.

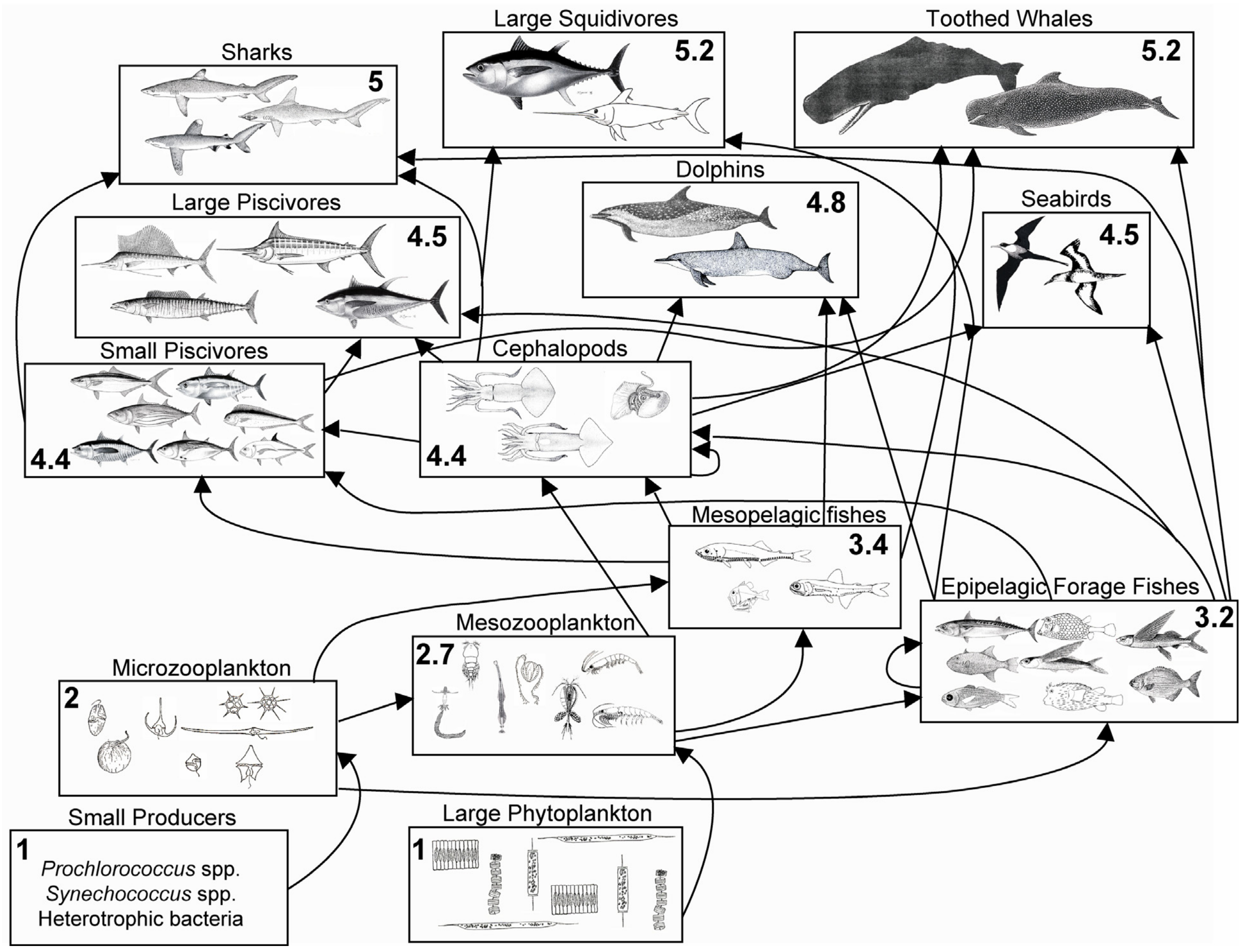


FIGURE 10-1. Simplified food-web diagram of the pelagic ecosystem in the tropical eastern Pacific Ocean.

FIGURA 10-1. Diagrama simplificado de la red trófica del ecosistema pelágico en el Océano Pacífico oriental tropical.

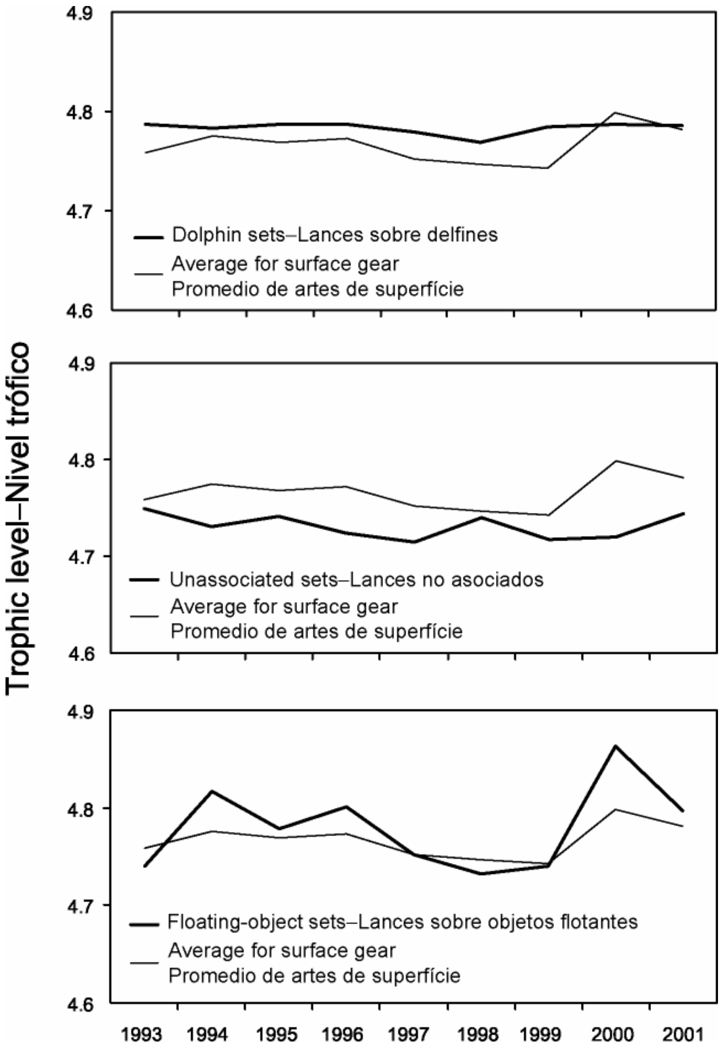


FIGURE 10-2. Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine fishery in the tropical eastern Pacific Ocean.
FIGURA 10-2. Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de la pesquería cerquera en el Océano Pacífico oriental tropical.

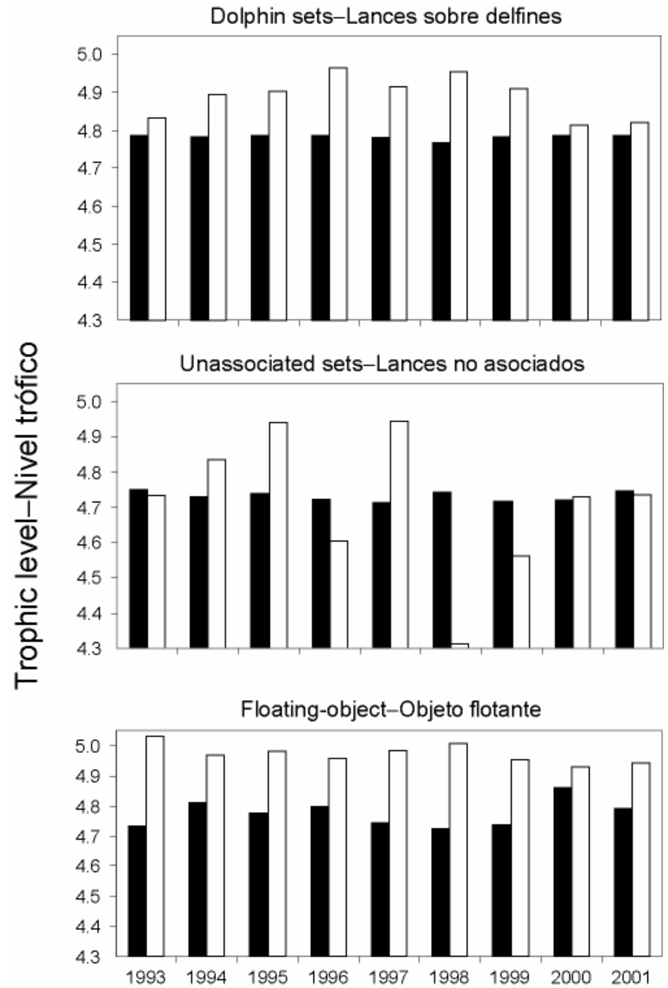


FIGURE 10-3. Trophic level estimates of the retained catches (solid bars) and discarded catches (open bars) by purse-seine fishing mode in the tropical eastern Pacific Ocean.
FIGURA 10-3. Estimaciones del nivel trófico de las capturas retenidas (barras negras) y descartadas (barras blancas) por modalidad de pesca cerquera en el Océano Pacífico oriental tropical.

TABLE 10-1. Preliminary estimates of mortalities of dolphins in 2003, estimates of population abundance pooled for 1986-1990 (from Report of the International Whaling Commission, 43: 477-493), and estimates of relative mortality (with approximate 95-percent confidence intervals), by stock. All the data for 2003 are preliminary.

TABLA 10-1. Estimaciones preliminares de la mortalidad incidental de delfines en la pesquería en 2003, estimaciones de abundancia de poblaciones agrupadas para 1986-1990 (del Informe de la Comisión Ballenera Internacional, 43: 477-493), y estimaciones de mortalidad relativa (con intervalos de confianza de 95% aproximados), por población. Todos los datos de 2003 son preliminares.

Species and stock	Incidental mortality	Population abundance	Relative mortality (%)
Especie y población	**Mortalidad incidental**	**Abundancia de la población**	**Mortalided relative (%)**
Offshore spotted dolphin—Delfín manchado de altamar			
Northeastern—Nororiental	289	730,900	0.04 (0.030, 0.050)
Western/southern—Occidental y sureño	340	1,298,400	0.03 (0.020, 0.037)
Spinner dolphin—Delfín tornillo			
Eastern—Oriental	287	631,800	0.05 (0.028, 0.069)
Whitebelly—Panza blanca	169	1,019,300	0.02 (0.010, 0.022)
Common dolphin—Delfín común			
Northern—Norteño	133	476,300	0.03 (0.016, 0.060)
Central	140	406,100	0.03 (0.018, 0.068)
Southern—Sureño	99	2,210,900	<0.01 (0.003, 0.007)
Other dolphins—Otros delfines[1]	44	2,802,300	<0.01 (0.001, 0.002)
Total	1,501	9,576,000	0.02 (0.014, 0.018)

[1] "Other dolphins" includes the following species and stocks, whose mortalities were as follows: striped dolphins (*Stenella coeruleoalba*), 11; bottlenose dolphins (*Tursiops truncatus*), 4; short-finned pilot whale (*Globicephala macrorhynchus*), 2; and unidentified dolphins, 27.

[1] "Otros delfines" incluye las siguientes especies y poblaciones, con las mortalidades correspondientes: delfín listado (*Stenella coeruleoalba*), 11; tonina (*Tursiops truncatus*), 4; ballena piloto de aletas cortas (*Globicephala macrorhynchus*), 2; y delfines no identificados, 27.