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# THE FISHERY FOR TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN IN 2007

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**IATTC**[1]


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## INTRODUCTION

This report provides a summary of the fishery for tunas in the eastern Pacific Ocean (EPO), assessments of the major stocks of tunas and billfishes that are exploited in the fishery, and an evaluation of the pelagic ecosystem in the EPO, in 2007.

The report is based on data available to the IATTC staff in March 2008. The sections on bluefin (E), and the three sections on billfishes (G, H, I) are essentially the same as the corresponding sections of IATTC Fishery Status Report 5, published in 2007, except for updates of the figures.

All weights of catches and discards are in metric tons (t). In the tables, 0 means no effort or catch <0.5 t; - means no data collected; * means data missing or not available. The following abbreviations are used:

**Species:**

| | |
|---|---|
| ALB | Albacore tuna (*Thunnus alalunga*) |
| BET | Bigeye tuna (*Thunnus obesus*) |
| BIL | Unidentified istiophorid billfishes |
| BKJ | Black skipjack (*Euthynnus lineatus*) |
| BLM | Black marlin (*Makaira indica*) |
| BUM | Blue marlin (*Makaira nigricans*) |
| BZX | Bonito (*Sarda* spp.) |
| CAR | Chondrichthyes, cartilaginous fishes nei[1] |
| CGX | Carangids (Carangidae) |
| DOX | Dorado (*Coryphaena* spp.) |
| MLS | Striped marlin (*Tetrapturus audax*) |
| MZZ | Osteichthyes, marine fishes nei |
| PBF | Pacific bluefin tuna (*Thunnus orientalis*) |
| SFA | Indo-Pacific sailfish (*Istiophorus platypterus)* |
| SKJ | Skipjack tuna (*Katsuwonus pelamis*) |
| SKX | Unidentified elasmobranchs |
| SSP | Shortbill spearfish (*Tetrapturus angustirostris*) |
| SWO | Swordfish (*Xiphias gladius*) |
| TUN | Unidentified tunas |
| YFT | Yellowfin tuna (*Thunnus albacares*) |

**Set types:**

| | |
|---|---|
| DEL | Dolphin |
| NOA | Unassociated school |
| OBJ | Floating object |
| | FLT: Flotsam |
| | FAD: Fish-aggregating device |

[1] not elsewhere included

| **Fishing gears:** | |
|---|---|
| FPN | Trap |
| GN | Gillnet |
| HAR | Harpoon |
| LL | Longline |
| LP | Pole and line |
| LTL | Troll |
| LX | Hook and line |
| OTR | Other[2] |
| NK | Unknown |
| PS | Purse seine |
| RG | Recreational |
| TX | Trawl |

| **Ocean areas:** | |
|---|---|
| EPO | Eastern Pacific Ocean |
| WCPO | Western and Central Pacific Ocean |

| **Stock assessment:** | |
|---|---|
| MSY | Maximum sustainable yield |
| B | Biomass |
| C | Catch |
| CPUE | Catch per unit of effort |
| *F* | Coefficient of fishing mortality |
| *S* | Index of spawning biomass |
| SBR | Spawning biomass ratio |
| SSB | Spawning stock biomass |

| **Flags:** | |
|---|---|
| BLZ | Belize |
| BOL | Bolivia |
| CAN | Canada |
| CHL | Chile |
| CHN | China |
| COK | Cook Islands |
| COL | Colombia |
| CRI | Costa Rica |
| ECU | Ecuador |
| ESP | Spain |
| GTM | Guatemala |
| HND | Honduras |
| JPN | Japan |
| KOR | Republic of Korea |
| MEX | Mexico |
| NIC | Nicaragua |
| PAN | Panama |
| PER | Peru |
| PYF | French Polynesia |
| SLV | El Salvador |
| TWN | Chinese Taipei |
| UNK | Unknown |
| USA | United States of America |
| VEN | Venezuela |
| VUT | Vanuatu |

[2] Used to group known gear types

## A. THE FISHERY FOR TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN



This section summarizes the fisheries for species covered by the IATTC Convention (tunas and other fishes caught by tuna-fishing vessels) in the eastern Pacific Ocean (EPO). The most important of these are the scombrids (Family Scombridae), which include tunas, bonitos, seerfishes, and mackerels. The principal species of tunas caught are yellowfin, skipjack, bigeye, and albacore, with lesser catches of Pacific bluefin, black skipjack, and frigate and bullet tunas; other scombrids, such as bonitos and wahoo, are also caught.

This report also covers other species caught by tuna-fishing vessels in the EPO: billfishes (swordfish, marlins, shortbill spearfish, and sailfish) carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes.

Most of the catches are made by the purse-seine and longline fleets; the pole-and-line fleet and various artisanal and recreational fisheries account for a small percentage of the total catches.

Detailed data are available for the purse-seine and pole-and-line fisheries; the data for the longline, artisanal, and recreational fisheries are incomplete.

The IATTC Regional Vessel Register contains details of vessels authorized to fish for tunas in the EPO. The IATTC has detailed records of most of the purse-seine and pole-and-line vessels that fish for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO. The Register is incomplete for small vessels. It contains records for most large (overall length >24 m) longline vessels that fish in the EPO and in other areas.

The data in this report are derived from various sources, including vessel logbooks, observer data, unloading records provided by canners and other processors, export and import records, reports from governments and other entities, and estimates derived from the species and size composition sampling program.

## 1. CATCHES AND LANDINGS OF TUNAS, BILLFISHES, AND ASSOCIATED SPECIES

Estimating the total catch of a species of fish is difficult, for various reasons. Some fish are discarded at sea, and the data for some gear types are incomplete. Data for fish discarded at sea by purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993, which allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the retained catch) are based principally on data from unloadings. Beginning with Fishery Status Report 3, which reports on the fishery in 2004, the unloading data for purse-seine and pole-and-line vessels have been adjusted, based on the species composition estimates for yellowfin, skipjack, and bigeye tunas. The current species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-

2007 are adjusted, based on estimates obtained for each year, by flag. The catch data for the previous years were adjusted by applying the average ratio by species from the 2000-2004 estimates, by flag, and summing over all flags. This has tended to increase the estimated catches of bigeye and decrease those of yellowfin and/or skipjack. These adjustments are all preliminary, and may be improved in the future. All of the purse-seine and pole-and-line data for 2007 are preliminary.

Data on the retained catches of most of the larger longline vessels are obtained from the governments of the nations that fish for tunas in the EPO. Longline vessels, particularly the larger ones, direct their effort primarily at bigeye, yellowfin, albacore, or swordfish. Data from smaller longliners, artisanal vessels, and other vessels that fish for tunas, billfishes, dorado, and sharks in the EPO were gathered either directly from the governments, from logbooks, or from reports published by the governments. Data for the western and central Pacific Ocean (WCPO) were provided by the Ocean Fisheries Programme of the Secretariat of the Pacific Community (SPC). All data for catches in the EPO by longlines and other gears for 2006 and 2007 are preliminary.

The data from all of the above sources are compiled in a database by the IATTC staff and summarized in this report. In recent years, the IATTC staff has increased its effort toward compiling data on the catches of tunas, billfishes, and other species caught by other gear types, such as trollers, harpooners, gillnetters, and recreational vessels. The estimated total catches from all sources mentioned above of yellowfin, skipjack, and bigeye in the entire Pacific Ocean are shown in Table A-1, and are discussed further in the sections below.

Estimates of the annual retained and discarded catches of tunas and other species taken by tuna-fishing vessels in the EPO during 1978-2007 are shown in Table A-2. The catches of tunas and bonitos by all gears during 2003-2007, by gear and flag, are shown in Tables A-3a-e, and the purse-seine and pole-and-line catches and the recreational landings of tunas and bonitos during 2006-2007 are summarized by flag in Tables A-4a and A-4b. There were no restrictions on fishing for tunas in the EPO during 1988-1997, but the catches of most species have been affected by restrictions on fishing during some or all of the last six months of 1998-2007. Furthermore, regulations placed on purse-seine vessels directing their effort at tunas associated with dolphins have affected the way these vessels operate, especially since the late 1980s, as discussed in Section 3.

The catches have also been affected by climate perturbations, such as the major El Niño events that occurred during 1982-1983 and 1997-1998. These events made the fish less vulnerable to capture by purse seiners due to the greater depth of the thermocline, but had no apparent effect on the longline catches. Yellowfin recruitment tends to be greater after an El Niño event. The effects of El Niño events and other environmental conditions on the fisheries of the EPO are discussed further in Section J.5, **PHYSICAL ENVIRONMENT**.

## 1.1. Catches by species

### 1.1.1. Yellowfin tuna

The annual catches of yellowfin during 1978-2007 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased during this period. In the EPO, the El Niño event of 1982-1983 led to a reduction in the catches in those years, whereas the catches in the WCPO were apparently not affected. Although the El Niño episode of 1997-1998 was greater in scope, it did not have the same effect on the yellowfin catches in the EPO. The catch of yellowfin in the EPO, in 2002, 444 thousand t, was the greatest on record, but in 2004, 2005, and 2006 it decreased substantially, and the catch during 2007, 171 thousand t, was the lowest since 1984. In the WCPO, the catches of yellowfin reached 353 thousand t in 1990, peaked at 457 thousand t in 1998, and remained high through 2003; they fell to 362 thousand t in 2004, increased in 2005 to 436 thousand t, and in 2006 fell to 400 thousand t.

The annual retained catches of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1978-2007 are shown in Table A-2a. The average annual retained catch during 1992-2006 was 271 thousand t (range: 167 to 413 thousand t). The preliminary estimate of the retained catch in 2007, 170 thousand t, was 2% greater than in 2006, but 37% less than the average for 1992-2006. The average amount of yellowfin discarded at sea during 1993-2006 was about 2% of the total purse-seine catch (retained catch plus discards) of yellowfin (range: 1 to 3%) (Table A-2a).

The annual retained catches of yellowfin in the EPO by longliners during 1978-2007 are shown in Table A-2a. During 1992-2006 they remained relatively stable, averaging about 20 thousand t (range: 9 to 30 thousand t), or about 7% of the total retained catches of yellowfin. Yellowfin are also caught by recreational vessels, as incidental catch in gillnets, and by artisanal fisheries. Estimates of these catches are shown in Table A-2a, under "Other gears" (OTR); during 1992-2006 they averaged about 1 thousand t.

### 1.1.2. Skipjack tuna

The annual catches of skipjack during 1978-2007 are shown in Table A-1. Most of the skipjack catch in the Pacific is taken in the WCPO. The greatest reported catch in the WCPO, about 1.5 million t, occurred in 2006, and the greatest total catch in the EPO, 312 thousand t, also occurred in 2006.

The annual retained catches of skipjack in the EPO by purse-seine and pole-and-line vessels during 1978-2007 are shown in Table A-2a. During 1992-2006 the annual retained catch averaged 172 thousand t (range 73 to 298 thousand t). The preliminary estimate of the retained catch in 2007, 211 thousand t, is 22% greater than the average for 1992-2006, and 29% less than the previous record-high retained catch of 2006. The average amount of skipjack discarded at sea during 1993-2006 was about 11% of the total catch of skipjack (range: 4 to 19%) (Table A-2a).

Small amounts of skipjack are caught with longlines and other gears (Table A-2a).

### 1.1.3. Bigeye tuna

The annual catches of bigeye during 1978-2007 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased, but with considerable fluctuation. The catches in the EPO reached 105 thousand t in 1986, and have fluctuated between about 73 and 148 thousand t since then, with the greatest catch in 2000. In the WCPO the catches of bigeye increased to more than 77 thousand t during the late 1970s, decreased during the 1980s, and then increased, with lesser fluctuations, until 1999, when the catches reached more than 115 thousand t. Catches of bigeye in the WCPO increased significantly in 2004 to 146 thousand t. In 2005 and 2006 the catches of bigeye in the WCPO were 132 and 114 thousand t, respectively.

Prior to 1994, the average annual retained catch of bigeye taken by purse-seine vessels in the EPO was about 8 thousand t (range 1 to 22 thousand t) (Table A-2a). Following the development of fish-aggregating devices (FADs), placed in the water by fishermen to aggregate tunas, the annual retained catches of bigeye increased from 35 thousand t in 1994 to between 44 and 95 thousand t during 1995-2000. A preliminary estimate of the retained catch in the EPO in 2007 is 61 thousand t. The average amount of bigeye discarded at sea during 1993-2006 was about 5% of the purse-seine catch of the species (range: 2 to 12%). Small amounts of bigeye have been caught in some years by pole-and-line vessels, as shown in Table A-2a.

During 1978-1993, prior to the increased use of FADs and the resulting greater catches of bigeye by purse-seine vessels, the longline catches of bigeye in the EPO ranged from 46 to 104 thousand t (average: 74 thousand t) about 89%, on average, of the retained catches of this species from the EPO. During 1994-2006 the annual retained catches of bigeye by the longline fisheries ranged from about 35 to 74 thousand t (average: 53 thousand t), an average of 45% of the total catch of bigeye in the EPO (Table A-2a). The preliminary estimate of the longline catch in the EPO in 2007 is 26 thousand t (Table A-2a).

Small amounts of bigeye are caught by other gears, as shown in Table A-2a.

#### 1.1.4. Bluefin tuna

The catches of Pacific bluefin in the entire Pacific Ocean, by flag and gear, are shown in Table A-5. The data, which were obtained from the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), are reported by fishing nation or entity, regardless of the area of the Pacific Ocean in which the fish were caught.

The catches of Pacific bluefin in the EPO during 1978-2007, by gear, are shown in Table A-2. During 1992-2006 the annual retained catch of bluefin from the EPO by purse-seine and pole-and-line vessels averaged 3,500 t (range 600 t to 10 thousand t). The preliminary estimate of the retained catch of bluefin in 2007, 4,200 t, is 800 t greater than the average for 1992-2006. Small amounts of bluefin are discarded at sea by purse-seine vessels (Table A-2a).

#### 1.1.5. Albacore tuna

The catches of albacore in the entire Pacific Ocean, by gear and area (north and south of the equator) are shown in Table A-6. The catches of albacore in the EPO, by gear, are shown in Table A-2a. A significant portion of the albacore catch is taken by troll gear, included under "Other gears" (OTR) in Table A-2a. The catch data were obtained from IATTC data for the EPO and from data compiled by the SPC for the WCPO.

#### 1.1.6. Other tunas and tuna-like species

While yellowfin, skipjack, and bigeye tunas comprise the most significant portion of the retained catches of the purse-seine and pole-and-line fleets in the EPO, other tunas and tuna-like species, such as black skipjack, bonito, wahoo, and frigate and bullet tunas, contribute to the overall harvest in this area. The estimated annual retained and discarded catches of these species during 1978-2007 are presented in Table A-2a. The catches reported in the unidentified tunas category (TUN) in Table A-2a contain some catches reported by species (frigate or bullet tunas, wahoo) along with the unidentified tunas. The total retained catch of these other species by these fisheries was about 19 thousand t in 2007, which is greater than the 1992-2006 annual average retained catch of about 3 thousand t (range: 500 t to 9 thousand t).

Black skipjack are also caught by other gears in the EPO, mostly by coastal artisanal fisheries. Bonitos are also caught by artisanal fisheries, and have been reported as catch by longline vessels in some years.

#### 1.1.7. Billfishes

Catch data for billfishes (swordfish, blue marlin, black marlin, striped marlin, shortbill spearfish, and sailfish) are shown in Table A-2b.

Swordfish are caught in the EPO with large-scale and artisanal longline gear, gillnets, harpoons, and occasionally with recreational gear. The average annual longline catch of swordfish during 1992-2006 was 10 thousand t, but during 2002-2006 was about 14 thousand t. It is not clear whether this is due to increased abundance of swordfish or increased effort directed toward that species.

Other billfishes are caught with large-scale and artisanal longline gear and recreational gear. The average annual longline catches of blue marlin and striped marlin during 1992-2006 were about 5 thousand and 3 thousand t, respectively. Smaller amounts of other billfishes are taken by longline.

Unfortunately, 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.

Small amounts of billfishes are caught by purse seiners, but these are considered to be discarded, although some may be landed but not reported. These data are also included in Table A-2b.

#### 1.1.8. Other species

Data on the catches and discards of carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes caught in the EPO are shown in Table A-2c.

Dorado are unloaded mainly in ports in South and Central America. Although the catches are greater than 10 thousand t in some years, the gear types used are often not reported.

### 1.2. Distributions of the catches of tunas

#### 1.2.1. Purse-seine catches

The average annual distributions of the purse-seine catches of yellowfin, skipjack, and bigeye, by set type, in the EPO during 1997-2006, are shown in Figures A-1a, A-2a, and A-3a, and preliminary estimates for 2007 are shown in Figures A-1b, A-2b, and A-3b. The catch of yellowfin in 2007, as in 2006, was significantly less than the average of 1997-2006. Yellowfin catches from dolphin sets in the Northern areas off Mexico and Central America have been significantly lower for the past several years. The yellowfin catch off South America in 2007 was also less than the average of 1997-2006. The skipjack catch in 2007 was less than the average of 1997-2006. Significant catches of skipjack were made throughout the year from about 5°N to 15°S, with large catches recorded in the nearshore areas off South America. As had been the case during 2004-2006, the catches of skipjack in the inshore areas off Mexico were greater, possibly due to changes in fishing strategy due to poor yellowfin fishing. The bigeye catch in 2007 was less than that of 2006, but greater than the 1997-2006 average. Bigeye are not often caught north of about 7°N. The catches of bigeye have decreased in the inshore areas off South America for several years. With the development of the fishery for tunas associated with FADs, the relative importance of the inshore areas has decreased, while that of the offshore areas has increased. Most of the bigeye catches are taken in sets on FADs between 5°N and 5°S.

#### 1.2.2. Longline catches

Data on the spatial and temporal distributions of the catches in the EPO by the distant-water longline fleets of China, Chinese Taipei, French Polynesia, Japan, the Republic of Korea, Spain, the United States, and Vanuatu are maintained in databases of the IATTC. Bigeye and yellowfin tunas make up the majority of the catches by most of these vessels. The distributions of the catches of bigeye and yellowfin tunas in the Pacific Ocean by longline vessels during 2002-2006 are shown in Figure A-4. Data for the Japanese longline fishery in the EPO during 1956-1997 are available in IATTC Bulletins describing that fishery.

### 1.3. Size compositions of the catches of tunas

#### 1.3.1. Purse-seine, pole-and-line, and recreational fisheries

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 populations for various purposes, including the integrated modeling that the staff has employed during the last several years. The results of such studies have been described in several IATTC Bulletins, in its Annual Reports for 1954-2002, and in its Stock Assessment Reports.

Length-frequency samples of yellowfin, skipjack, bigeye, Pacific bluefin, and, occasionally, black skipjack from the 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 and in IATTC Stock Assessment Reports 2 and 4. Briefly, the fish in a well of a purse-seine 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 A-5), based on the staff's most recent stock assessments.

Data for fish caught during the 2002-2007 period are presented in this report. Two sets of length-frequency histograms are presented for each species, except bluefin and black skipjack; the first shows the data by stratum (gear type, set type, and area) for 2007, and the second shows the combined data for each year of the 2002-2007 period. For bluefin, the histograms show the 2002-2007 catches by commercial and recreational gear combined. For black skipjack, the histograms show the 2002-2007 catches by commercial gear. Only a small amount of catch was taken by pole-and-line vessels in 2007, and no samples were obtained from these vessels.

For stock assessments of yellowfin, nine purse-seine fisheries (four associated with floating objects, three associated with dolphins, and two unassociated) and one pole-and-line fishery are defined (Figure A-5). The last fishery includes all 13 sampling areas. Of the 805 wells sampled, 569 contained yellowfin. The estimated size compositions of the fish caught during 2007 are shown in Figure A-6a. The majority of the yellowfin catch was taken in sets associated with dolphins and in unassociated sets. Most of the larger yellowfin (>100 cm) were caught throughout the year in the Inshore dolphin fishery, in the second, third and fourth quarters in the Northern dolphin-associated fishery, and during the second quarter in the Southern dolphin-associated fishery. Larger yellowfin were also caught during the second quarter in the Northern unassociated fishery, and during the fourth quarter in the Southern unassociated fishery. A small amount of large yellowfin was taken in the Southern floating-object fishery during the second and third quarters. A mode of smaller yellowfin, ranging from 40 to 60 cm in length, was evident in all the floating-object fisheries during the year, in the Southern unassociated fishery during the second quarter, and in the Northern unassociated fishery during the third quarter. Small amounts of yellowfin in the 40- to 60 cm size range were taken by pole-and-line vessels, mostly during the third and fourth quarters.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2002-2007 are shown in Figure A-6b. The average weights of the yellowfin caught in 2007 were greater than those of 2006, but considerably less than those of the 2002-2005 period.

For stock assessments of skipjack, seven purse-seine fisheries (four associated with floating objects, two unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last two fisheries include all 13 sampling areas. Of the 805 wells sampled, 602 contained skipjack. The estimated size compositions of the fish caught during 2007 are shown in Figure A-7a. Large amounts of skipjack in the 40- to 50-cm size range were caught in all of the floating-object fisheries, primarily during the second, third, and fourth quarters of 2007, and in the Southern unassociated fishery, primarily during the first and fourth quarters. Larger skipjack in the 50- to 70-cm size range were caught primarily during the first, second, and third quarters in the unassociated fishery in the South. Lesser amounts of larger skipjack were taken in the Inshore floating-object fishery in the first quarter, and in the Equatorial floating-object fishery in the fourth quarter. Negligible amounts of skipjack were caught by pole-and-line vessels.

The estimated size compositions of the skipjack caught by all fisheries combined during 2002-2007 are shown in Figure A-7b. The average weight of skipjack in 2007, 2.3 kg, was the same as that of 2006, but less than the average weights for 2002-2005.

For stock assessments of bigeye, six purse-seine fisheries (four associated with floating objects, one unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last three fisheries include all 13 sampling areas. Of the 805 wells sampled, 219 contained bigeye. The estimated size compositions of the fish caught during 2007 are shown in Figure A-8a. In 2000 the majority of the catch was taken in floating-object sets in the Equatorial area, whereas from 2001 to 2003 the majority of the bigeye catch was taken in sets on floating objects in the Southern area. In 2007, as in 2004-2006, nearly equal amounts of bigeye were taken in the Northern, Equatorial, and Southern floating-object fisheries. Small amounts of bigeye were caught in unassociated sets, and in floating-object sets in the Inshore area. 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 2002-2007 are shown in Figure A-8b. The average weight of the fish was greatest in 2000, when the greatest catch of bigeye was taken. From 2002 to 2005 the average weights of bigeye were fairly constant, but in 2006 and 2007 they were considerably less. The smaller bigeye (40-60 cm) were caught primarily in the Northern, Equatorial, and Southern floating-object fisheries throughout the year, while most of the larger fish (>80 cm) were caught throughout the year in the Southern floating-object fishery.

Pacific bluefin are caught by purse-seine and recreational gear off California and Baja California from about 23°N to 35°N, with most of the catch being taken during May through October. During 2007 bluefin were caught between 26°N and 32°N from May through August. The majority of the catches of bluefin by both commercial and recreational vessels were taken during June and July. In the past, the sizes of the fish in the commercial and recreational catches have been reported separately. During 2004-2007, however, small sample sizes made it infeasible to estimate the size compositions separately. Therefore, the sizes of the fish in the commercial and recreational catches of bluefin were combined for each year of the 2002-2007 period. The estimated size compositions are shown in Figure A-9.

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 catches are discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. Seventeen samples of black skipjack were taken in 2007; the estimated size compositions are shown in Figure A-10.

#### 1.3.2. Longline fishery

The estimated size compositions of the catches of yellowfin and bigeye by the Japanese longline fishery in the EPO during 2002-2006 are shown in Figures A-11 and A-12. The average weights of both yellowfin and bigeye taken by that fishery have remained about the same throughout its existence. Information on the size compositions of fish caught by the Japanese longline fishery in the EPO during 1958-1997 is available in IATTC Bulletins describing that fishery.

### 1.4. Catches of tunas and bonitos, by flag and gear

The annual retained catches of tunas and bonitos in the EPO during 2003-2007, by flag and gear, are shown in Tables A-3a-e. These tables include all of the known catches of tunas and bonitos compiled from various sources, including vessel logbooks, observer data, unloading records provided by canners and other processors, export and import records, estimates derived from the species and size composition sampling program, reports from governments and other entities, and estimates derived from the species- and size-composition sampling program. Similar information on tunas and bonitos prior to 2001, and historic data for tunas, billfishes, sharks, carangids, dorado, and miscellaneous fishes are available on the IATTC web site. The purse-seine and pole-and-line catches of tunas and bonitos in 2006 and 2007, by flag, are summarized in Tables A-4a and A-4b (top panels).

### 1.5. Landings of tunas and bonitos by purse-seine and pole-and-line vessels

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 for 2006 and 2007 (Tables A-4a and A-4b, lower panels) indicate that, of the 469 thousand t of tunas and bonitos landed in 2007, 49% was landed in Ecuador and 22% in Mexico. Other countries with significant landings of tunas and bonitos caught in the EPO included Colombia and Venezuela with 11% and 4% respectively. 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.

## 2. EFFORT

### 2.1. Purse seine

Estimates of the numbers of purse-seine sets of each type (associated with dolphins, associated with floating objects, and unassociated) in the EPO during the 1990-2007 period, and the retained catches of these sets, are shown in Table A-7 and in Figure 1. The estimates for vessels ≤363 t carrying capacity were calculated from logbook data in the IATTC statistical data base, and those for vessels >363 t carrying capacity were calculated from the observer data bases of the IATTC, Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, the United States, and Venezuela. The greatest numbers of sets associated with floating objects and unassociated sets 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 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 widely used for about 13 years, and their relative importance has increased during this period, while that of flotsam has decreased, as shown by the data in Table A-8.

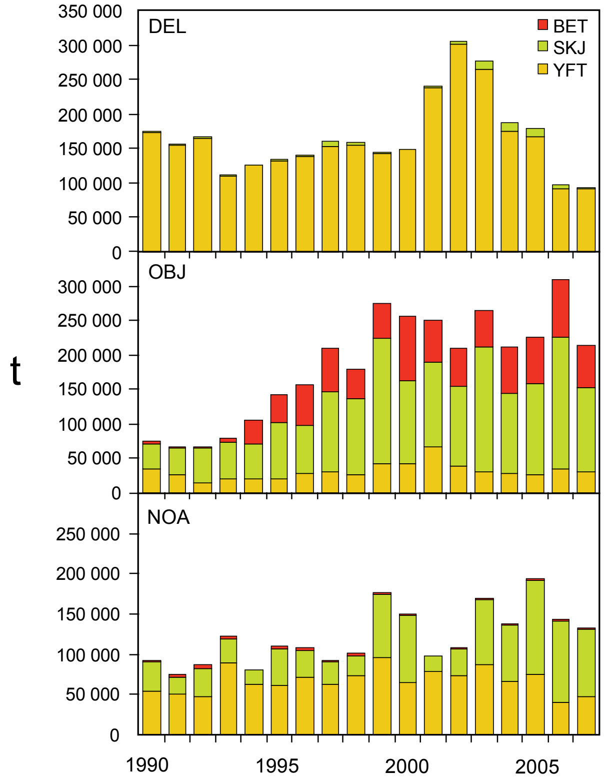


**Figure 1.** Purse-seine catches of tunas, by species and set type, 1990-2007

### 2.2. Longline

The reported nominal fishing effort (in thousands of hooks) by longline vessels in the EPO, and their catches of the predominant tuna species, are shown in Table A-9.

## 3. THE FLEETS

### 3.1. The purse-seine and pole-and-line fleets

The IATTC staff maintains detailed records of gear, flag, and fish-carrying capacity for most of the vessels that fish with purse-seine or pole-and-line gear for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO. The fleet described here includes purse-seine and pole-and-line vessels that have fished all or part of the year in the EPO for any of 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.

Since 2000, the IATTC has used well volume, in cubic meters ($m^3$), instead of weight, in metric tons (t), 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 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 was converted to cubic meters.

Until about 1960 fishing for tunas in the EPO was dominated by pole-and-line vessels operating in 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 fishery was dominated by these vessels. From 1961 to 2007 the number of pole-and-line vessels decreased from 93 to 4, and their total well volume from about 11 thousand to about 380 $m^3$. During the same period the

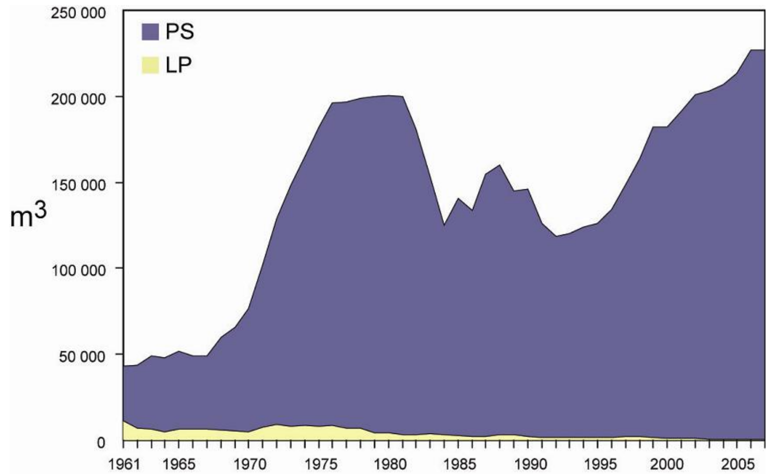


**Figure 2.** Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2007

number of purse-seine vessels increased from 125 to 227, and their total well volume from about 32 thousand to about 227 thousand m$^3$, an average of about 1,000 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 195 thousand m$^3$, an average of about 700 m$^3$ per vessel (Table A-10; Figure 2).

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 of purse-seine and pole-and-line vessels 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 122 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 117 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 2007 was 227 thousand m$^3$.

The 2006 and preliminary 2007 data for numbers and total well volumes of purse-seine and pole-and-line vessels that fished for tunas in the EPO are shown in Tables A-11a and A-11b. During 2007, the fleet was dominated by vessels operating under the Ecuadorian and Mexican flags, with about 26% of the total well volume each; they were followed by Panama (16%), Venezuela (13%), Colombia (6%), El Salvador, Nicaragua, and Spain (3% each), and Vanuatu (2%) .

The cumulative capacity at sea during 2007 is compared to those of the previous four years in Figure 3.

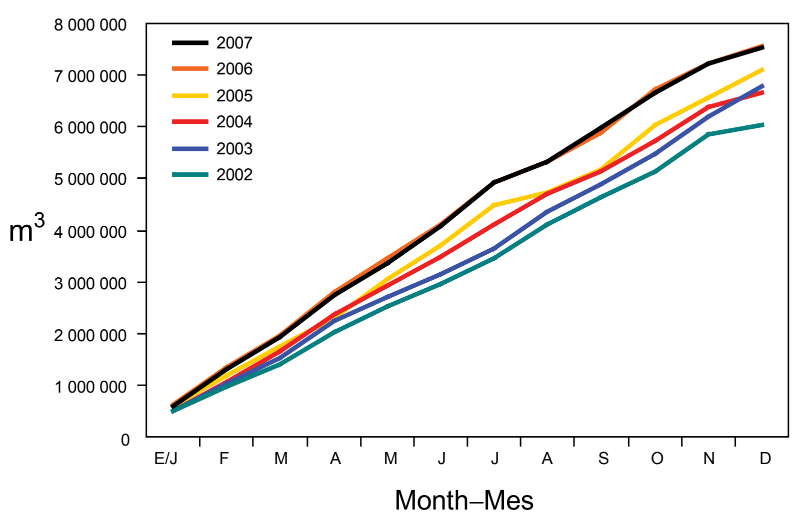


**Figure 3.** Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2002-2007

The monthly average, minimum, and maximum total well volumes at sea (VAS), in thousands of cubic meters, of purse-seine and pole-and-line vessels that fished for tunas in the EPO during 1997-2006, and the 2007 values, are shown in Table A-12. 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 1998-2007, so the VAS values for September-December 2007 are not comparable to the average VAS values for those months of 1997-2006. The average VAS values for 1997-2006 and 2007 were 116 thousand $m^3$ (60% of total capacity) and 146 thousand $m^3$ (64% of total capacity), respectively.

### 3.2. Other fleets of the EPO

Information on other types of vessels that fish for tunas in the EPO is available on the IATTC's Regional Vessel Register, on the IATTC web site. The Register is incomplete for small vessels. In some cases, particularly for large longline vessels, the Register contains information for vessels authorized to fish not only in the EPO, but also in other oceans, and which may not have fished in the EPO during 2007, or ever.

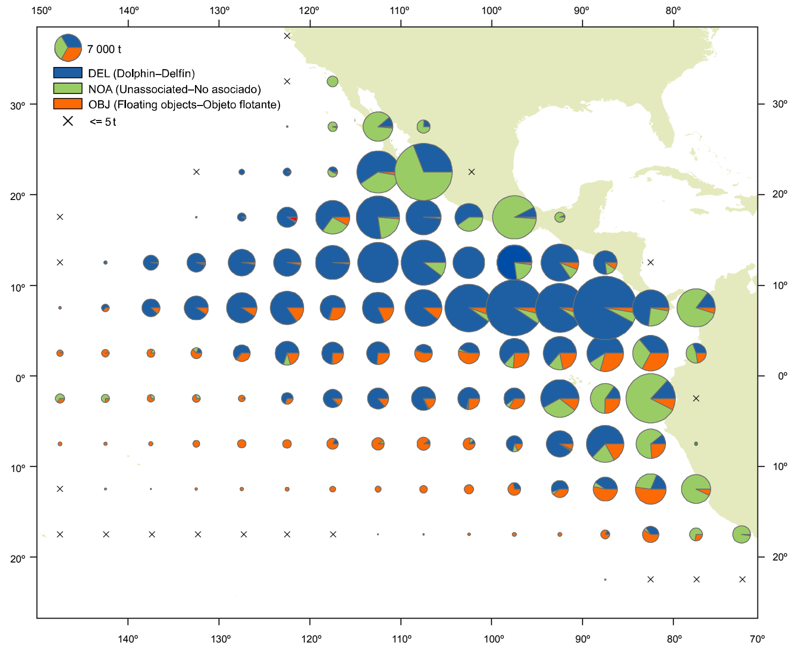


**FIGURE A-1a.** Average annual distributions of the purse-seine catches of yellowfin, by set type, 1997-2006. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
**FIGURA A-1a.** Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 1997-2006. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

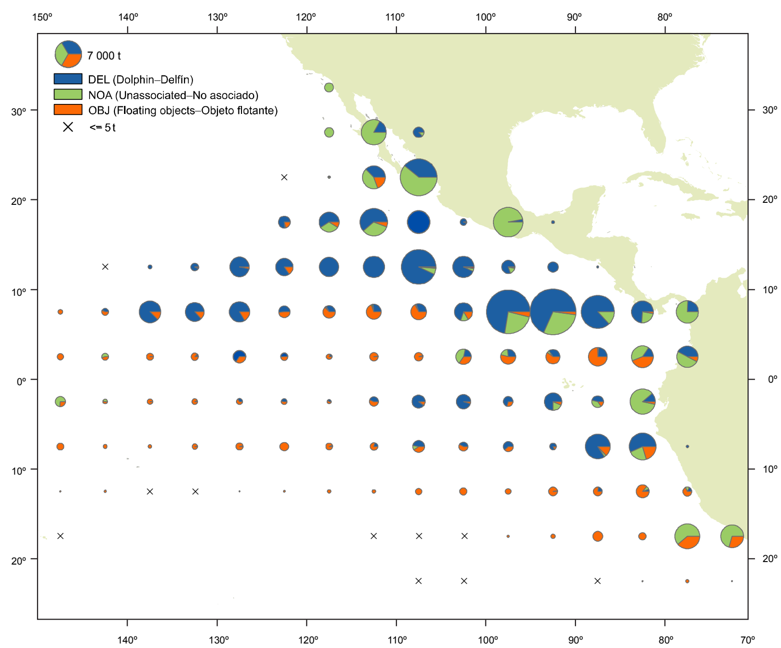


**FIGURE A-1b.** Annual distributions of the purse-seine catches of yellowfin, by set type, 2007. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
**FIGURA A-1b.** Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2007. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

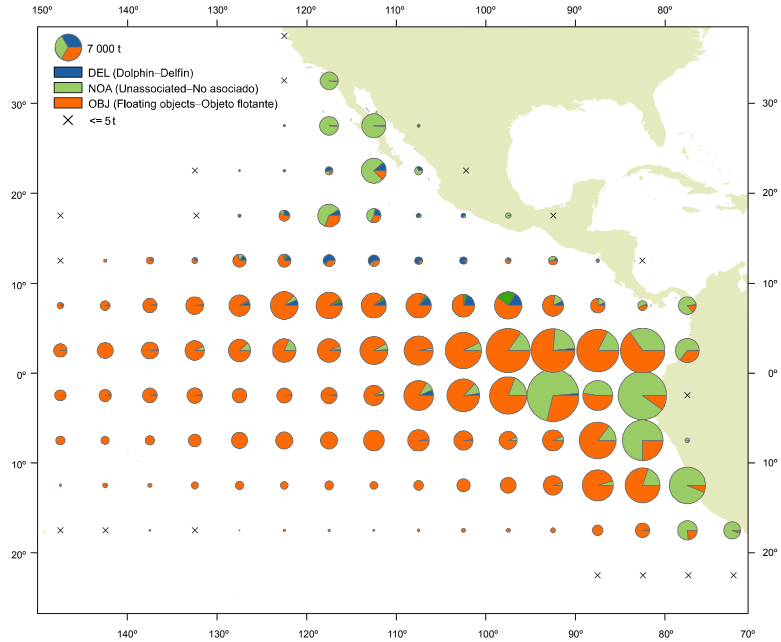


**FIGURE A-2a.** Average annual distributions of the purse-seine catches of skipjack, by set type, 1997-2006. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
**FIGURA A-2a.** Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 1997-2006. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

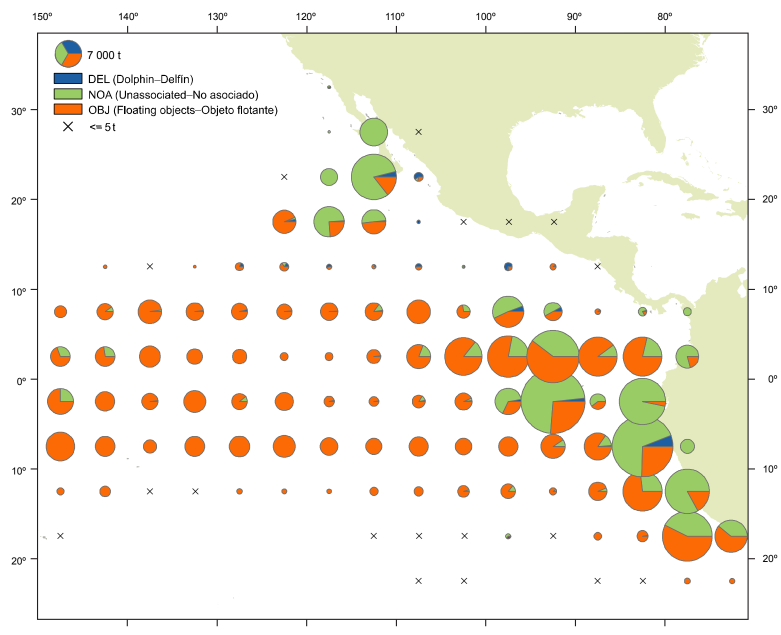


**FIGURE A-2b.** Annual distributions of the purse-seine catches of skipjack, by set type, 2007. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
**FIGURA A-2b.** Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2007. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

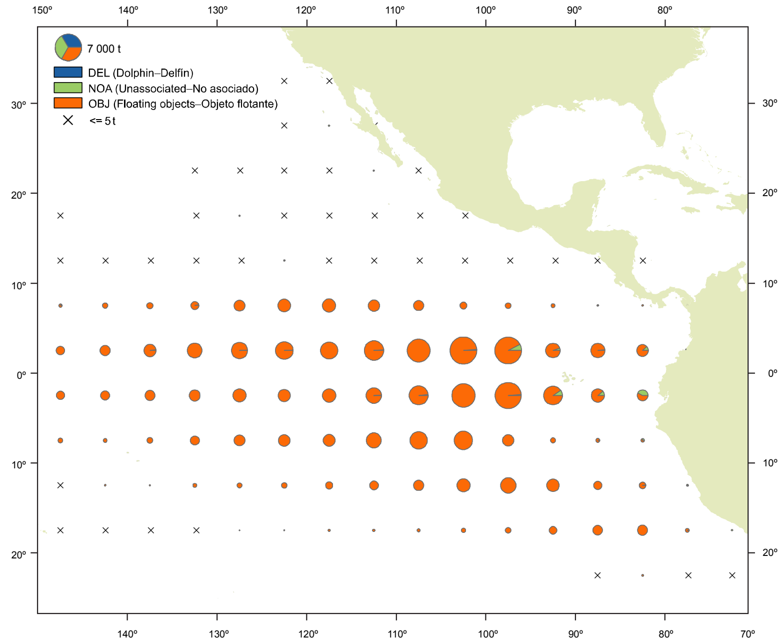


**FIGURE A-3a.** Average annual distributions of the purse-seine catches of bigeye, by set type, 1997-2006. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
**FIGURA A-3a.** Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 1997-2006. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

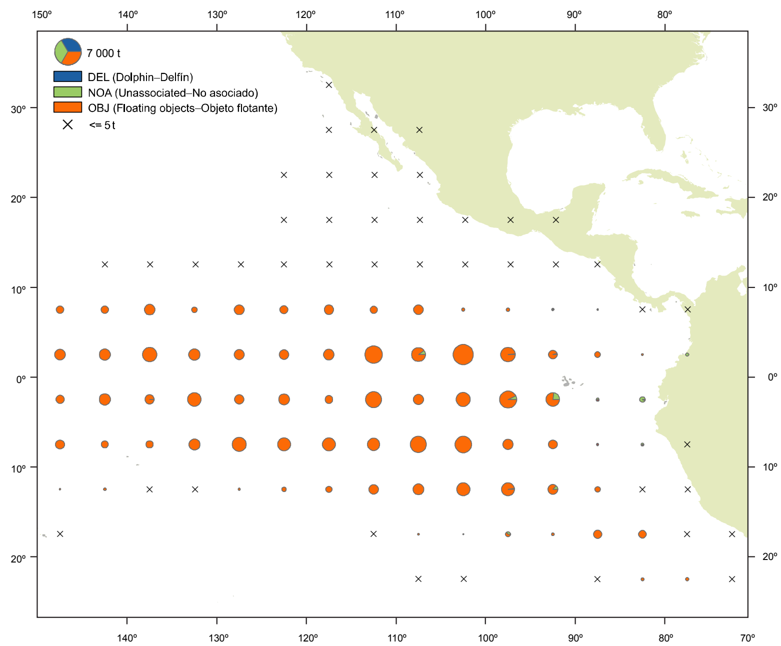


**FIGURE A-3b.** Annual distributions of the purse-seine catches of bigeye, by set type, 2007. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
**FIGURA A-3b.** Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2007. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

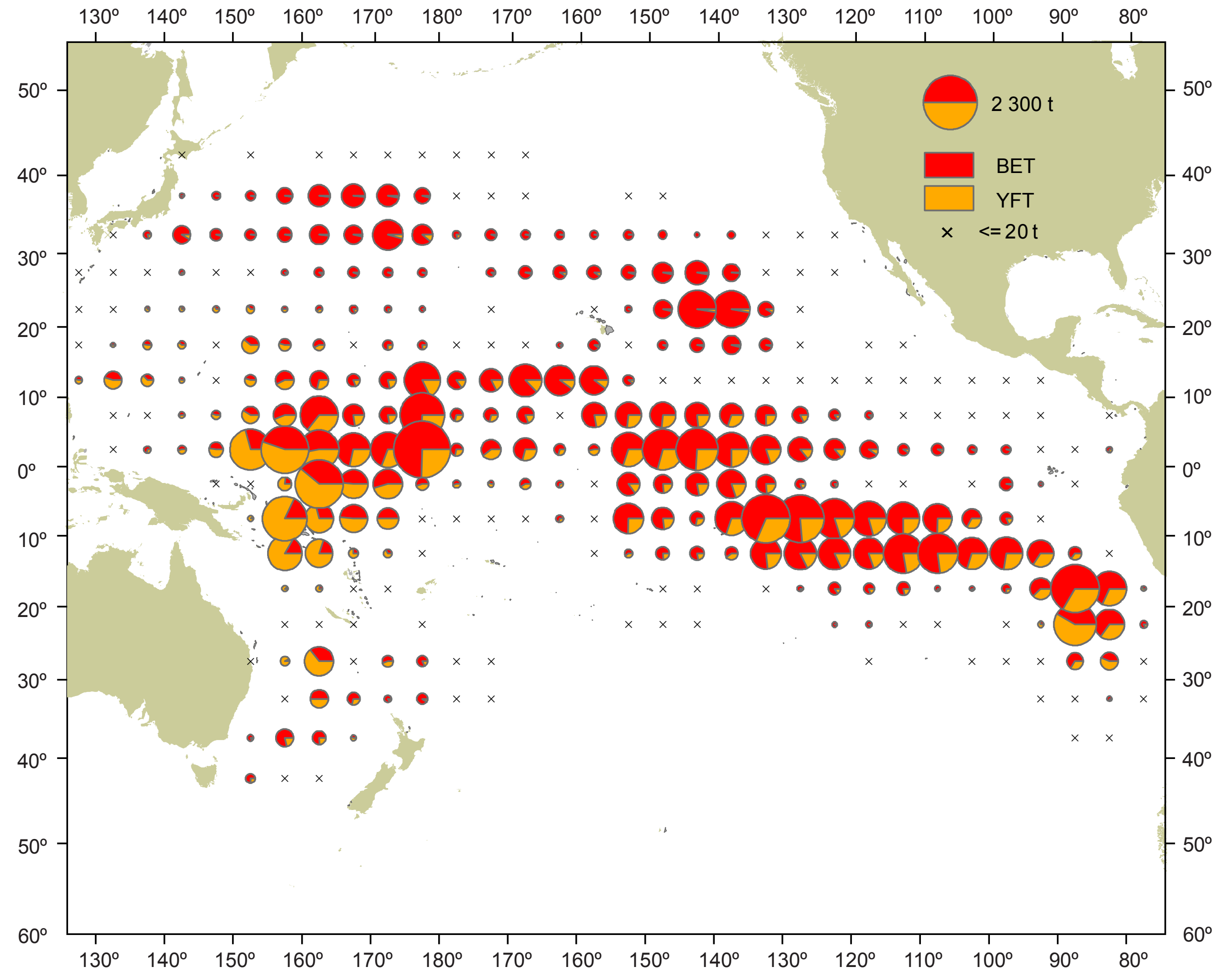


**FIGURE A-4.** Distributions of the average annual catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by Japanese and Korean longline vessels, 2002-2006. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.

**FIGURA A-4.** Distribución de las capturas anuales medias de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por buques palangreros de Corea y Japón, 2002-2006. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

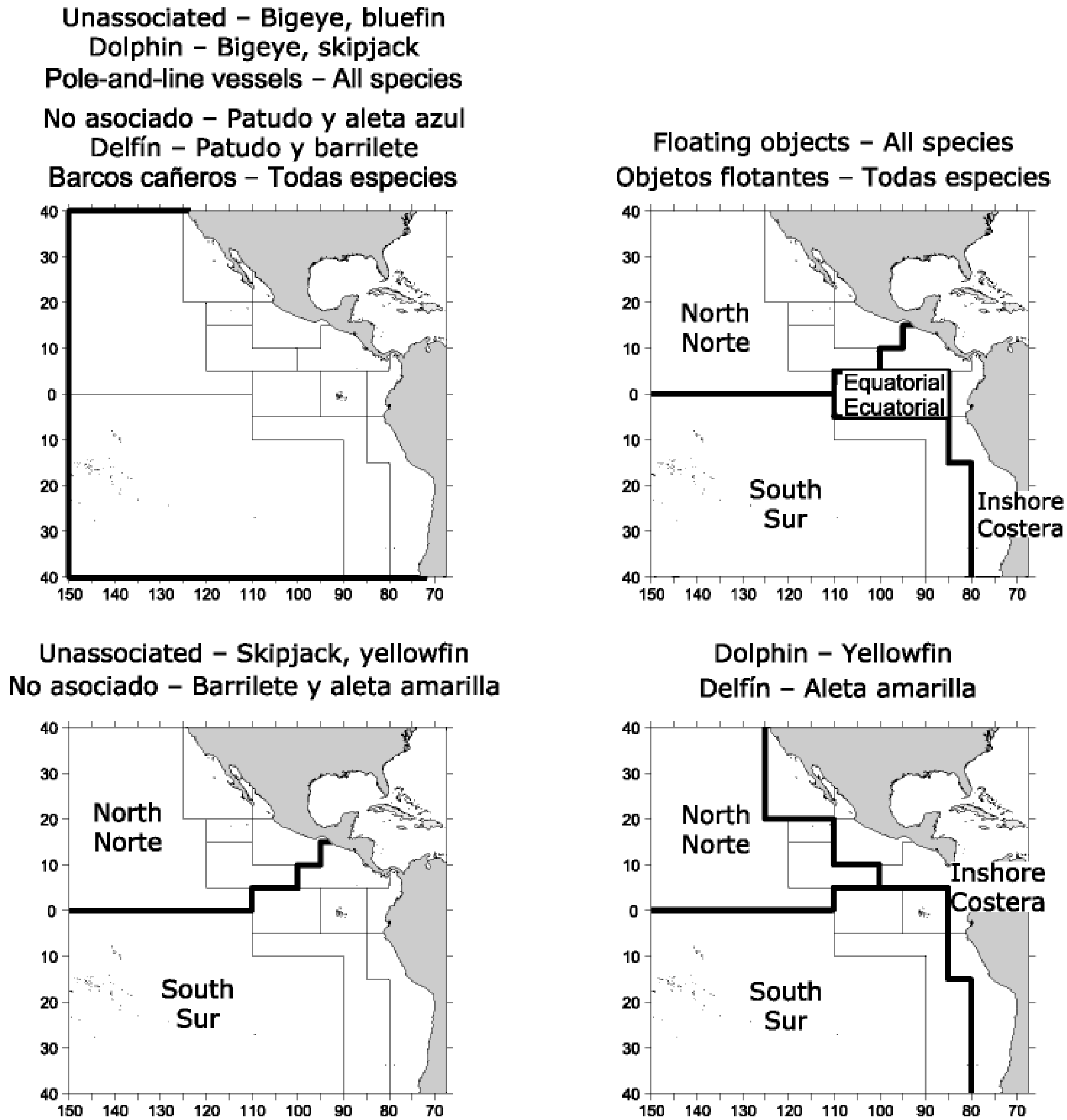


**FIGURE A-5.** The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

**FIGURA A-5.** 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.

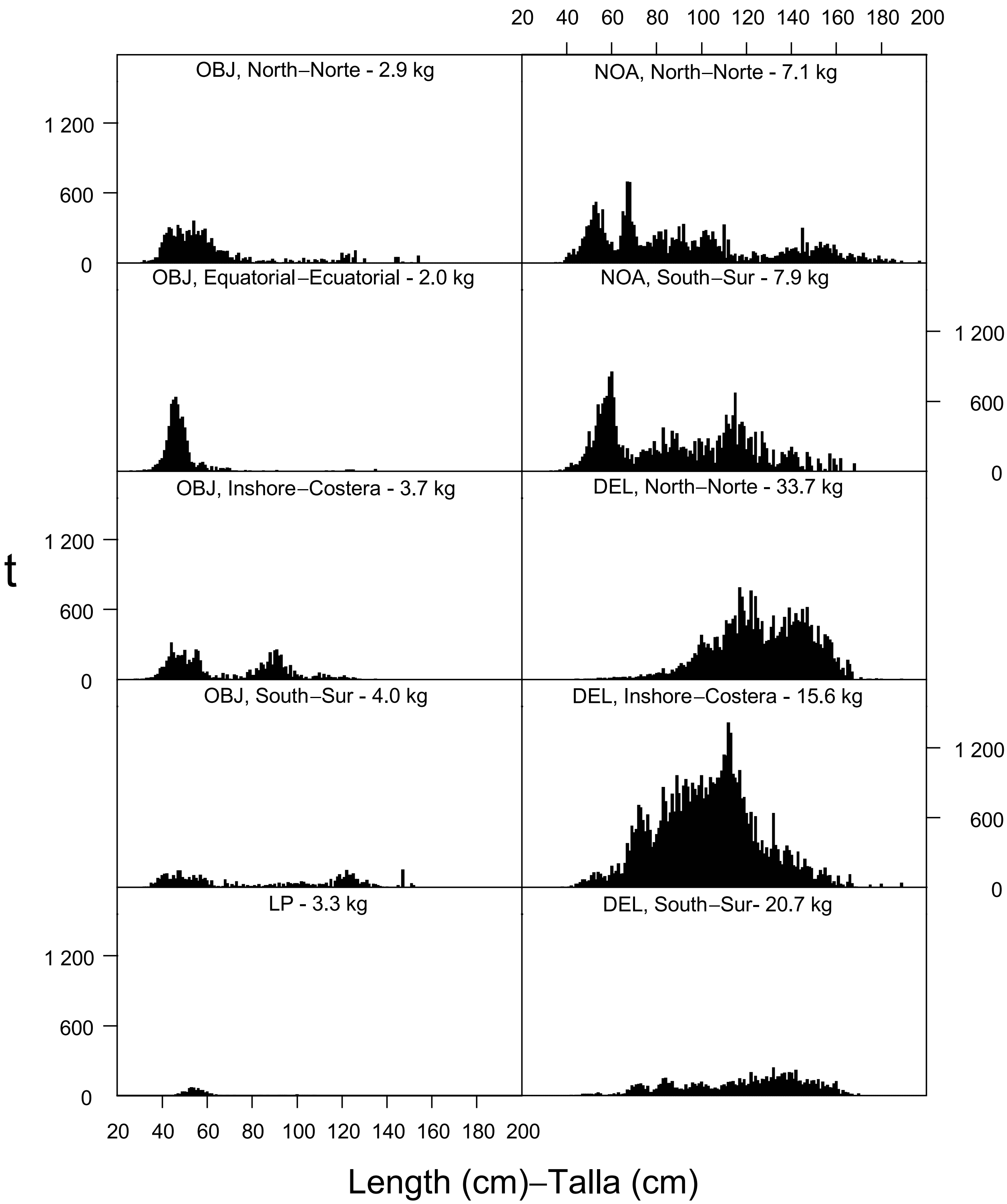


**FIGURE A-6a.** Estimated size compositions of the yellowfin caught in the EPO during 2007 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

**FIGURA A-6a.** Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2007 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

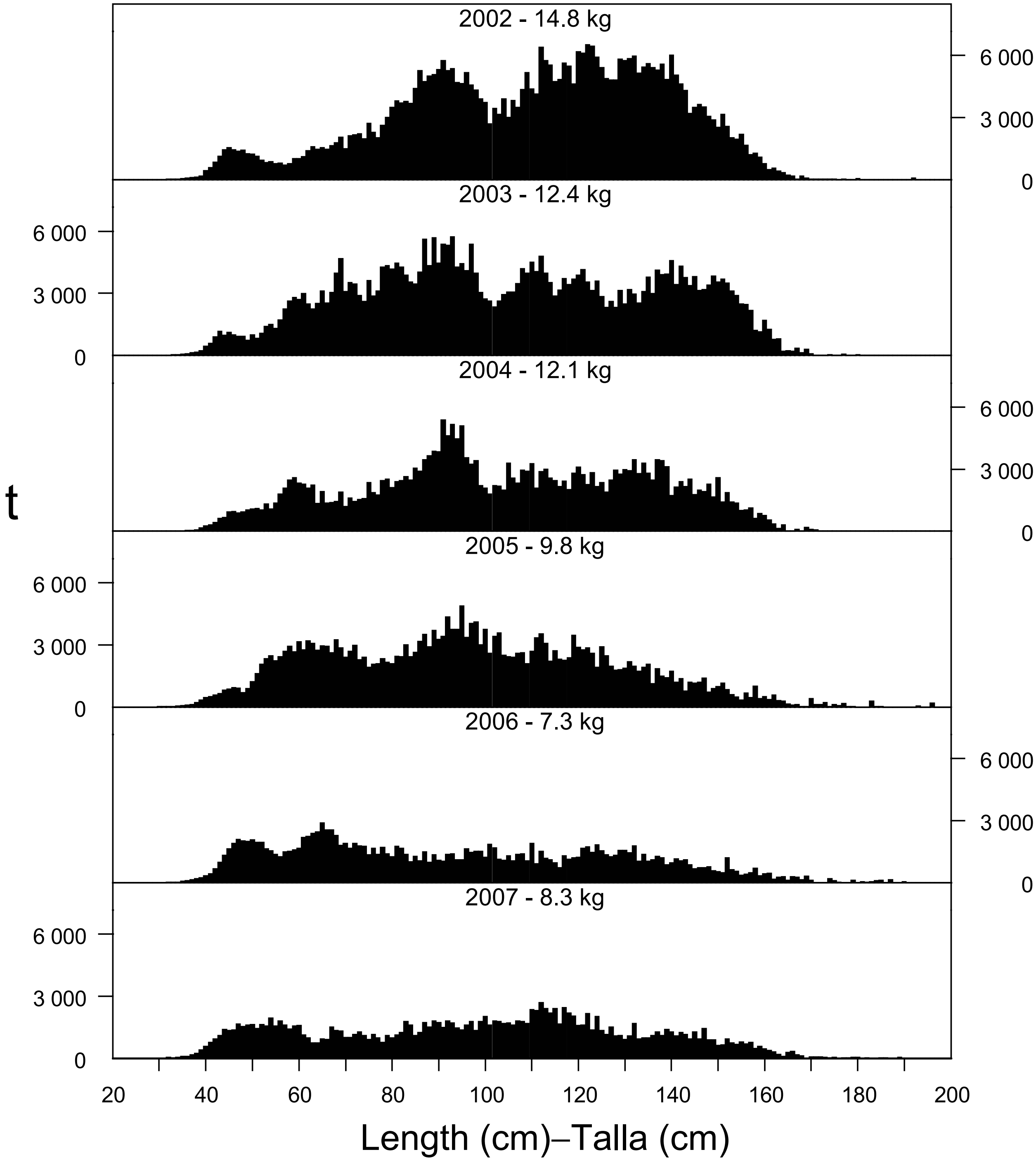


**FIGURE A-6b.** Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2002-2007. The average weights of the fish in the samples are given at the tops of the panels.

**FIGURA A-6b.** Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2002-2007. En cada recuadro se detalla el peso promedio de los peces en las muestras.

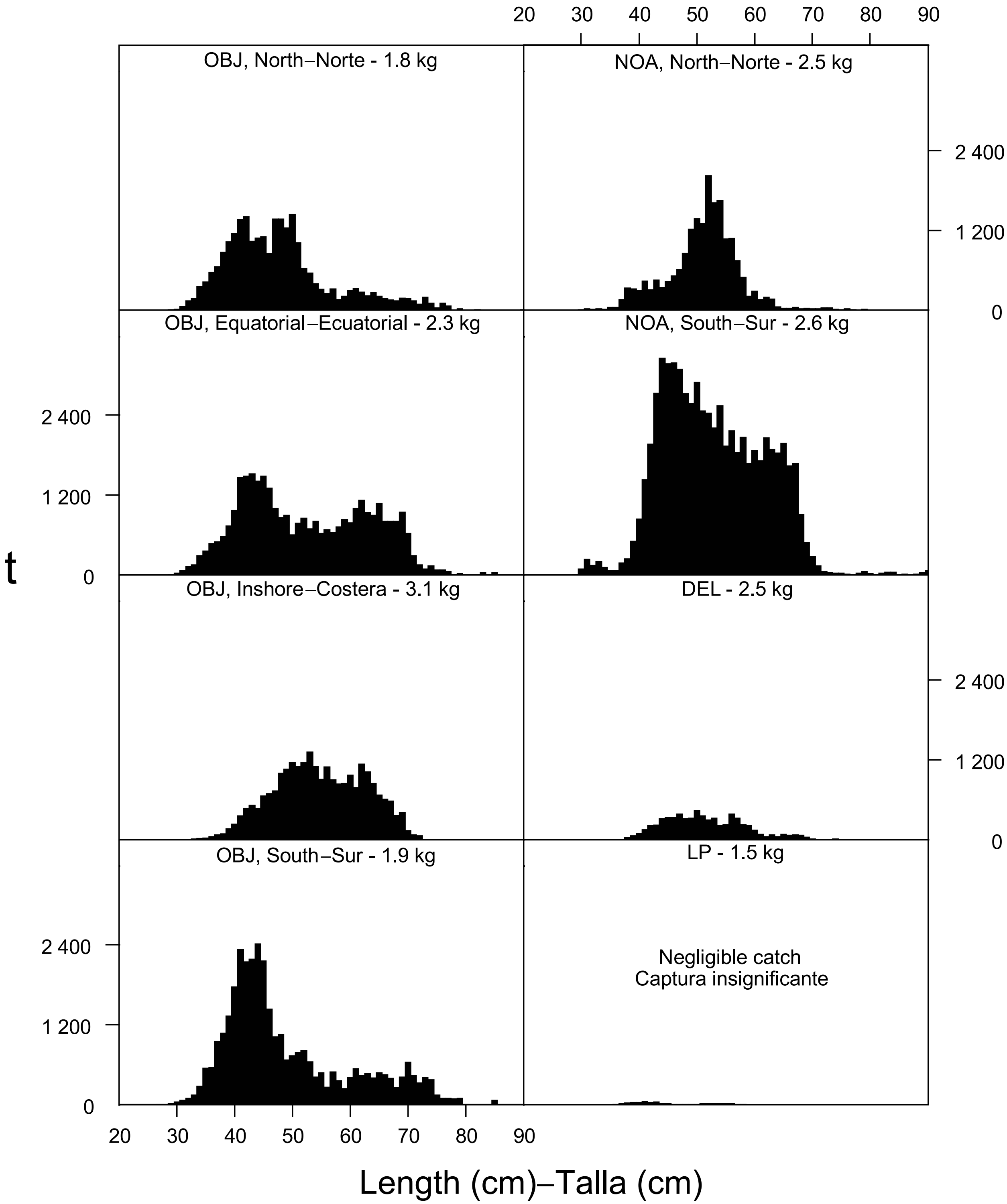


**FIGURE A-7a.** Estimated size compositions of the skipjack caught in the EPO during 2007 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

**FIGURA A-7a.** Composición por tallas estimada del barrilete capturado en el OPO durante 2007 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

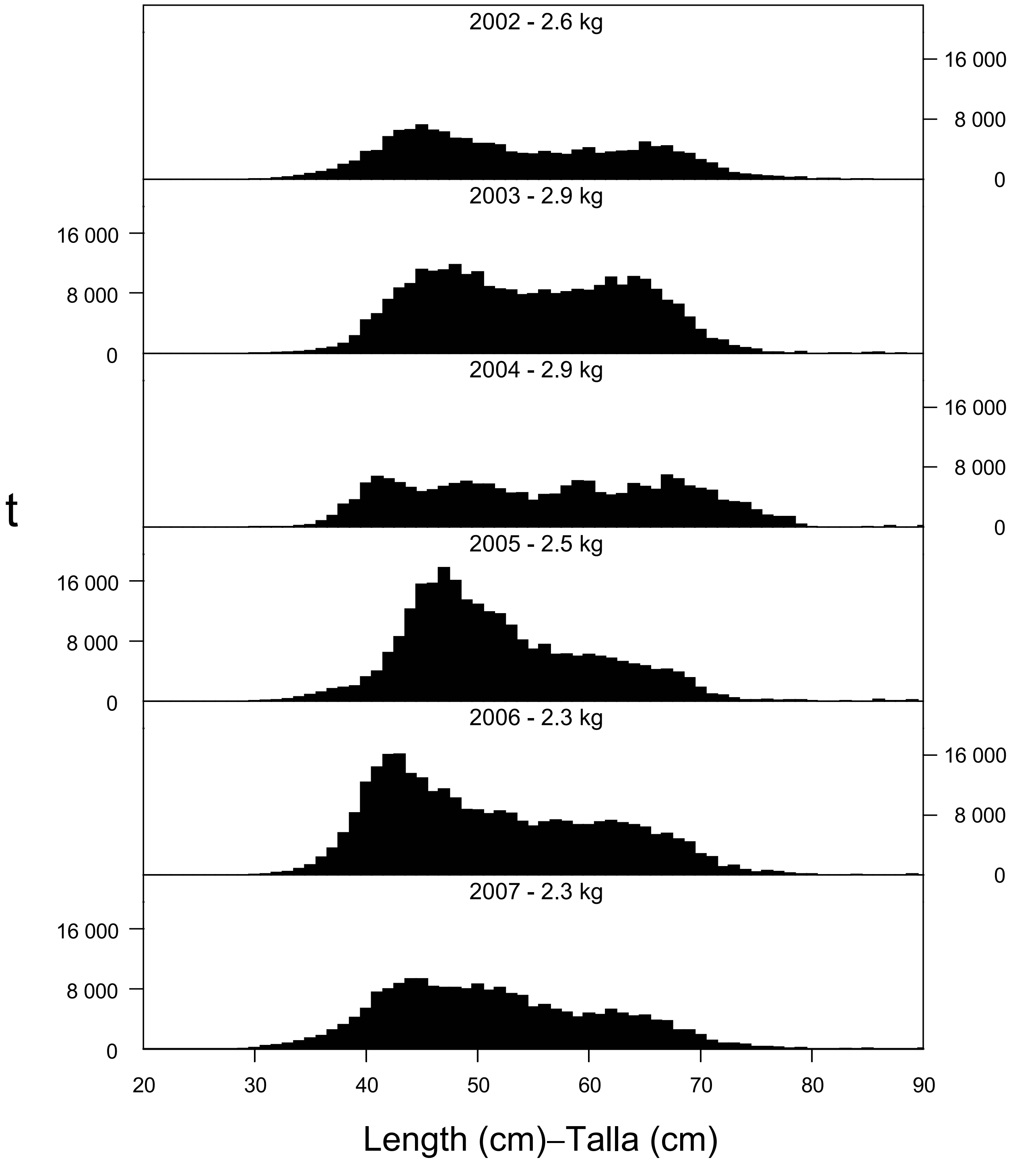


**FIGURE A-7b**. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2002-2007. The average weights of the fish in the samples are given at the tops of the panels.

**FIGURA A-7b.** Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2002-2007. En cada recuadro se detalla el peso promedio de los peces en las muestras.

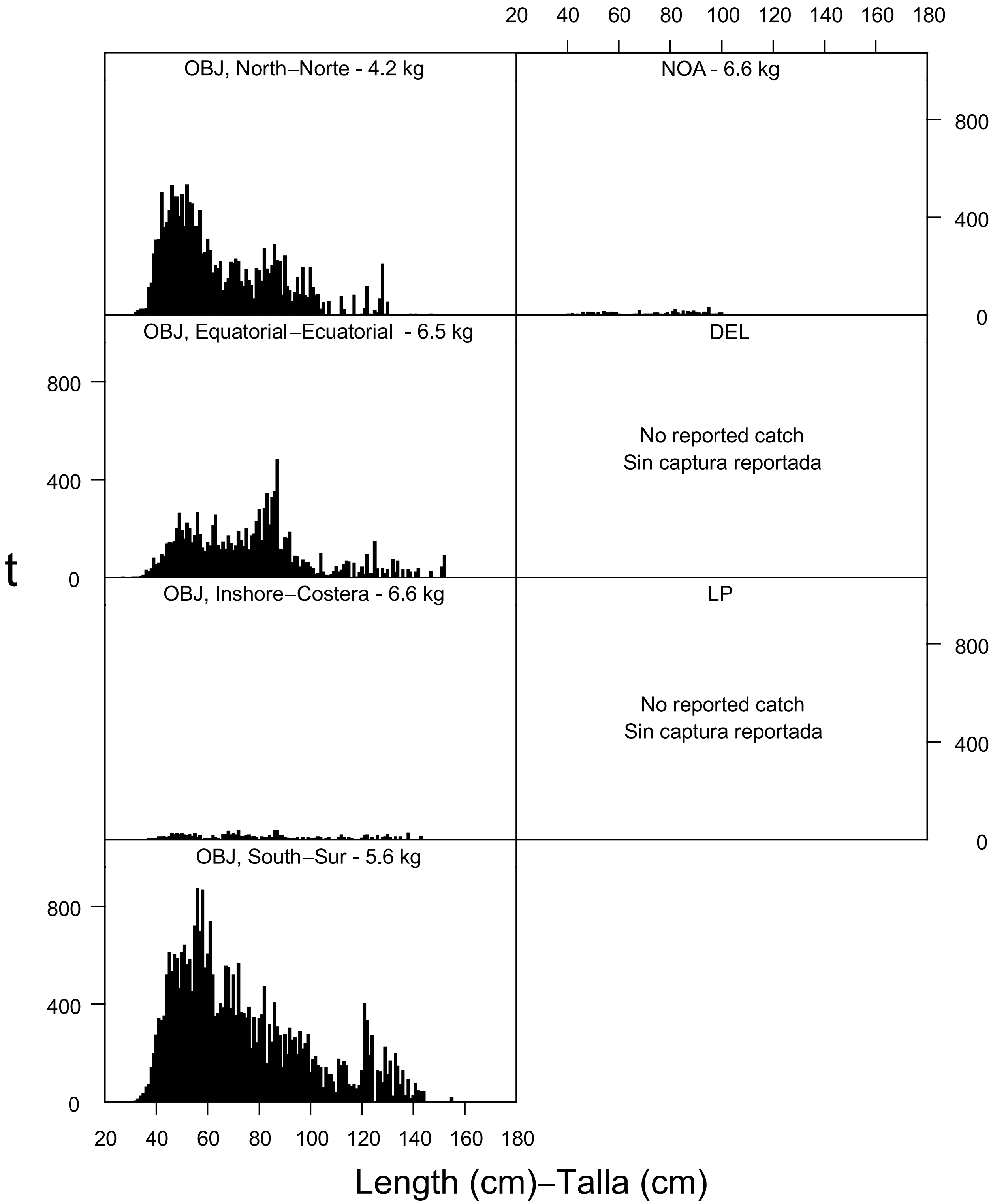


**FIGURE A-8a**. Estimated size compositions of the bigeye caught in the EPO during 2007 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

**FIGURA A-8a**. Composición por tallas estimada del patudo capturado e en el OPO durante 2007 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

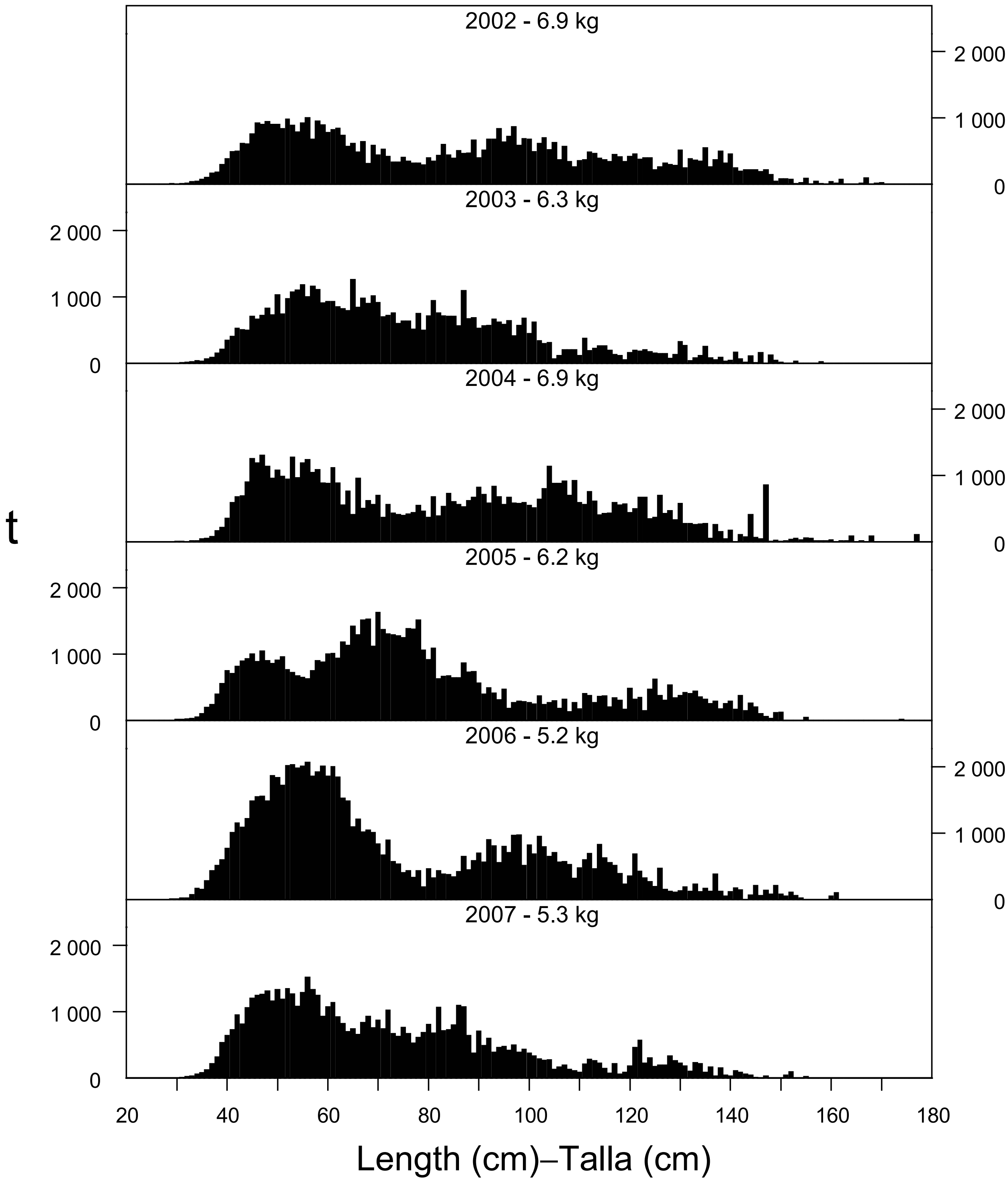


**FIGURE A-8b.** Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2002-2007. The average weights of the fish in the samples are given at the tops of the panels.
**FIGURA A-8b**. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2002-2007. En cada recuadro se detalla el peso promedio de los peces en las muestras.

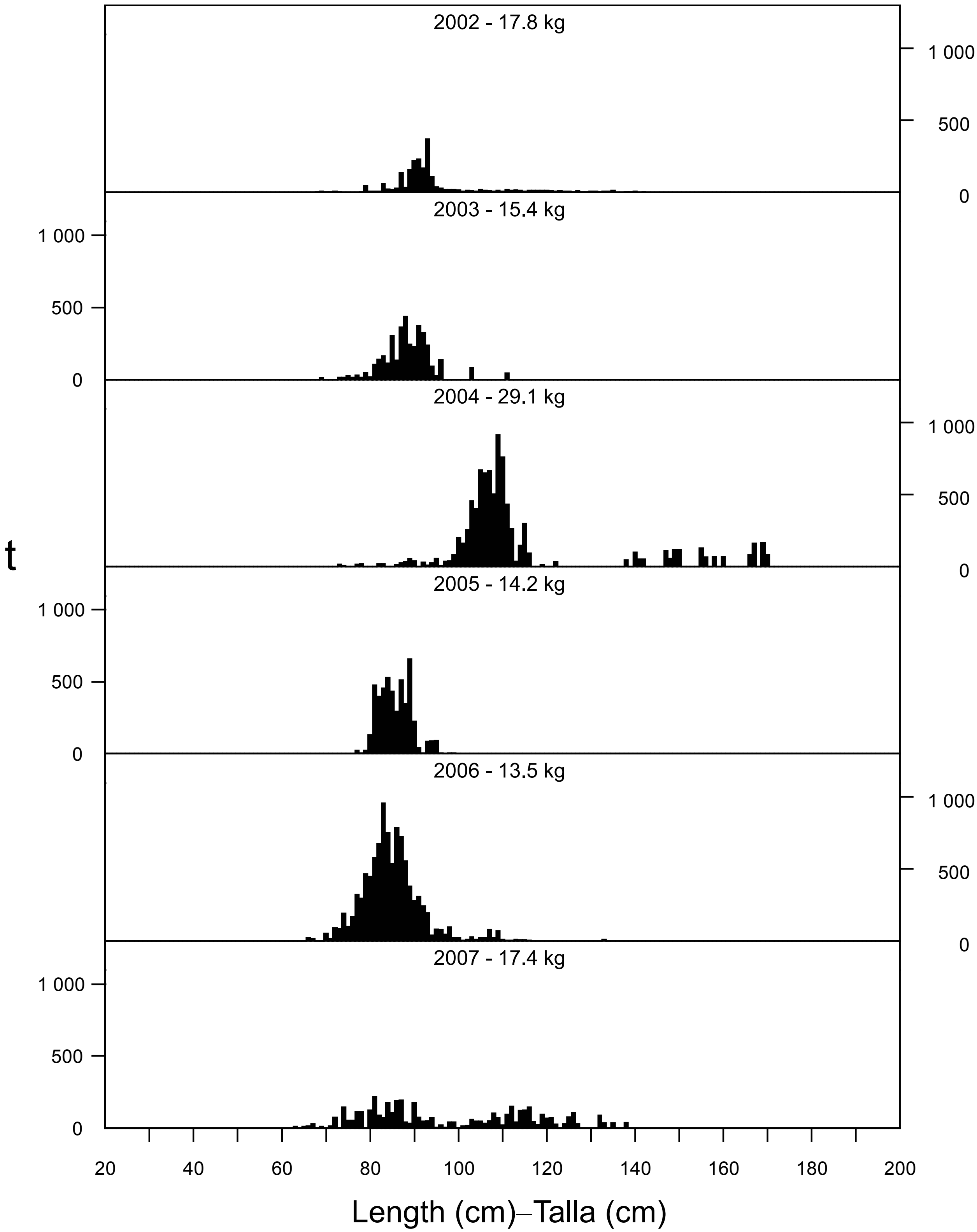


**FIGURE A-9.** Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 2002-2007. The values at the tops of the panels are the average weights.

**FIGURA A-9.** Captura estimada de aleta azul del Pacífico con arte de cerco y deportiva en el OPO durante 2002-2007. El valor en cada recuadro representa el peso promedio.

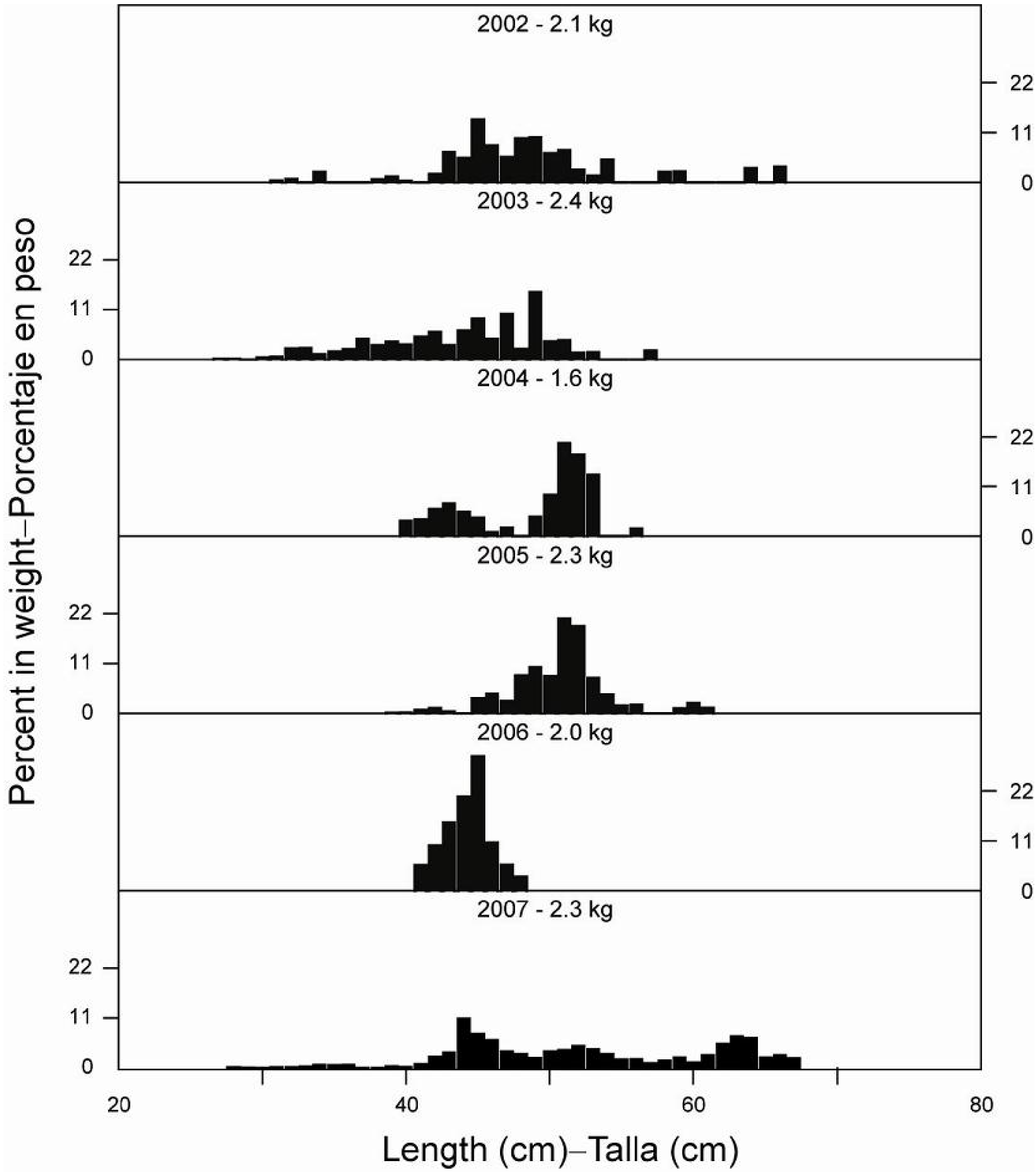


**FIGURE A-10.** Estimated size compositions of the catches of black skipjack by purse-seine vessels in the EPO during 2002-2007. The values at the tops of the panels are the average weights.

**FIGURA A-10.** Composición por tallas estimada del barrilete negro capturado por buques cerqueros en el OPO durante 2002-2007. El valor en cada recuadro representa el peso promedio.

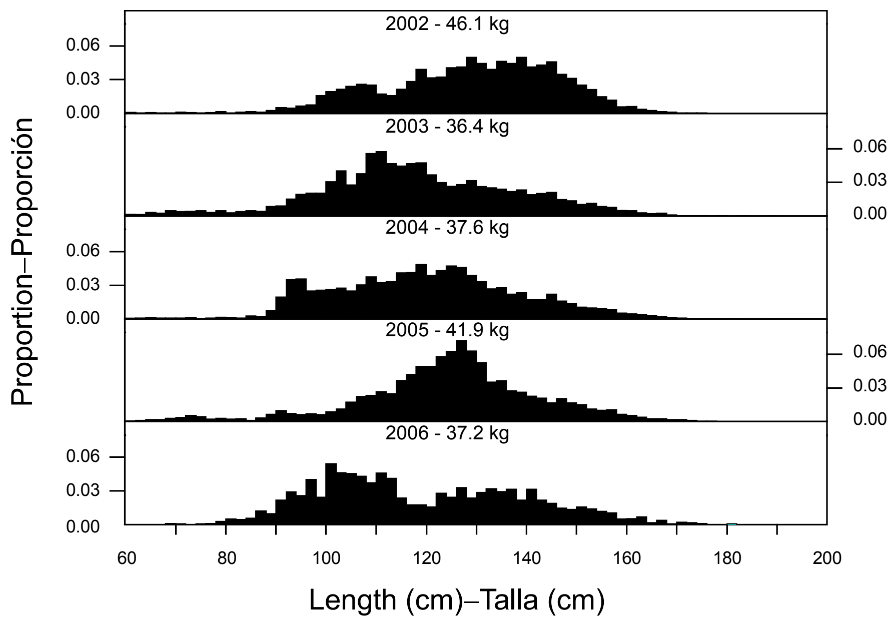


**FIGURE A-11.** Estimated size compositions of the catches of yellowfin tuna by the Japanese longline fishery in the EPO, 2002-2006.
**FIGURA A-11.** Composición por tallas estimada de las capturas de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 2002-2006.

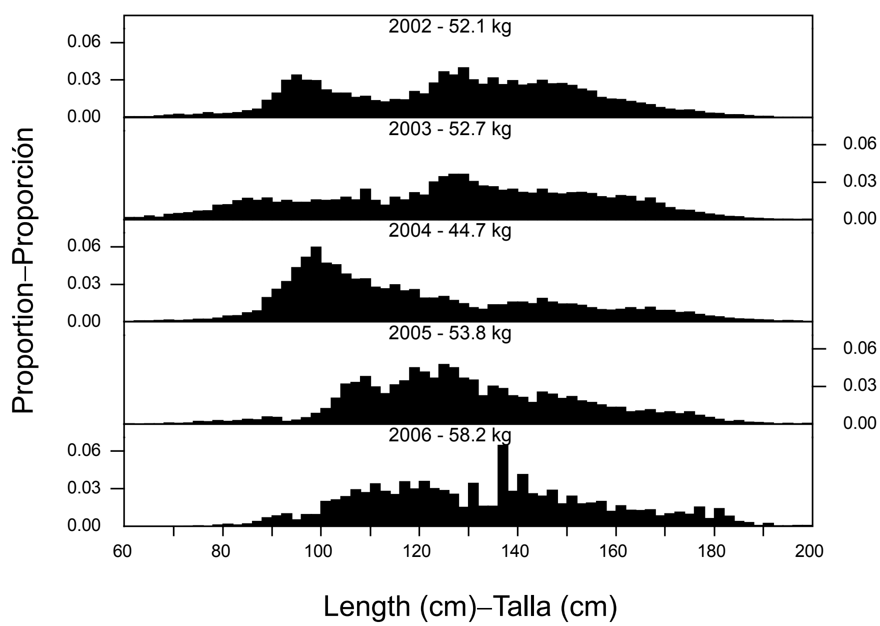


**FIGURE A-12.** Estimated size compositions of the catches of bigeye tuna by the Japanese longline fishery in the EPO, 2002-2006.
**FIGURA A-12.** Composición por tallas estimada de las capturas de atún patudo por la pesquería palangrera japonesa en el OPO, 2002-2006.

**TABLE A-1.** Annual catches of yellowfin, skipjack, and bigeye, by all types of gear combined, in the Pacific Ocean, 1978-2007. The EPO totals for 1993-2006 include discards from purse-seine vessels with carrying capacities greater than 363 t.

**TABLA A-1**. Capturas anuales de aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico, 1978-2007. Los totales del OPO de 1993-2006 incluyen los descartes de buques cerqueros de más de 363 t de capacidad de acarreo.

| | YFT | | | SKJ | | | BET | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | EPO | WCPO | Total | EPO | WCPO | Total | EPO | WCPO | Total | EPO | WCPO | Total |
| **1978** | 173,979 | 174,073 | 348,052 | 179,665 | 452,373 | 632,038 | 89,198 | 59,094 | 148,292 | 442,842 | 685,540 | 1,128,382 |
| **1979** | 187,124 | 194,442 | 381,566 | 141,503 | 414,299 | 555,802 | 67,533 | 66,372 | 133,905 | 396,160 | 675,113 | 1,071,273 |
| **1980** | 158,860 | 213,139 | 371,999 | 138,102 | 459,594 | 597,696 | 86,403 | 65,133 | 151,536 | 383,366 | 737,866 | 1,121,232 |
| **1981** | 178,512 | 225,922 | 404,434 | 126,002 | 438,242 | 564,244 | 68,345 | 53,346 | 121,691 | 372,859 | 717,510 | 1,090,369 |
| **1982** | 127,533 | 221,010 | 348,543 | 104,668 | 490,178 | 594,846 | 60,349 | 59,301 | 119,650 | 292,550 | 770,489 | 1,063,039 |
| **1983** | 99,677 | 257,109 | 356,786 | 61,974 | 683,530 | 745,504 | 64,694 | 59,896 | 124,590 | 226,345 | 1,000,535 | 1,226,880 |
| **1984** | 149,465 | 256,247 | 405,712 | 63,610 | 761,806 | 825,416 | 55,268 | 64,680 | 119,948 | 268,343 | 1,082,733 | 1,351,076 |
| **1985** | 225,937 | 259,475 | 485,412 | 52,003 | 603,478 | 655,481 | 72,399 | 68,706 | 141,105 | 350,339 | 931,659 | 1,281,998 |
| **1986** | 286,071 | 250,661 | 536,732 | 67,745 | 755,183 | 822,928 | 105,184 | 63,777 | 168,961 | 459,000 | 1,069,621 | 1,528,621 |
| **1987** | 286,162 | 303,565 | 589,727 | 66,467 | 687,711 | 754,178 | 101,346 | 79,269 | 180,615 | 453,975 | 1,070,545 | 1,524,520 |
| **1988** | 296,428 | 263,032 | 559,460 | 92,127 | 848,855 | 940,982 | 74,314 | 68,447 | 142,761 | 462,868 | 1,180,334 | 1,643,202 |
| **1989** | 299,435 | 313,793 | 613,228 | 98,923 | 823,224 | 922,147 | 72,995 | 77,237 | 150,232 | 471,353 | 1,214,254 | 1,685,607 |
| **1990** | 301,519 | 353,492 | 655,011 | 77,109 | 889,969 | 967,078 | 104,850 | 90,418 | 195,268 | 483,478 | 1,333,879 | 1,817,357 |
| **1991** | 265,968 | 394,712 | 660,680 | 65,890 | 1,117,698 | 1,183,588 | 109,121 | 73,767 | 182,888 | 440,979 | 1,586,177 | 2,027,156 |
| **1992** | 252,513 | 400,908 | 653,421 | 87,293 | 1,014,405 | 1,101,698 | 92,001 | 91,062 | 183,063 | 431,807 | 1,506,375 | 1,938,182 |
| **1993** | 256,208 | 386,585 | 642,793 | 100,507 | 916,296 | 1,016,803 | 82,835 | 79,667 | 162,502 | 439,550 | 1,382,548 | 1,822,098 |
| **1994** | 248,238 | 395,554 | 643,792 | 84,643 | 1,019,118 | 1,103,761 | 109,327 | 89,672 | 198,999 | 442,207 | 1,504,344 | 1,946,551 |
| **1995** | 244,639 | 380,215 | 624,854 | 150,664 | 1,050,678 | 1,201,342 | 108,209 | 83,398 | 191,607 | 503,512 | 1,514,291 | 2,017,803 |
| **1996** | 266,930 | 316,333 | 583,263 | 132,680 | 1,023,159 | 1,155,839 | 114,707 | 84,981 | 199,688 | 514,317 | 1,424,473 | 1,938,790 |
| **1997** | 277,575 | 438,471 | 716,046 | 188,504 | 965,170 | 1,153,674 | 122,352 | 111,890 | 234,242 | 588,431 | 1,515,531 | 2,103,962 |
| **1998** | 280,627 | 456,764 | 737,391 | 165,701 | 1,308,963 | 1,474,664 | 93,985 | 113,211 | 207,196 | 540,312 | 1,878,938 | 2,419,250 |
| **1999** | 304,730 | 399,584 | 704,314 | 292,053 | 1,175,280 | 1,467,333 | 93,321 | 114,815 | 208,136 | 690,103 | 1,689,679 | 2,379,782 |
| **2000** | 289,423 | 424,318 | 713,741 | 231,088 | 1,238,435 | 1,469,523 | 148,148 | 113,633 | 261,781 | 668,659 | 1,776,386 | 2,445,045 |
| **2001** | 424,554 | 420,055 | 844,609 | 158,491 | 1,136,528 | 1,295,019 | 131,223 | 105,994 | 237,217 | 714,269 | 1,662,577 | 2,376,846 |
| **2002** | 443,592 | 397,976 | 841,568 | 166,924 | 1,318,355 | 1,485,279 | 132,813 | 119,684 | 252,497 | 743,329 | 1,836,015 | 2,579,344 |
| **2003** | 413,232 | 438,354 | 851,586 | 301,881 | 1,314,801 | 1,616,682 | 116,231 | 108,519 | 224,750 | 831,345 | 1,861,674 | 2,693,019 |
| **2004** | 293,843 | 362,431 | 656,274 | 218,565 | 1,412,789 | 1,631,354 | 112,852 | 146,111 | 258,963 | 625,260 | 1,921,331 | 2,546,591 |
| **2005** | 286,417 | 435,876 | 722,293 | 284,579 | 1,532,361 | 1,816,940 | 113,544 | 132,151 | 245,695 | 684,540 | 2,100,388 | 2,784,928 |
| **2006** | 178,735 | 399,828 | 578,563 | 311,751 | 1,538,112 | 1,849,863 | 121,263 | 114,247 | 235,510 | 611,750 | 2,052,187 | 2,663,937 |
| **2007** | 173,413 | * | 173,413 | 220,665 | * | 220,665 | 88,208 | * | 88,208 | 482,286 | * | 482,286 |

**TABLE A-2a.** Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels with carrying capacities greater than 363 t only, of tunas and bonitos, in metric tons, in the EPO, 1978-2007 The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary. The data for 2005-2007 are preliminary.
**TABLA A-2a.** Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de atunes y bonitos, en toneladas métricas, en el OPO, 1978-2007. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares. Los datos de 2005-2007 son preliminares.

| | Yellowfin—Aleta amarilla | | | | | | Skipjack—Barrilete | | | | | | Bigeye—Patudo | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total |
| | Ret. | Dis. | | | | | Ret. | Dis. | | | | | Ret. | Dis. | | | | |
| **1978** | 158,800 | - | 3,887 | 10,188 | 1,103 | 173,979 | 172,293 | - | 6,048 | 61 | 1,263 | 179,665 | 18,539 | - | - | 70,659 | 0 | 89,198 |
| **1979** | 170,648 | - | 4,790 | 11,473 | 212 | 187,124 | 133,695 | - | 6,345 | 33 | 1,429 | 141,503 | 12,097 | - | - | 55,435 | 1 | 67,533 |
| **1980** | 143,042 | - | 1,480 | 13,477 | 861 | 158,860 | 130,912 | - | 5,226 | 26 | 1,939 | 138,102 | 21,939 | - | - | 64,335 | 130 | 86,403 |
| **1981** | 168,235 | - | 1,477 | 7,999 | 800 | 178,512 | 119,165 | - | 5,906 | 20 | 911 | 126,002 | 14,922 | - | - | 53,416 | 7 | 68,345 |
| **1982** | 114,754 | - | 1,538 | 10,961 | 280 | 127,533 | 100,498 | - | 3,760 | 28 | 382 | 104,668 | 6,939 | - | 42 | 53,365 | 3 | 60,349 |
| **1983** | 83,928 | - | 4,007 | 10,894 | 848 | 99,677 | 56,851 | - | 4,387 | 28 | 708 | 61,974 | 4,575 | - | 39 | 60,043 | 37 | 64,694 |
| **1984** | 135,785 | - | 2,991 | 10,345 | 344 | 149,465 | 59,859 | - | 2,884 | 32 | 836 | 63,610 | 8,860 | - | 2 | 46,394 | 11 | 55,268 |
| **1985** | 211,460 | - | 1,069 | 13,198 | 211 | 225,937 | 50,829 | - | 946 | 44 | 183 | 52,003 | 6,056 | - | 2 | 66,326 | 15 | 72,399 |
| **1986** | 260,512 | - | 2,537 | 22,807 | 214 | 286,071 | 65,635 | - | 1,921 | 57 | 132 | 67,745 | 2,685 | - | - | 102,425 | 74 | 105,184 |
| **1987** | 262,007 | - | 5,107 | 18,911 | 137 | 286,162 | 64,019 | - | 2,233 | 38 | 177 | 66,467 | 1,177 | - | - | 100,121 | 49 | 101,346 |
| **1988** | 277,293 | - | 3,723 | 14,659 | 752 | 296,428 | 87,113 | - | 4,325 | 26 | 664 | 92,127 | 1,535 | - | 5 | 72,758 | 15 | 74,314 |
| **1989** | 277,995 | - | 4,145 | 17,032 | 263 | 299,435 | 94,935 | - | 2,941 | 28 | 1,019 | 98,923 | 2,031 | - | - | 70,963 | 1 | 72,995 |
| **1990** | 263,251 | - | 2,675 | 34,634 | 960 | 301,519 | 74,370 | - | 824 | 41 | 1,874 | 77,109 | 5,920 | - | - | 98,871 | 59 | 104,850 |
| **1991** | 231,257 | - | 2,856 | 30,898 | 957 | 265,968 | 62,229 | - | 1,717 | 36 | 1,909 | 65,890 | 4,870 | - | 31 | 104,195 | 25 | 109,121 |
| **1992** | 228,121 | - | 3,789 | 18,645 | 1,958 | 252,513 | 84,283 | - | 1,956 | 24 | 1,030 | 87,293 | 7,179 | - | - | 84,809 | 13 | 92,001 |
| **1993** | 219,494 | 4,722 | 4,950 | 24,008 | 3,033 | 256,208 | 83,829 | 10,588 | 3,772 | 62 | 2,257 | 100,507 | 9,657 | 645 | - | 72,498 | 35 | 82,835 |
| **1994** | 208,409 | 4,691 | 3,625 | 30,026 | 1,487 | 248,238 | 70,127 | 10,472 | 3,240 | 73 | 731 | 84,643 | 34,900 | 2,261 | - | 71,360 | 806 | 109,327 |
| **1995** | 215,434 | 5,275 | 1,268 | 20,596 | 2,066 | 244,639 | 127,045 | 16,378 | 5,253 | 77 | 1,912 | 150,664 | 45,319 | 3,251 | - | 58,269 | 1369 | 108,209 |
| **1996** | 238,606 | 6,314 | 3,761 | 16,610 | 1,639 | 266,930 | 103,976 | 24,837 | 2,555 | 51 | 1,261 | 132,680 | 61,312 | 5,689 | - | 46,958 | 748 | 114,707 |
| **1997** | 244,878 | 5,516 | 4,418 | 22,163 | 600 | 277,575 | 153,456 | 31,558 | 3,260 | 135 | 96 | 188,504 | 64,270 | 5,482 | - | 52,580 | 20 | 122,352 |
| **1998** | 253,959 | 4,718 | 5,084 | 15,337 | 1,529 | 280,627 | 140,631 | 22,856 | 1,684 | 293 | 237 | 165,701 | 44,128 | 2,853 | - | 46,375 | 628 | 93,985 |
| **1999** | 281,920 | 6,638 | 1,783 | 11,683 | 2,706 | 304,730 | 261,564 | 26,851 | 2,044 | 200 | 1,393 | 292,053 | 51,158 | 5,176 | - | 36,450 | 537 | 93,321 |
| **2000** | 255,231 | 6,796 | 2,431 | 23,855 | 1,109 | 289,423 | 204,307 | 26,415 | 231 | 68 | 67 | 231,088 | 94,640 | 5,649 | - | 47,605 | 253 | 148,148 |
| **2001** | 382,702 | 7,808 | 3,916 | 29,607 | 521 | 424,554 | 143,561 | 13,233 | 448 | 1,215 | 34 | 158,491 | 61,156 | 1,294 | - | 68,754 | 19 | 131,223 |
| **2002** | 412,507 | 4,019 | 950 | 25,565 | 551 | 443,592 | 153,303 | 12,625 | 616 | 261 | 119 | 166,924 | 57,440 | 937 | - | 74,424 | 12 | 132,813 |
| **2003** | 381,107 | 5,338 | 470 | 25,173 | 1,145 | 413,232 | 274,529 | 23,302 | 638 | 635 | 2,777 | 301,881 | 54,174 | 2,260 | - | 59,776 | 21 | 116,231 |
| **2004** | 269,597 | 2,967 | 1,884 | 18,770 | 626 | 293,843 | 198,664 | 17,555 | 528 | 713 | 1,105 | 218,565 | 67,592 | 1,588 | - | 43,478 | 194 | 112,852 |
| **2005** | 267,599 | 3,186 | 1,822 | 11,958 | 1,852 | 286,417 | 261,780 | 19,488 | 1,299 | 232 | 1,780 | 284,579 | 69,826 | 1,973 | - | 41,720 | 25 | 113,544 |
| **2006** | 166,330 | 1,522 | 686 | 8,739 | 1,458 | 178,735 | 297,408 | 12,696 | 435 | 226 | 986 | 311,751 | 83,978 | 1,886 | - | 35,363 | 36 | 121,263 |
| **2007** | 168,952 | 2,363 | 894 | 961 | 243 | 173,413 | 210,620 | 8,896 | 276 | 866 | 6 | 220,665 | 61,434 | 1,215 | - | 25,560 | * | 88,208 |

**TABLE A-2a.** (continued)
**TABLA A-2a.** (continuación)

| | Pacific bluefin—Aleta azul del Pacífico | | | | | | Albacore—Albacora | | | | | | Black skipjack—Barrilete negro | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total |
| | Ret. | Dis. | | | | | Ret. | Dis. | | | | | Ret. | Dis. | | | | |
| **1978** | 5,389 | - | 4 | 9 | 8 | 5,410 | 157 | - | 1,577 | 11,939 | 17,436 | 31,109 | 2,167 | - | 3 | - | - | 2,170 |
| **1979** | 6,102 | - | 5 | 6 | 26 | 6,139 | 148 | - | 179 | 5,583 | 5,043 | 10,953 | 1,336 | - | 30 | - | - | 1,366 |
| **1980** | 2,909 | - | - | - | 32 | 2,941 | 194 | - | 407 | 5,319 | 5,649 | 11,569 | 3,653 | - | 28 | - | - | 3,680 |
| **1981** | 1,086 | - | - | 4 | 7 | 1,097 | 99 | - | 608 | 7,275 | 12,301 | 20,282 | 1,907 | - | 3 | - | - | 1,911 |
| **1982** | 3,145 | - | - | 7 | 6 | 3,158 | 355 | - | 198 | 8,407 | 3,562 | 12,522 | 1,338 | - | - | - | - | 1,338 |
| **1983** | 836 | - | - | 2 | 38 | 876 | 7 | - | 449 | 7,433 | 7,840 | 15,730 | 1,222 | - | 0 | - | 13 | 1,236 |
| **1984** | 839 | - | 0 | 3 | 51 | 894 | 3,910 | - | 1,441 | 6,712 | 9,794 | 21,857 | 663 | - | - | - | 3 | 666 |
| **1985** | 3,996 | - | - | 1 | 77 | 4,074 | 42 | - | 877 | 7,268 | 6,654 | 14,840 | 289 | - | 0 | - | 7 | 296 |
| **1986** | 5,040 | - | - | 1 | 63 | 5,104 | 47 | - | 86 | 6,450 | 4,701 | 11,284 | 568 | - | - | - | 18 | 586 |
| **1987** | 980 | - | - | 3 | 88 | 1,071 | 1 | - | 320 | 9,994 | 2,661 | 12,976 | 571 | - | - | - | 2 | 573 |
| **1988** | 1,380 | - | - | 2 | 52 | 1,433 | 17 | - | 271 | 9,934 | 5,549 | 15,771 | 956 | - | | - | 311 | 1,267 |
| **1989** | 1,102 | - | 5 | 4 | 91 | 1,202 | 1 | - | 21 | 6,784 | 2,695 | 9,501 | 803 | - | 0 | - | - | 803 |
| **1990** | 1,430 | - | 61 | 12 | 103 | 1,606 | 39 | - | 170 | 6,536 | 4,105 | 10,850 | 787 | - | - | - | 4 | 791 |
| **1991** | 419 | - | - | 5 | 55 | 479 | - | - | 834 | 7,894 | 2,754 | 11,482 | 421 | - | - | - | 25 | 446 |
| **1992** | 1,928 | - | - | 21 | 147 | 2,096 | - | - | 255 | 17,081 | 5,740 | 23,076 | 104 | - | - | 3 | - | 107 |
| **1993** | 580 | - | - | 11 | 325 | 916 | - | - | 1 | 11,194 | 4,410 | 15,605 | 104 | 4,116 | - | 31 | - | 4,250 |
| **1994** | 969 | - | - | 12 | 111 | 1,092 | - | - | 85 | 10,390 | 10,143 | 20,618 | 188 | 834 | - | 40 | - | 1,062 |
| **1995** | 630 | - | - | 25 | 300 | 955 | - | - | 465 | 6,184 | 7,425 | 14,074 | 202 | 1,448 | - | - | - | 1,650 |
| **1996** | 8,223 | - | - | 19 | 84 | 8,326 | 11 | - | 72 | 7,631 | 8,398 | 16,112 | 704 | 2,304 | - | 12 | - | 3,020 |
| **1997** | 2,608 | 3 | 2 | 14 | 245 | 2,871 | 1 | - | 59 | 9,678 | 7,541 | 17,279 | 101 | 2,512 | - | 11 | - | 2,624 |
| **1998** | 1,772 | 0 | 0 | 95 | 525 | 2,392 | 42 | 0 | 81 | 12,635 | 13,155 | 25,914 | 490 | 1,876 | 39 | - | - | 2,405 |
| **1999** | 2,553 | 54 | 5 | 151 | 564 | 3,327 | 47 | - | 227 | 11,632 | 14,557 | 26,463 | 171 | 3,424 | - | - | - | 3,595 |
| **2000** | 3,712 | - | 61 | 46 | 378 | 4,197 | 71 | - | 86 | 9,663 | 13,455 | 23,275 | 294 | 1,877 | - | - | - | 2,170 |
| **2001** | 1,155 | 3 | 1 | 148 | 401 | 1,709 | 3 | - | 157 | 19,410 | 13,766 | 33,336 | 2,258 | 1,253 | - | - | - | 3,511 |
| **2002** | 1,758 | 6 | 3 | 70 | 653 | 2,491 | 31 | - | 381 | 15,289 | 14,453 | 30,155 | 1,459 | 2,207 | 8 | - | | 3,674 |
| **2003** | 3,233 | - | 3 | 87 | 404 | 3,728 | 34 | - | 59 | 24,900 | 20,544 | 45,538 | 433 | 1,606 | 6 | 13 | 117 | 2,175 |
| **2004** | 8,880 | 19 | - | 15 | 62 | 8,977 | 105 | - | 126 | 18,444 | 22,159 | 40,835 | 883 | 392 | - | 27 | 862 | 2,164 |
| **2005** | 4,744 | 15 | - | 0 | 85 | 4,844 | 2 | - | 66 | 8,901 | 15,635 | 24,604 | 1,472 | 2,490 | - | - | 22 | 3,984 |
| **2006** | 9,806 | - | - | 0 | 102 | 9,908 | 109 | - | 22 | 10,969 | 19,293 | 30,393 | 1,999 | 1,759 | - | - | - | 3,758 |
| **2007** | 4,245 | - | - | * | 14 | 4,259 | 40 | * | * | 2,435 | 6,112 | 8,587 | 2,067 | 1,434 | * | 33 | 4 | 3,538 |

**TABLE A-2a.** (continued)
**TABLA A-2a.** (continuación)

| | Bonitos | | | | | | Unidentified tunas—Atunes no identificados | | | | | | Total | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total | PS | | LP | LL | OTR | Total |
| | Ret. | Dis. | | | | | Ret. | Dis. | | | | | Ret. | Dis. | | | | |
| **1978** | 4,801 | - | 35 | - | 2,419 | 7,256 | 190 | - | - | | 6,677 | 6,867 | 362,335 | - | 11,555 | 92,857 | 28,906 | 495,653 |
| **1979** | 1,802 | - | 3 | - | 2,658 | 4,463 | 559 | - | - | | 3,016 | 3,575 | 326,386 | - | 11,354 | 72,530 | 12,386 | 422,656 |
| **1980** | 6,089 | - | 36 | - | 2,727 | 8,852 | 441 | - | - | | 836 | 1,277 | 309,180 | - | 7,176 | 83,156 | 12,174 | 411,686 |
| **1981** | 5,691 | - | 27 | - | 4,609 | 10,326 | 214 | - | 3 | | 1,109 | 1,326 | 311,320 | - | 8,024 | 68,714 | 19,743 | 407,801 |
| **1982** | 2,121 | - | - | - | 6,776 | 8,897 | 51 | - | - | | 382 | 433 | 229,202 | - | 5,537 | 72,767 | 11,391 | 318,898 |
| **1983** | 3,827 | - | 2 | - | 7,291 | 11,120 | 81 | - | - | | 4,711 | 4,792 | 151,327 | - | 8,884 | 78,402 | 21,487 | 260,099 |
| **1984** | 3,514 | - | - | - | 7,291 | 10,805 | 6 | - | - | | 2,524 | 2,530 | 213,437 | - | 7,318 | 63,486 | 20,854 | 305,095 |
| **1985** | 3,599 | - | 5 | - | 7,869 | 11,473 | 18 | - | - | | 678 | 696 | 276,291 | - | 2,899 | 86,836 | 15,694 | 381,719 |
| **1986** | 232 | - | 258 | - | 1,889 | 2,379 | 177 | - | 4 | | 986 | 1,167 | 334,896 | - | 4,806 | 131,741 | 8,078 | 479,521 |
| **1987** | 3,194 | - | 121 | - | 1,782 | 5,098 | 480 | - | - | | 2,043 | 2,523 | 332,429 | - | 7,781 | 129,066 | 6,939 | 476,216 |
| **1988** | 8,811 | - | 739 | - | 947 | 10,497 | 258 | - | - | | 2,939 | 3,197 | 377,363 | - | 9,063 | 97,380 | 11,229 | 495,034 |
| **1989** | 11,277 | - | 817 | - | 465 | 12,560 | 469 | - | - | | 627 | 1,095 | 388,612 | - | 7,930 | 94,812 | 5,160 | 496,514 |
| **1990** | 13,641 | - | 215 | - | 371 | 14,227 | 393 | - | - | 3 | 692 | 1,088 | 359,830 | - | 3,946 | 140,096 | 8,168 | 512,041 |
| **1991** | 1,207 | - | 82 | - | 242 | 1,530 | 4 | - | - | 30 | 192 | 227 | 300,406 | - | 5,520 | 143,057 | 6,159 | 455,143 |
| **1992** | 978 | - | - | - | 318 | 1,296 | 133 | - | - | 27 | 1,071 | 1,232 | 322,726 | - | 6,000 | 120,610 | 10,277 | 459,614 |
| **1993** | 599 | 12 | 1 | - | 436 | 1,047 | 13 | 2,172 | - | 12 | 4,082 | 6,279 | 314,274 | 22,254 | 8,724 | 107,816 | 14,579 | 467,648 |
| **1994** | 8,331 | 147 | 361 | - | 185 | 9,024 | 10 | 969 | - | 1 | 464 | 1,444 | 322,934 | 19,373 | 7,311 | 111,902 | 13,927 | 475,447 |
| **1995** | 7,929 | 55 | 81 | - | 54 | 8,119 | 12 | 1,006 | - | 1 | 1,004 | 2,024 | 396,571 | 27,412 | 7,066 | 85,153 | 14,130 | 530,333 |
| **1996** | 648 | 1 | 7 | - | 16 | 672 | 37 | 1,300 | - | 2 | 1,038 | 2,376 | 413,516 | 40,444 | 6,395 | 71,284 | 13,184 | 544,823 |
| **1997** | 1,097 | 4 | 8 | - | 34 | 1,142 | 74 | 3,879 | - | 8 | 1,437 | 5,398 | 466,484 | 48,954 | 7,747 | 84,588 | 9,972 | 617,746 |
| **1998** | 1,330 | 4 | 7 | - | 588 | 1,929 | 15 | 1,633 | - | 26 | 18,158 | 19,832 | 442,367 | 33,940 | 6,896 | 74,759 | 34,821 | 592,784 |
| **1999** | 1,720 | 0 | - | 24 | 369 | 2,113 | 29 | 3,266 | - | 2,116 | 4,279 | 9,690 | 599,162 | 45,410 | 4,059 | 62,256 | 24,404 | 735,292 |
| **2000** | 636 | - | - | 75 | 56 | 767 | 190 | 1,795 | - | 1,994 | 1,468 | 5,448 | 559,080 | 42,532 | 2,809 | 83,307 | 16,787 | 704,516 |
| **2001** | 17 | - | 0 | 34 | 19 | 71 | 206 | 1,861 | - | 2,453 | 56 | 4,576 | 591,059 | 25,453 | 4,522 | 121,622 | 14,816 | 757,472 |
| **2002** | - | - | - | 42 | 1 | 43 | 576 | 2,709 | - | 3,278 | 1,422 | 7,985 | 627,075 | 22,503 | 1,958 | 118,930 | 17,211 | 787,678 |
| **2003** | - | - | 1 | - | 25 | 26 | 81 | 1,629 | - | 373 | 750 | 2,833 | 713,591 | 34,135 | 1,177 | 110,958 | 25,783 | 885,644 |
| **2004** | 15 | 35 | 1 | 8 | 3 | 62 | 259 | 1,426 | - | 504 | 258 | 2,448 | 545,995 | 23,982 | 2,539 | 81,960 | 25,269 | 679,745 |
| **2005** | 313 | 18 | - | - | 11 | 343 | 190 | 2,380 | - | 518 | 427 | 3,515 | 605,926 | 29,550 | 3,187 | 63,330 | 19,837 | 721,830 |
| **2006** | 3,507 | 84 | 12 | - | 3 | 3,605 | 99 | 2,457 | - | 163 | 293 | 3,012 | 563,236 | 20,404 | 1,155 | 55,461 | 22,171 | 662,426 |
| **2007** | 15,680 | 687 | 107 | 1,136 | * | 17,610 | 703 | 1,810 | * | 2,429 | 81 | 5,023 | 463,741 | 16,405 | 1,277 | 33,420 | 6,460 | 521,301 |

**TABLE A-2b.** Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with carrying capacities greater than 363 t only, of billfishes, in metric tons, in the EPO, 1978-2007 Data for 2005-2007 are preliminary. PS dis. = discards by purse-seine vessels.
**TABLA A-2b.** Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes, por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de peces picudos, en toneladas métricas, en el OPO, 1978-2007. Los datos de 2005-2007 son preliminares. PS dis. = descartes por buques cerqueros.

| | Swordfish—Pez espada | | | | Blue marlin—Marlín azul | | | | Black marlin—Marlín negro | | | | Striped marlin—Marlín rayado | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total |
| **1978** | - | 4,103 | 2,205 | 6,308 | - | 3,570 | - | 3,570 | - | 417 | - | 417 | - | 2,495 | - | 2,495 |
| **1979** | - | 2,658 | 614 | 3,272 | - | 4,528 | - | 4,528 | - | 332 | - | 332 | - | 4,137 | - | 4,137 |
| **1980** | - | 3,746 | 1,107 | 4,853 | - | 4,016 | - | 4,016 | - | 335 | - | 335 | - | 4,827 | - | 4,827 |
| **1981** | - | 3,070 | 1,134 | 4,204 | - | 4,476 | - | 4,476 | - | 247 | - | 247 | - | 4,876 | - | 4,876 |
| **1982** | - | 2,604 | 1,551 | 4,155 | - | 4,745 | - | 4,745 | - | 213 | - | 213 | - | 4,711 | - | 4,711 |
| **1983** | - | 3,341 | 2,338 | 5,679 | - | 4,459 | - | 4,459 | - | 240 | - | 240 | - | 4,472 | - | 4,472 |
| **1984** | - | 2,752 | 3,336 | 6,088 | - | 5,197 | - | 5,197 | - | 248 | - | 248 | - | 2,662 | - | 2,662 |
| **1985** | - | 1,885 | 3,768 | 5,653 | - | 3,588 | - | 3,588 | - | 180 | - | 180 | - | 1,599 | - | 1,599 |
| **1986** | - | 3,286 | 3,294 | 6,580 | - | 5,278 | - | 5,278 | - | 297 | - | 297 | - | 3,540 | - | 3,540 |
| **1987** | - | 4,676 | 3,740 | 8,416 | - | 7,282 | - | 7,282 | - | 358 | - | 358 | - | 7,647 | - | 7,647 |
| **1988** | - | 4,916 | 5,642 | 10,558 | - | 5,662 | - | 5,662 | - | 288 | - | 288 | - | 5,283 | - | 5,283 |
| **1989** | - | 5,202 | 6,072 | 11,274 | - | 5,392 | - | 5,392 | - | 193 | - | 193 | - | 3,473 | - | 3,473 |
| **1990** | - | 5,807 | 5,066 | 10,873 | - | 5,540 | - | 5,540 | - | 223 | - | 223 | - | 3,260 | - | 3,260 |
| **1991** | 17 | 10,671 | 4,307 | 14,995 | 69 | 6,719 | - | 6,788 | 58 | 246 | - | 304 | 76 | 2,993 | - | 3,069 |
| **1992** | 4 | 9,820 | 4,267 | 14,091 | 52 | 6,627 | - | 6,679 | 95 | 228 | - | 323 | 69 | 3,054 | - | 3,123 |
| **1993** | 5 | 6,187 | 4,414 | 10,606 | 105 | 6,571 | - | 6,676 | 93 | 217 | - | 310 | 71 | 3,575 | - | 3,646 |
| **1994** | 3 | 4,990 | 3,822 | 8,815 | 97 | 9,027 | - | 9,124 | 72 | 256 | - | 328 | 36 | 3,396 | - | 3,432 |
| **1995** | 4 | 4,495 | 2,974 | 7,473 | 99 | 7,288 | - | 7,387 | 76 | 158 | - | 234 | 24 | 3,249 | - | 3,273 |
| **1996** | 1 | 7,071 | 2,486 | 9,558 | 85 | 3,596 | - | 3,681 | 79 | 99 | - | 178 | 25 | 3,218 | - | 3,243 |
| **1997** | 4 | 10,580 | 1,781 | 12,365 | 150 | 5,808 | - | 5,958 | 101 | 153 | - | 254 | 28 | 4,473 | - | 4,501 |
| **1998** | 3 | 9,800 | 3,246 | 13,049 | 153 | 5,057 | - | 5,210 | 102 | 168 | - | 270 | 21 | 3,558 | - | 3,579 |
| **1999** | 2 | 7,569 | 1,965 | 9,536 | 213 | 3,690 | - | 3,903 | 117 | 94 | - | 211 | 37 | 2,621 | - | 2,658 |
| **2000** | 2 | 8,930 | 2,383 | 11,315 | 153 | 3,634 | - | 3,785 | 95 | 105 | - | 200 | 20 | 1,889 | 0 | 1,909 |
| **2001** | 4 | 16,007 | 1,964 | 17,975 | 175 | 4,197 | - | 4,372 | 122 | 123 | - | 245 | 23 | 1,961 | 0 | 1,984 |
| **2002** | 1 | 17,598 | 2,119 | 19,718 | 233 | 3,481 | - | 3,714 | 125 | 78 | - | 203 | 79 | 2,159 | 1 | 2,239 |
| **2003** | 5 | 18,161 | 354 | 18,520 | 209 | 4,016 | - | 4,225 | 144 | 72 | - | 216 | 35 | 1,906 | 6 | 1,947 |
| **2004** | 2 | 15,370 | 309 | 15,681 | 168 | 3,782 | - | 3,950 | 74 | 41 | - | 115 | 23 | 1,548 | - | 1,571 |
| **2005** | 3 | 8,938 | 4,304 | 13,245 | 236 | 3,350 | - | 3,586 | 103 | 37 | - | 140 | 39 | 1,532 | - | 1,571 |
| **2006** | 5 | 8,812 | 3,895 | 12,712 | 221 | 2,093 | 105 | 2,419 | 140 | 37 | - | 177 | 59 | 1,530 | - | 1,589 |
| **2007** | 5 | 585 | 11 | 601 | 180 | 136 | * | 316 | 91 | * | - | 91 | 36 | 104 | * | 140 |

**TABLE A-2b.** (continued)
**TABLA A-2b.** (continuación)

| | Shortbill spearfish—Marlín trompa corta | | | | Sailfish—Pez vela | | | | Unidentified istiophorid billfishes—Picudos istiofóridos no identificados | | | | Total billfishes—Total de peces picudos | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total | PS dis. | LL | OTR | Total |
| **1978** | - | - | - | - | - | 878 | - | 878 | - | 3 | - | 3 | - | 11,466 | 2,205 | 13,671 |
| **1979** | - | - | - | - | - | 251 | - | 251 | - | 6 | - | 6 | - | 11,912 | 614 | 12,526 |
| **1980** | - | - | - | - | - | 244 | - | 244 | - | - | - | - | - | 13,168 | 1,107 | 14,275 |
| **1981** | - | - | - | - | - | 379 | - | 379 | - | 9 | - | 9 | - | 13,057 | 1,134 | 14,191 |
| **1982** | - | - | - | - | - | 1,084 | - | 1,084 | - | 3 | - | 3 | - | 13,360 | 1,551 | 14,911 |
| **1983** | - | - | - | - | - | 890 | - | 890 | - | 2 | - | 2 | - | 13,404 | 2,338 | 15,742 |
| **1984** | - | - | - | - | - | 345 | - | 345 | - | - | - | - | - | 11,204 | 3,336 | 14,540 |
| **1985** | - | - | - | - | - | 395 | - | 395 | - | 1 | - | 1 | - | 7,648 | 3,768 | 11,416 |
| **1986** | - | 5 | - | 5 | - | 583 | - | 583 | - | 1 | - | 1 | - | 12,990 | 3,294 | 16,284 |
| **1987** | - | 15 | - | 15 | - | 649 | - | 649 | - | 398 | - | 398 | - | 21,025 | 3,740 | 24,765 |
| **1988** | - | 13 | - | 13 | - | 649 | - | 649 | - | 368 | - | 368 | - | 17,179 | 5,642 | 22,821 |
| **1989** | - | - | - | - | - | 192 | - | 192 | - | 51 | - | 51 | - | 14,503 | 6,072 | 20,575 |
| **1990** | - | - | - | - | - | 6 | - | 6 | - | 125 | - | 125 | - | 14,961 | 5,066 | 20,027 |
| **1991** | - | 1 | - | 1 | 40 | 717 | - | 757 | - | 112 | - | 112 | 260 | 21,459 | 4,307 | 26,026 |
| **1992** | 1 | 1 | - | 2 | 41 | 1,351 | - | 1,392 | - | 1,123 | - | 1,123 | 262 | 22,204 | 4,267 | 26,733 |
| **1993** | 0 | 1 | - | 1 | 58 | 2,266 | - | 2,324 | 96 | 1,650 | - | 1,746 | 426 | 20,467 | 4,414 | 25,307 |
| **1994** | 0 | 144 | - | 144 | 37 | 1,682 | - | 1,719 | 23 | 1,028 | - | 1,051 | 269 | 20,523 | 3,822 | 24,614 |
| **1995** | 1 | 155 | - | 156 | 28 | 1,351 | - | 1,379 | 12 | 232 | 1 | 245 | 243 | 16,928 | 2,975 | 20,146 |
| **1996** | 1 | 126 | - | 127 | 22 | 738 | - | 760 | 19 | 308 | - | 327 | 231 | 15,156 | 2,486 | 17,873 |
| **1997** | 1 | 141 | - | 142 | 24 | 1,217 | - | 1,241 | 8 | 1,324 | | 1,332 | 315 | 23,696 | 1,833 | 25,844 |
| **1998** | 0 | 200 | - | 200 | 58 | 1,382 | - | 1,440 | 13 | 575 | 52 | 640 | 350 | 20,740 | 3,246 | 24,336 |
| **1999** | 1 | 278 | - | 279 | 40 | 1,216 | - | 1,256 | 16 | 1,135 | - | 1,151 | 425 | 16,603 | 2,101 | 19,129 |
| **2000** | 1 | 285 | - | 285 | 55 | 1,376 | - | 1,431 | 7 | 879 | 136 | 1,022 | 331 | 17,098 | 2,587 | 20,016 |
| **2001** | 1 | 304 | - | 304 | 34 | 1,477 | 325 | 1,836 | 6 | 1,742 | 204 | 1,952 | 364 | 25,811 | 2,303 | 28,477 |
| **2002** | 1 | 273 | - | 274 | 39 | 1,792 | 17 | 1,848 | 10 | 2,467 | 14 | 2,491 | 487 | 27,848 | 2,137 | 30,472 |
| **2003** | 4 | 290 | - | 294 | 96 | 1,174 | - | 1,270 | 11 | 1,387 | - | 1,398 | 504 | 27,006 | 360 | 27,870 |
| **2004** | 1 | 207 | - | 208 | 36 | 1,400 | 17 | 1,453 | 9 | 1,384 | - | 1,393 | 313 | 23,732 | 326 | 24,371 |
| **2005** | 1 | 232 | - | 233 | 40 | 805 | 15 | 860 | 10 | 896 | - | 906 | 432 | 15,790 | 4,694 | 20,916 |
| **2006** | 1 | 262 | - | 263 | 50 | 658 | 61 | 769 | 30 | 101 | 375 | 506 | 505 | 13,493 | 4,061 | 18,059 |
| **2007** | 2 | * | * | 2 | 49 | 114 | 10 | 173 | 19 | 41 | * | 60 | 382 | 980 | 21 | 1,383 |

**TABLE A-2c.** Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels of more than 363 t carrying capacity only, of other species, in metric tons, in the EPO, 1978-2007. The data for 2005-2007are preliminary.

**TABLA A-2c.** Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de otras especies, en toneladas métricas, en el OPO, 1978-2007. Los datos de 2005-2007 son preliminares.

| | **Carangids—Carángidos** | | | | | | **Dorado (*Coryphaena* spp.)** | | | | | | **Elasmobranchs—Elasmobranquios** | | | | | | **Other fishes—Otros peces** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PS** | | **LP** | **LL** | **OTR** | **Total** | **PS** | | **LP** | **LL** | **OTR** | **Total** | **PS** | | **LP** | **LL** | **OTR** | **Total** | **PS** | | **LP** | **LL** | **OTR** | **Total** |
| | **Ret.** | **Dis.** | | | | | **Ret.** | **Dis.** | | | | | **Ret.** | **Dis.** | | | | | **Ret.** | **Dis.** | | | | |
| **1978** | 238 | - | 1 | - | - | 239 | 87 | - | - | - | 738 | 825 | 145 | - | - | - | 390 | 535 | 148 | - | - | - | - | 148 |
| **1979** | 81 | - | - | - | - | 81 | 124 | - | - | - | 927 | 1,051 | 7 | - | - | 17 | 1,290 | 1,314 | 478 | - | - | 7 | - | 485 |
| **1980** | 224 | - | 2 | - | - | 226 | 124 | - | - | - | 1,001 | 1,125 | 16 | - | - | 7 | 858 | 881 | 301 | - | - | - | - | 301 |
| **1981** | 111 | - | 17 | - | - | 128 | 410 | - | - | - | 628 | 1,038 | 49 | - | - | 120 | 1,211 | 1,380 | 201 | - | 3 | 51 | - | 255 |
| **1982** | 122 | - | - | - | - | 122 | 274 | - | - | - | 980 | 1,254 | 22 | - | 30 | 215 | 864 | 1,131 | 284 | - | - | 59 | - | 343 |
| **1983** | 1,240 | - | - | - | - | 1,240 | 88 | - | - | - | 3,374 | 3,462 | 34 | - | - | 85 | 695 | 814 | 267 | - | 1 | - | - | 268 |
| **1984** | 414 | - | - | - | - | 414 | 103 | - | - | - | 202 | 305 | 48 | - | - | 6 | 1,039 | 1,093 | 415 | - | - | - | 3 | 418 |
| **1985** | 317 | - | 4 | - | - | 321 | 93 | - | - | - | 108 | 201 | 27 | - | - | 13 | 481 | 521 | 77 | - | - | 7 | - | 84 |
| **1986** | 188 | - | 19 | - | - | 207 | 632 | - | - | - | 1,828 | 2,460 | 29 | - | - | 1 | 1,979 | 2,009 | 94 | - | - | - | - | 94 |
| **1987** | 566 | - | 5 | - | - | 571 | 271 | - | - | - | 4,272 | 4,543 | 96 | - | - | 87 | 1,020 | 1,203 | 210 | - | - | 535 | - | 745 |
| **1988** | 825 | - | 1 | - | - | 826 | 69 | - | - | - | 1,560 | 1,629 | 1 | - | - | 23 | 1,041 | 1,065 | 141 | - | - | 360 | - | 501 |
| **1989** | 60 | - | 2 | - | - | 62 | 210 | - | - | - | 1,680 | 1,890 | 29 | - | - | 66 | 1,025 | 1,120 | 237 | - | - | 152 | - | 389 |
| **1990** | 234 | - | - | - | 1 | 235 | 63 | - | - | - | 1,491 | 1,554 | - | - | - | 280 | 1,095 | 1,375 | 240 | - | - | 260 | 13 | 513 |
| **1991** | 116 | - | - | - | - | 116 | 57 | - | - | 7 | 613 | 677 | 1 | - | 6 | 1112 | 1,345 | 2,464 | 462 | - | 1 | 457 | - | 920 |
| **1992** | 116 | - | - | - | - | 116 | 69 | - | - | 37 | 708 | 814 | - | - | - | 2,293 | 1,190 | 3,483 | 445 | - | - | 182 | - | 627 |
| **1993** | 17 | 64 | - | - | 3 | 84 | 36 | 719 | - | 17 | 724 | 1,496 | 24 | 2,252 | - | 1,026 | 917 | 4,219 | 223 | 477 | 2 | 182 | - | 884 |
| **1994** | 7 | 40 | - | - | 16 | 63 | 279 | 1,237 | - | 46 | 3,459 | 5,021 | 113 | 2,351 | - | 1,234 | 1,315 | 5,013 | 10 | 354 | - | 251 | - | 615 |
| **1995** | 11 | 48 | - | - | 9 | 68 | 110 | 1,097 | - | 39 | 2,127 | 3,373 | 20 | 2,691 | - | 922 | 1,077 | 4,711 | - | 561 | - | 209 | - | 770 |
| **1996** | 55 | 217 | - | - | 57 | 329 | 119 | 1,332 | - | 43 | 183 | 1,677 | 3 | 2,452 | - | 1,120 | 2,151 | 5,726 | 5 | 354 | - | 455 | - | 814 |
| **1997** | 2 | 150 | - | - | 39 | 191 | 36 | 1,241 | - | 6,866 | 3,109 | 11,252 | 22 | 3,465 | - | 956 | 2,328 | 6,772 | 14 | 426 | - | 847 | - | 1,287 |
| **1998** | 57 | 178 | - | - | 4 | 239 | 15 | 836 | - | 2,528 | 9,167 | 12,546 | 6 | 3,227 | - | 2,099 | 4,392 | 9,724 | 65 | 983 | - | 1,338 | - | 2,386 |
| **1999** | 35 | 216 | 1 | - | - | 252 | 75 | 1,262 | - | 6,283 | 1,160 | 8,780 | - | 2,208 | - | 5,997 | 2,088 | 10,293 | 86 | 762 | - | 973 | - | 1,821 |
| **2000** | 57 | 121 | - | 4 | 4 | 186 | 109 | 1,547 | - | 3,537 | 1,041 | 6,233 | 3 | 1,689 | - | 8,621 | 406 | 10,719 | 1 | 287 | - | 1,487 | - | 1,775 |
| **2001** | - | 170 | - | 18 | 26 | 214 | 148 | 2,266 | - | 15,942 | 2,825 | 21,182 | - | 1,555 | - | 12,551 | 107 | 14,214 | - | 517 | - | 1,721 | 1 | 2,239 |
| **2002** | - | 135 | - | 15 | 20 | 171 | 45 | 1,849 | - | 11,806 | 4,137 | 17,837 | - | 682 | - | 14,694 | 99 | 15,475 | - | 517 | - | 1,895 | 0 | 2,412 |
| **2003** | - | 160 | - | 54 | - | 214 | 23 | 904 | - | 5,053 | 288 | 6,269 | - | 1,826 | - | 14,594 | 372 | 16,793 | - | 245 | - | 4,518 | - | 4,762 |
| **2004** | - | 161 | - | 1 | - | 162 | 99 | 1,005 | - | 3,969 | 4,645 | 9,718 | - | 1,455 | 9 | 11,040 | 164 | 12,668 | 14 | 684 | - | 515 | - | 1,213 |
| **2005** | 61 | 106 | - | - | - | 167 | 111 | 1,073 | - | 3,846 | 8,667 | 13,697 | - | 1,019 | 4 | 11,899 | 220 | 13,143 | 195 | 206 | - | 403 | - | 804 |
| **2006** | 133 | 468 | - | - | - | 601 | 132 | 1,272 | - | 1,849 | 13,122 | 16,375 | - | 1,308 | 8 | 2,599 | 2,810 | 6,725 | 509 | 386 | - | 103 | - | 998 |
| **2007** | 124 | 451 | 9 | * | * | 584 | 332 | 1,313 | * | 534 | 2,126 | 4,305 | 4 | 771 | * | 240 | * | 1,015 | 508 | 334 | * | 234 | * | 1,076 |

**TABLE A-3a.** Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2003. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.
**TABLA A-3a.** Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2003 Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

| 2003 | | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| BLZ | LL | 353 | 0 | 604 | 42 | 600 | 0 | 0 | 0 | 1,599 |
| CAN | LTL | 0 | 0 | 0 | 0 | 6,295 | 0 | 0 | 0 | 6,295 |
| CHL | LL | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 13 |
| | NK | 73 | 0 | 14 | 0 | 1 | 0 | 24 | 0 | 112 |
| CHN | LL | 2,739 | 0 | 10,066 | 0 | 1,743 | 0 | 0 | 0 | 14,548 |
| COL | PS | 17,638 | 5,862 | 258 | 0 | 0 | 0 | 0 | 0 | 23,758 |
| CRI | LL | 1,418 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 1,436 |
| ECU | LL | 148 | 293 | 0 | 0 | 0 | 0 | 0 | 0 | 441 |
| | NK | 0 | 93 | 0 | 0 | 0 | 0 | 0 | 0 | 93 |
| | PS | 33,027 | 139,232 | 24,711 | 0 | 0 | 61 | 0 | 38 | 197,069 |
| ESP | LL | 0 | 0 | 58 | 0 | 0 | 0 | 0 | 186 | 244 |
| | PS | 3,737 | 28,778 | 7,895 | 0 | 0 | 0 | 0 | 0 | 40,410 |
| JPN | LL | 9,125 | 50 | 24,888 | 3 | 2,122 | 0 | 0 | 0 | 36,187 |
| KOR | LL | 4,911 | 25 | 10,272 | 0 | 343 | 0 | 0 | 0 | 15,551 |
| MEX | LL | 365 | 0 | 0 | 43 | 0 | 0 | 0 | 0 | 408 |
| | LP | 468 | 637 | 0 | 0 | 0 | 6 | 0 | 0 | 1,111 |
| | PS | 172,164 | 8,793 | 8 | 3,211 | 29 | 193 | 0 | 0 | 184,398 |
| PAN | PS | 24,888 | 13,554 | 4,621 | 0 | 0 | 3 | 0 | 10 | 43,076 |
| PER | NK | 806 | 2,575 | 0 | 0 | 0 | 117 | 0 | 750 | 4,248 |
| PYF | LL | 462 | 60 | 346 | 0 | 3,233 | 0 | 0 | 144 | 4,246 |
| TWN | LL | 3,477 | 172 | 12,016 | 0 | 12,663 | 0 | 0 | 0 | 28,328 |
| USA | GN | 0 | 9 | 6 | 14 | 16 | 0 | 1 | 0 | 46 |
| | LL | 5 | 1 | 232 | 0 | 24 | 0 | 0 | 4 | 266 |
| | LP | 2 | 1 | 0 | 3 | 59 | 0 | 1 | 0 | 66 |
| | LTL | 0 | 0 | 0 | 0 | 11,622 | 0 | 0 | 0 | 11,622 |
| | PS | 906 | 8,242 | 2,779 | 22 | 3 | 163 | 0 | 25 | 12,140 |
| | RG | 266 | 100 | 1 | 390 | 2,212 | 0 | 0 | 0 | 2,969 |
| VEN | PS | 95,168 | 7,883 | 438 | 0 | 0 | 0 | 0 | 0 | 103,489 |
| VUT | LL | 699 | 0 | 1,258 | 0 | 4,133 | 0 | 0 | 0 | 6,090 |
| | PS | 2,925 | 21,182 | 6,510 | 0 | 0 | 13 | 0 | 0 | 30,630 |
| OTR[1] | LL[2] | 1,472 | 33 | 18 | 0 | 438 | 0 | 0 | 39 | 2,001 |
| | PS[3] | 30,654 | 41,003 | 6,954 | 0 | 2 | 0 | 0 | 8 | 78,621 |

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

**TABLE A-3b.** Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2004. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.
**TABLA A-3b.** Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2004 Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

| 2004 | | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| BLZ | LL | 190 | 26 | 120 | 0 | 296 | 0 | 0 | 0 | 632 |
| CAN | LTL | 0 | 0 | 0 | 0 | 7,676 | 0 | 0 | 0 | 7,676 |
| CHL | LL | 86 | 0 | 9 | 0 | 8 | 27 | 8 | 0 | 138 |
| CHN | LL | 798 | 0 | 2,645 | 0 | 590 | 0 | 0 | 0 | 4,034 |
| CRI | LL | 1,701 | 0 | 21 | 0 | 0 | 0 | 0 | 0 | 1,722 |
| ECU | LL | 0 | 0 | 312 | 0 | 0 | 0 | 0 | 0 | 312 |
| | NK | 0 | 0 | 185 | 0 | 0 | 0 | 0 | 0 | 185 |
| | PS | 40,839 | 89,120 | 31,368 | 0 | 0 | 97 | 7 | 12 | 161,442 |
| ESP | LL | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 318 | 323 |
| HND | PS | 1,056 | 3,602 | 1,830 | 0 | 0 | 0 | 0 | 1 | 6,489 |
| JPN | LL | 7,338 | 97 | 21,236 | 2 | 2,264 | 0 | 0 | 0 | 30,936 |
| KOR | LL | 2,997 | 31 | 10,729 | 0 | 783 | 0 | 0 | 0 | 14,540 |
| MEX | LL | 32 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 46 |
| | LP | 1,882 | 528 | 0 | 0 | 0 | 0 | 0 | 0 | 2,410 |
| | PS | 90,902 | 24,968 | 0 | 8,880 | 104 | 418 | 8 | 54 | 125,333 |
| NIC | LL | 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 43 |
| PAN | LL | 2,802 | 148 | 48 | 0 | 143 | 0 | 0 | 11 | 3,152 |
| PAN | PS | 31,236 | 20,184 | 11,261 | 0 | 0 | 25 | 0 | 2 | 62,708 |
| PER | NK | 291 | 1,098 | 0 | 0 | 0 | 862 | 0 | 258 | 2,509 |
| PYF | LL | 767 | 56 | 405 | 0 | 1,802 | 0 | 0 | 143 | 3,173 |
| TWN | LL | 1,824 | 339 | 7,384 | 0 | 9,988 | 0 | 0 | 0 | 19,535 |
| USA | GN | 1 | 0 | 0 | 10 | 12 | 0 | 3 | 0 | 26 |
| | LL | 6 | 3 | 149 | 0 | 8 | 0 | 0 | 1 | 167 |
| | LP | 2 | 0 | 0 | 0 | 126 | 0 | 1 | 0 | 129 |
| | LTL | 1 | 0 | 0 | 0 | 12,718 | 0 | 0 | 0 | 12,719 |
| | PS | 2,523 | 5,071 | 3,689 | 0 | 1 | 296 | 0 | 178 | 11,758 |
| | RG | 334 | 7 | 9 | 52 | 1,506 | 0 | 0 | 0 | 1,908 |
| VEN | PS | 54,095 | 12,942 | 1,040 | 0 | 0 | 47 | 0 | 1 | 68,125 |
| VUT | LL | 171 | 0 | 407 | 0 | 2,554 | 0 | 0 | 0 | 3,132 |
| VUT | PS | 1,621 | 8,313 | 5,096 | 0 | 0 | 0 | 0 | 0 | 15,030 |
| OTR[1] | LL | 15 | 13 | 9 | 0 | 256 | 0 | 0 | 31 | 324 |
| | PS[2] | 47,325 | 34,464 | 13,308 | 0 | 0 | 1 | 0 | 12 | 95,110 |

[1] This category is used to avoid revealing the operations of individual vessels or companies—Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes Bolivia, Colombia, El Salvador, Guatemala, Nicaragua, Spain, and Unknown—Incluye Bolivia, Colombia, El Salvador, España, Guatemala, Nicaragua, y Desconocido.

**TABLE A-3c.** Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2005. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.

**TABLA A-3c.** Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2005 Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

| 2005 | | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| BLZ | LL | 164 | 16 | 112 | 0 | 46 | 0 | 0 | 0 | 338 |
| CAN | LTL | 0 | 0 | 0 | 0 | 4,799 | 0 | 0 | 0 | 4,799 |
| CHL | NK | 110 | 0 | 24 | 0 | 7 | 22 | 11 | 0 | 174 |
| CHN | LL | 682 | 0 | 2,104 | 0 | 895 | 0 | 0 | 0 | 3,681 |
| CRI | LL | 1,791 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 1,814 |
| ECU | LL | 0 | 0 | 39 | 0 | 0 | 0 | 0 | 0 | 39 |
| | PS | 40,754 | 138,609 | 32,680 | 0 | 0 | 141 | 40 | 28 | 212,252 |
| ESP | LL | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 362 | 362 |
| HND | PS | 2,215 | 5,406 | 3,618 | 0 | 0 | 0 | 0 | 0 | 11,239 |
| JPN | LL | 4,028 | 41 | 19,401 | 0 | 2,633 | 0 | 0 | 0 | 26,103 |
| KOR | LL | 532 | 0 | 11,580 | 0 | 172 | 0 | 0 | 0 | 12,284 |
| MEX | LP | 1,822 | 1,299 | 0 | 0 | 0 | 0 | 0 | 0 | 3,121 |
| | PS | 111,458 | 31,685 | 0 | 4,542 | 0 | 1,193 | 273 | 92 | 149,244 |
| NIC | LL | 18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 |
| | PS | 6,912 | 2,469 | 33 | 0 | 0 | 0 | 0 | 0 | 9,414 |
| PAN | LL | 1,782 | 94 | 30 | 0 | 91 | 0 | 0 | 0 | 1,997 |
| | PS | 29,897 | 28,055 | 13,026 | 0 | 0 | 8 | 0 | 8 | 70,994 |
| PER | NK | 458 | 365 | 0 | 0 | 0 | 0 | 0 | 427 | 1,250 |
| | OTR | 708 | 1,398 | 0 | 0 | 0 | 0 | 0 | 0 | 2,106 |
| PYF | LL | 530 | 14 | 398 | 0 | 1,572 | 0 | 0 | 146 | 2,661 |
| SLV | PS | 6,905 | 5,258 | 989 | 0 | 0 | 73 | 0 | 60 | 13,285 |
| TWN | LL | 2,422 | 66 | 6,441 | 0 | 3,300 | 0 | 0 | 0 | 12,229 |
| USA | GN | 2 | 0 | 0 | 5 | 20 | 0 | 0 | 0 | 27 |
| | LL | 7 | 1 | 536 | 0 | 13 | 0 | 0 | 9 | 566 |
| | LP | 0 | 0 | 0 | 0 | 66 | 0 | 0 | 0 | 66 |
| | LTL | 0 | 0 | 0 | 0 | 9,033 | 0 | 0 | 0 | 9,033 |
| | NK | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 3 |
| | RG | 574 | 17 | 1 | 77 | 1,719 | 0 | 0 | 0 | 2,388 |
| VEN | PS | 41,604 | 14,015 | 116 | 0 | 0 | 41 | 0 | 2 | 55,778 |
| VUT | LL | * | * | 1,056 | * | 179 | * | * | * | 1,235 |
| OTR[1] | LL | 2 | 0 | 0 | 0 | 57 | 0 | 0 | 1 | 60 |
| | PS[2] | 27,854 | 36,283 | 19,364 | 201 | 2 | 16 | 0 | 0 | 83,720 |

[1] This category is used to avoid revealing the operations of individual vessels or companies—Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

[2] Includes Colombia, Guatemala, Spain, United States, Vanuatu, and Unknown —Incluye Colombia, España, Estados Unidos, Guatemala, Vanuatú, y Desconocido.

**TABLE A-3d.** Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2006. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.
**TABLA A-3d.** Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2006. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

| 2006 | | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| BLZ | LL | 105 | 13 | 75 | * | 8 | * | * | * | 201 |
| CAN | LTL | * | * | * | * | 5,819 | * | * | * | 5,819 |
| CHL | NK | 79 | * | 36 | * | 5 | * | 3 | * | 123 |
| CHN | LL | 36 | * | 709 | * | 13 | * | * | 2 | 760 |
| CRI | LL | 794 | * | 10 | * | * | * | * | * | 804 |
| ECU | PS | 25,544 | 140,610 | 38,597 | * | * | 80 | * | 67 | 204,898 |
| HND | PS | 1,492 | 6,270 | 3,832 | * | * | * | * | * | 11,594 |
| JPN | LL | 3,412 | 20 | 18,017 | 0 | 2,571 | * | * | * | 24,020 |
| KOR | LL | * | * | 8,694 | * | 58 | * | * | * | 8,752 |
| MEX | LP | 686 | 435 | * | * | * | * | 12 | * | 1,133 |
| | PS | 67,958 | 18,220 | 59 | 9,806 | 109 | 1,897 | 3,259 | 31 | 101,339 |
| NIC | PS | 7,201 | 4,886 | 2,486 | * | * | 0 | * | 1 | 14,574 |
| PAN | LL | 2,164 | 114 | 37 | * | 110 | * | * | * | 2,425 |
| | PS | 23,516 | 44,013 | 13,247 | * | * | 8 | * | * | 80,784 |
| PER | NK | 595 | 73 | * | * | * | * | * | 192 | 860 |
| PYF | LL | 537 | 22 | 388 | * | 2,273 | * | * | 156 | 3,376 |
| | NK | 434 | 899 | * | * | 114 | * | * | 100 | 1,547 |
| TWN | LL | 1,671 | 57 | 6,412 | * | 4,235 | * | * | * | 12,375 |
| USA | GN | 1 | 2 | * | 1 | 3 | * | * | 1 | 8 |
| | LL | 20 | * | 86 | * | 13 | * | * | 2 | 121 |
| | LP | * | * | * | * | 22 | * | * | * | 22 |
| | LTL | * | * | * | * | 12,854 | * | * | * | 12,854 |
| | RG | 349 | 12 | * | 101 | 291 | * | * | * | 753 |
| VEN | PS | 17,916 | 23,804 | 3,729 | * | * | 9 | 248 | 0 | 45,706 |
| VUT | LL | * | * | 935 | * | 1,688 | * | * | * | 2,623 |
| OTR[1] | LL | * | * | * | * | 207 | * | * | 3 | 210 |
| | PS[2] | 22,703 | 59,605 | 22,028 | * | * | 5 | * | * | 104,341 |

[1] This category is used to avoid revealing the operations of individual vessels or companies—Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes Bolivia, Colombia, El Salvador, Guatemala, Spain, United States, and Vanuatu—Incluye Bolivia, Colombia, El Salvador, España, Estados Unidos, Guatemala, y Vanuatú.

**TABLE A-3e.** Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2007. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.

**TABLA A-3e.** Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2007 Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

| 2007 | | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| CAN | LTL | * | * | * | * | 6,112 | * | * | * | 6,112 |
| CRI | LL | 59 | * | 4 | * | * | * | * | * | 63 |
| ECU | PS | 19,449 | 93,116 | 38,210 | * | * | 479 | 1,246 | 148 | 152,648 |
| JPN | LL | * | * | 13,262 | * | 332 | * | * | * | 13,594 |
| KOR | LL | * | * | 5,611 | * | 73 | * | * | * | 5,684 |
| MEX | LL | 902 | 866 | * | * | * | 33 | 1,136 | 235 | 3,172 |
| | LP | 894 | 276 | * | * | * | * | 107 | * | 1,277 |
| | PS | 64,506 | 22,459 | 0 | 4,245 | 40 | 1,412 | 14,407 | 304 | 107,373 |
| NIC | PS | 5,228 | 3,040 | 527 | * | * | 0 | * | 0 | 8,795 |
| PAN | LL | * | * | * | * | * | * | * | 2,194 | 2,194 |
| | PS | 28,878 | 23,616 | 8,592 | * | * | 92 | 23 | 3 | 61,204 |
| PER | NK | 152 | 5 | * | * | * | 4 | * | 81 | 242 |
| TWN | LL | * | * | 5,859 | * | 2,030 | * | * | * | 7,889 |
| USA | LL | * | * | 330 | * | * | * | * | * | 330 |
| | RG | 91 | 1 | * | 14 | * | * | * | * | 106 |
| VEN | PS | 24,039 | 21,424 | 1,095 | * | * | 48 | 4 | 16 | 46,626 |
| VUT | LL | * | * | 494 | * | * | * | * | * | 494 |
| OTR[1] | PS[2] | 26,852 | 46,965 | 13,010 | * | * | 36 | * | 232 | 87,095 |

[1] This category is used to avoid revealing the operations of individual vessels or companies—Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

[2] Includes Bolivia, Colombia, El Salvador, Guatemala, Honduras,Spain, United States, Unknown and Vanuatu—Incluye Bolivia, Colombia, El Salvador, España, Estados Unidos, Guatemala, Vanuatú y Desconocido

**TABLE A-4a.** Preliminary estimates of the retained catches and landings, in metric tons, of tunas and bonitos caught by purse-seine and pole-and-line vessels in 2006, by species and vessel flag (upper panel) and locations where processed (lower panel). The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates, and are preliminary.

**TABLA A-4a.** Estimaciones preliminares de las capturas retenidas y descargas, en toneladas métricas, de atunes y bonitos efectuadas por buques cerqueros y cañeros en el OPO en 2006, por especie y bandera del buque (panel superior) y localidad donde fueron procesadas (panel inferior). Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a las estimaciones de composición por especie, y son preliminares.

| | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Retained catches–Capturas retenidas** | | | | | | | | | |
| ECU | 25,544 | 140,610 | 38,597 | * | * | 80 | * | 67 | 204,898 | 36.3 |
| HND | 1,492 | 6,270 | 3,832 | * | * | * | * | * | 11,594 | 2.0 |
| MEX | 68,644 | 18,655 | 59 | 9,806 | 109 | 1,897 | 3,270 | 31 | 102,472 | 18.2 |
| NIC | 7,201 | 4,886 | 2,486 | * | * | * | * | 1 | 14,574 | 2.6 |
| PAN | 23,516 | 44,013 | 13,247 | * | * | 8 | * | * | 80,784 | 14.3 |
| VEN | 17,916 | 23,804 | 3,729 | * | * | 9 | 248 | * | 45,706 | 8.1 |
| OTR[1] | 22,703 | 59,605 | 22,028 | * | 22 | 5 | * | * | 104,363 | 18.5 |
| **Total** | 167,016 | 297,843 | 83,978 | 9,806 | 131 | 1,999 | 3,518 | 99 | 564,390 | |
| | **Landings–Descargas** | | | | | | | | | |
| COL | 14,831 | 20,932 | 6,352 | * | * | 8 | * | * | 42,123 | 7.4 |
| ECU | 52,289 | 212,908 | 67,705 | * | * | 82 | 248 | 67 | 333,299 | 59.0 |
| MEX | 68,511 | 17,958 | 0 | 9,806 | 109 | 1,897 | 3,270 | 31 | 101,582 | 18.0 |
| VEN | 13,862 | 16,047 | 560 | * | * | 9 | * | * | 30,478 | 5.4 |
| OTR[2] | 24,635 | 25,347 | 7,724 | * | 22 | 3 | * | 1 | 57,732 | 10.2 |
| **Total** | 174,128 | 293,191 | 82,342 | 9,806 | 131 | 1,999 | 3,518 | 99 | 565,214 | |

[1] Includes Colombia, Guatemala, Spain, United States, Vanuatu, and Unknown. This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye, Colombia, España, Guatemala, Estados Unidos, Vanuatú, y Desconocido. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatamala, Peru, Spain, United States, and Unknown. This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador, España, Estados Unidos, Guatamala, Perú, y Desconocido. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

**TABLE A-4b.** Preliminary estimates of the retained catches and landings, in metric tons, of tunas and bonitos caught by purse-seine and pole-and-line vessels in the EPO in 2007, by species and vessel flag (upper panel) and locations where processed (lower panel). The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates, and are preliminary.

**TABLA A-4b.** Estimaciones preliminares de las capturas retenidas y descargas, en toneladas métricas, de atunes y bonitos efectuadas por buques cerqueros y cañeros en el OPO en 2007, por especie y bandera del buque (panel superior) y localidad donde fueron procesadas (panel inferior). Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a las estimaciones de composición por especie, y son preliminares.

| | YFT | SKJ | BET | PBF | ALB | BKJ | BZX | TUN | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Retained catches–Capturas retenidas** | | | | | | | | | |
| ECU | 19,449 | 93,116 | 38,210 | * | * | 479 | 1,246 | 148 | 152,648 | 32.8 |
| MEX | 65,400 | 22,735 | * | 4,245 | 40 | 1,412 | 14,514 | 304 | 108,650 | 23.4 |
| NIC | 5,228 | 3,040 | 527 | * | * | 0 | * | * | 8,795 | 1.9 |
| PAN | 28,878 | 23,616 | 8,592 | * | * | 92 | 23 | 3 | 61,204 | 13.2 |
| VEN | 24,039 | 21,424 | 1,095 | * | * | 48 | 4 | 16 | 46,626 | 10.0 |
| OTR[1] | 26,852 | 46,965 | 13,010 | * | * | 36 | * | 232 | 87,095 | 18.7 |
| **Total** | 169,846 | 210,896 | 61,434 | 4,245 | 40 | 2,067 | 15,787 | 703 | 465,018 | |
| | **Landings–Descargas** | | | | | | | | | |
| COL | 30,412 | 19,212 | 3,390 | * | * | * | * | * | 53,014 | 11.3 |
| ECU | 38,178 | 136,424 | 52,399 | * | * | 595 | 1,439 | 151 | 229,186 | 48.9 |
| MEX | 59,292 | 22,291 | 377 | 4,242 | 39 | 1,382 | 14,343 | 304 | 102,270 | 21.8 |
| VEN | 9,615 | 10,552 | 460 | * | * | 22 | 4 | 5 | 20,658 | 4.4 |
| OTR[2] | 35,165 | 22,416 | 5,760 | 3 | * | 42 | * | 232 | 63,618 | 13.6 |
| **Total** | 172,663 | 210,894 | 62,387 | 4,245 | 39 | 2,041 | 15,786 | 692 | 468,746 | |

[1] Includes Bolivia, Colombia, El Salvador, Guatemala, Spain, United States, and Vanuatu. This category is used to avoid revealing the operations of individual vessels or companies.

[1] Incluye Bolivia, Colombia, El Salvador, España, Estados Unidos, Guatemala, y Vanuatú. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

[2] Includes Costa Rica, El Salvador, Guatemala, Peru, United States, and Unknown. This category is used to avoid revealing the operations of individual vessels or companies.

[2] Incluye Costa. Rica, El Salvador, Estados Unidos, Guatemala, Perú, y Desconocido. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

**TABLE A-5.** Annual retained catches of Pacific bluefin tuna, by gear type and flag, in metric tons. The data for 2005 and 2006 are preliminary.
**TABLA A-5.** Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas métricas. Los datos de 2005 y 2006 son preliminares.

| PBF | Western Pacific flags—Banderas del Pacífico occidental[1] | | | | | | | | | | Eastern Pacific flags—Banderas del Pacífico oriental | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | JPN | | | | KOR[1] | | TWN | | | Sub-total | USA[2] | | MEX | | OTR | Sub-total | |
| | PS | LP | LL | OTR | PS | OTR | PS | LL | OTR | | PS | OTR | PS | OTR | OTR | | |
| **1977** | 5,110 | 2,256 | 712 | 5,519 | - | - | - | 131 | - | 13,727 | 3,265 | 44 | 2,184 | - | | 5,493 | 19,220 |
| **1978** | 10,427 | 1,154 | 1,049 | 9,486 | - | - | - | 66 | - | 22,183 | 4,663 | 12 | 546 | - | | 5,221 | 27,404 |
| **1979** | 13,881 | 1,250 | 1,223 | 9,418 | - | - | - | 58 | - | 25,830 | 5,889 | 24 | 213 | - | | 6,126 | 31,956 |
| **1980** | 11,327 | 1,392 | 1,170 | 5,945 | - | - | - | 114 | - | 19,948 | 2,327 | 31 | 582 | - | | 2,940 | 22,888 |
| **1981** | 25,430 | 754 | 796 | 6,428 | - | - | - | 179 | - | 33,587 | 867 | 9 | 218 | - | | 1,094 | 34,681 |
| **1982** | 19,234 | 1,777 | 880 | 4,161 | 31 | - | - | 207 | 11 | 26,302 | 2,639 | 12 | 506 | - | | 3,157 | 29,459 |
| **1983** | 14,784 | 356 | 707 | 3,883 | 13 | - | 9 | 175 | 12 | 19,939 | 621 | 34 | 214 | - | | 869 | 20,808 |
| **1984** | 4,433 | 587 | 360 | 4,797 | 4 | - | 5 | 477 | - | 10,664 | 673 | 65 | 167 | - | | 905 | 11,569 |
| **1985** | 4,162 | 1,817 | 496 | 5,475 | 1 | - | 80 | 210 | 67 | 12,308 | 3,320 | 111 | 676 | - | | 4,107 | 16,415 |
| **1986** | 7,412 | 1,086 | 249 | 4,944 | 344 | - | 16 | 70 | 81 | 14,202 | 4,851 | 66 | 189 | - | | 5,106 | 19,308 |
| **1987** | 8,672 | 1,565 | 346 | 3,536 | 89 | - | 21 | 365 | 87 | 14,681 | 861 | 54 | 119 | - | | 1,034 | 15,715 |
| **1988** | 3,601 | 907 | 241 | 2,436 | 32 | - | 197 | 108 | 431 | 7,953 | 923 | 49 | 448 | 1 | | 1,421 | 9,374 |
| **1989** | 6,166 | 754 | 440 | 1,977 | 71 | - | 259 | 205 | 578 | 10,450 | 1,045 | 129 | 57 | - | | 1,231 | 11,681 |
| **1990** | 2,959 | 536 | 396 | 2,359 | 132 | - | 149 | 189 | 454 | 7,174 | 1,380 | 151 | 50 | - | | 1,581 | 8,755 |
| **1991** | 4,336 | 286 | 285 | 3,994 | 265 | - | - | 342 | 107 | 9,614 | 411 | 94 | 9 | - | | 514 | 10,128 |
| **1992** | 4,255 | 166 | 573 | 3,102 | 288 | - | 73 | 464 | 76 | 8,998 | 1,928 | 117 | 0 | - | | 2,045 | 11,043 |
| **1993** | 5,156 | 129 | 857 | 1,645 | 40 | - | 1 | 471 | 4 | 8,302 | 579 | 329 | 0 | - | | 908 | 9,210 |
| **1994** | 7,345 | 162 | 1,138 | 4,887 | 50 | - | - | 559 | - | 14,141 | 906 | 120 | 63 | 2 | | 1,091 | 15,232 |
| **1995** | 5,334 | 270 | 769 | 6,702 | 821 | - | - | 335 | 2 | 14,233 | 619 | 275 | 10 | - | | 904 | 15,137 |
| **1996** | 5,540 | 94 | 978 | 4,628 | 102 | - | - | 956 | - | 12,299 | 4,523 | 87 | 3,700 | - | | 8,310 | 20,609 |
| **1997** | 6,137 | 34 | 1,383 | 3,817 | 1054 | - | - | 1814 | - | 14,239 | 2,240 | 266 | 368 | - | | 2,874 | 17,113 |
| **1998** | 2,715 | 85 | 1,260 | 3,663 | 188 | - | - | 1910 | - | 9,820 | 1,771 | 585 | 1 | - | | 2,357 | 12,177 |
| **1999** | 11,619 | 35 | 1,155 | 4,411 | 256 | - | - | 3089 | - | 20,565 | 184 | 656 | 2,369 | 35 | | 3,244 | 23,809 |
| **2000** | 8,193 | 102 | 1,005 | 5,763 | 794 | - | - | 2780 | 2 | 18,638 | 693 | 378 | 3,019 | 99 | | 4,188 | 22,827 |
| **2001** | 3,139 | 180 | 1,004 | 4,947 | 995 | 10 | - | 1839 | 104 | 12,218 | 28 | 395 | 863 | - | | 1,287 | 13,505 |
| **2002** | 4,171 | 99 | 889 | 4,023 | 674 | 1 | - | 1523 | 4 | 11,384 | 0 | 360 | 1,708 | 2 | | 2,070 | 13,454 |
| **2003** | 945 | 44 | 1,230 | 3,246 | 1591 | - | - | 1863 | 21 | 8,940 | 22 | 412 | 3,211 | 43 | | 3,688 | 12,628 |
| **2004** | 4,792 | 132 | 1,311 | 4,054 | 636 | - | - | 1714 | - | 12,639 | 0 | 59 | 8,880 | 14 | | 8,953 | 21,592 |
| **2005** | 3,927 | 549 | 1,824 | 8,702 | 950 | - | - | 1368 | - | 17,319 | 201 | 84 | 4,542 | * | | 4,827 | 22,147 |
| **2006** | 3,780 | 108 | 1,037 | 5,049 | * | - | - | 1148 | - | 11,123 | * | 96 | 9,795 | * | | 9,891 | 21,013 |

[1] Source: International Scientific Committee, Report of the 7th Working Group on Pacific Bluefin Tuna, December 2007, Table 1—Fuente: Comité Científico Internacional, Informe del 7º Grupo de Trabajo sobre el Atún Aleta Azul del Pacífico, diciembre de 2007, Tabla 1.

**TABLE A-6a.** Annual retained catches of North Pacific albacore by region and gear, in metric tons, compiled from IATTC data (EPO) and SPC data (WCPO). The data for 2006 and 2007 are preliminary.
**TABLA A-6a.** Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas, compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2006 y 2007 son preliminares.

| ALB (N) | Eastern Pacific Ocean Océano Pacífico oriental | | | | | | Western and central Pacific Ocean Océano Pacífico occidental y central | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LL | LP | LTL | PS | OTR | Subtotal | LL | LP | LTL | OTR | Subtotal | |
| **1978** | 790 | 1,577 | 16,613 | 155 | 821 | 19,956 | 12,610 | 57,018 | 23 | 6,406 | 76,057 | 96,013 |
| **1979** | 1,394 | 179 | 4,955 | 148 | 74 | 6,750 | 13,163 | 45,635 | 2,347 | 4,144 | 65,289 | 72,039 |
| **1980** | 1,268 | 407 | 5,421 | 194 | 168 | 7,458 | 14,245 | 43,495 | 2,347 | 4,534 | 64,620 | 72,079 |
| **1981** | 2,040 | 608 | 12,039 | 99 | 227 | 15,013 | 16,517 | 26,375 | 798 | 11,293 | 54,983 | 69,996 |
| **1982** | 1,971 | 198 | 3,303 | 355 | 257 | 6,084 | 15,693 | 29,744 | 3,410 | 13,696 | 62,543 | 68,627 |
| **1983** | 1,572 | 449 | 7,751 | 7 | 87 | 9,866 | 14,416 | 20,155 | 1,833 | 7,463 | 43,867 | 53,733 |
| **1984** | 2,592 | 1,441 | 8,343 | 3,910 | 1427 | 17,713 | 12,972 | 25,928 | 1,011 | 17,285 | 57,196 | 74,909 |
| **1985** | 1,312 | 877 | 5,308 | 42 | 1176 | 8,714 | 13,252 | 21,967 | 1,163 | 13,776 | 50,158 | 58,873 |
| **1986** | 698 | 86 | 4,282 | 47 | 196 | 5,309 | 12,349 | 14,525 | 456 | 10,819 | 38,149 | 43,458 |
| **1987** | 1,114 | 320 | 2,300 | 1 | 171 | 3,906 | 14,171 | 19,103 | 570 | 11,578 | 45,422 | 49,328 |
| **1988** | 899 | 271 | 4,202 | 17 | 64 | 5,454 | 14,417 | 7,839 | 165 | 18,892 | 41,312 | 46,766 |
| **1989** | 957 | 21 | 1,852 | 1 | 160 | 2,991 | 12,921 | 11,241 | 148 | 19,425 | 43,735 | 46,726 |
| **1990** | 1,139 | 170 | 2,440 | 39 | 24 | 3,812 | 15,034 | 13,944 | 465 | 26,093 | 55,536 | 59,348 |
| **1991** | 1,514 | 834 | 1,783 | - | 6 | 4,137 | 15,985 | 5,729 | 201 | 11,658 | 33,573 | 37,710 |
| **1992** | 1,635 | 255 | 4,515 | - | 2 | 6,407 | 17,788 | 14,774 | 419 | 17,238 | 50,219 | 56,626 |
| **1993** | 1,772 | 1 | 4,331 | - | 25 | 6,129 | 28,777 | 12,844 | 2,417 | 2,878 | 46,916 | 53,045 |
| **1994** | 2,356 | 85 | 9,574 | - | 106 | 12,121 | 28,015 | 30,439 | 3,560 | 3,576 | 65,590 | 77,711 |
| **1995** | 1,381 | 465 | 7,306 | - | 102 | 9,254 | 30,911 | 22,619 | 3,452 | 1,725 | 58,707 | 67,961 |
| **1996** | 1,675 | 72 | 8,195 | 11 | 88 | 10,041 | 37,286 | 22,548 | 13,654 | 657 | 74,145 | 84,186 |
| **1997** | 1,365 | 59 | 6,057 | 1 | 1018 | 8,500 | 46,000 | 35,056 | 12,617 | 1,749 | 95,422 | 103,922 |
| **1998** | 1,730 | 81 | 11,936 | 42 | 1208 | 14,996 | 45,868 | 27,797 | 8,138 | 1,515 | 83,319 | 98,315 |
| **1999** | 2,701 | 227 | 10,831 | 47 | 3621 | 17,428 | 43,058 | 54,817 | 3,022 | 7,212 | 108,109 | 125,536 |
| **2000** | 1,880 | 86 | 10,874 | 71 | 1798 | 14,710 | 38,840 | 21,767 | 4,371 | 2,940 | 67,917 | 82,627 |
| **2001** | 1,822 | 157 | 11,597 | 3 | 1635 | 15,215 | 34,250 | 29,254 | 5,141 | 1,372 | 70,016 | 85,231 |
| **2002** | 1,226 | 382 | 11,906 | 31 | 2357 | 15,901 | 21,782 | 49,574 | 4,417 | 3,631 | 79,405 | 95,306 |
| **2003** | 1,125 | 59 | 17,786 | 34 | 2228 | 21,231 | 28,976 | 34,648 | 4,100 | 1,181 | 68,906 | 90,137 |
| **2004** | 919 | 126 | 20,196 | 105 | 1518 | 22,864 | 22,138 | 34,950 | 1,977 | 7,284 | 66,348 | 89,213 |
| **2005** | 2,597 | 66 | 13,708 | 2 | 1739 | 18,112 | 23,853 | 16,504 | 1,016 | 1,505 | 42,878 | 60,990 |
| **2006** | 4,777 | 22 | 18,258 | 109 | 291 | 23,458 | 15,496 | 16,370 | 1,083 | 900 | 33,848 | 57,306 |
| **2007** | 2,448 | * | 6,112 | 37 | * | 8,597 | * | * | * | 6,406 | * | 8,597 |

**TABLE A-6b.** Annual retained catches of South Pacific albacore by region, in metric tons, compiled from IATTC data (EPO) and SPC data (WCPO). The data for 2006 and 2007 are preliminary.

**TABLA A-6b.** Capturas retenidas anuales de atún albacora del Pacífico Sur por región, en toneladas métricas, compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2006 y 2007 son preliminares.

| ALB (S) | Eastern Pacific Ocean Océano Pacífico oriental | | | | Western and central Pacific Ocean Océano Pacífico occidental y central | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| | LL | LTL | OTR | Subtotal | LL | LP | LTL | OTR | Subtotal | |
| **1978** | 11,149 | - | 2 | 11,151 | 21,740 | 100 | 1686 | - | 23,526 | 34,678 |
| **1979** | 4,189 | - | 14 | 4,203 | 21,973 | 100 | 814 | - | 22,887 | 27,090 |
| **1980** | 4,050 | - | 60 | 4,110 | 26,922 | 101 | 1468 | - | 28,491 | 32,601 |
| **1981** | 5,235 | - | 35 | 5,270 | 27,459 | - | 2085 | - | 29,544 | 34,814 |
| **1982** | 6,436 | - | 2 | 6,438 | 21,911 | 1 | 2434 | - | 24,346 | 30,784 |
| **1983** | 5,862 | - | 2 | 5,864 | 18,447 | 0 | 744 | 37 | 19,228 | 25,092 |
| **1984** | 4,120 | - | 24 | 4,144 | 16,220 | 2 | 2773 | 1565 | 20,560 | 24,704 |
| **1985** | 5,955 | - | 170 | 6,125 | 21,183 | - | 3253 | 1767 | 26,203 | 32,328 |
| **1986** | 5,752 | 74 | 149 | 5,975 | 26,889 | - | 1929 | 1797 | 30,615 | 36,590 |
| **1987** | 8,880 | 188 | 3 | 9,071 | 13,090 | 9 | 1946 | 927 | 15,972 | 25,043 |
| **1988** | 9,035 | 1,282 | 0 | 10,317 | 19,250 | - | 3014 | 5283 | 27,546 | 37,863 |
| **1989** | 5,828 | 593 | 90 | 6,510 | 12,396 | - | 7777 | 21878 | 42,051 | 48,562 |
| **1990** | 5,397 | 1,336 | 306 | 7,038 | 13,972 | 245 | 5639 | 7232 | 27,088 | 34,126 |
| **1991** | 6,380 | 795 | 170 | 7,345 | 17,005 | 14 | 7010 | 1319 | 25,348 | 32,693 |
| **1992** | 15,446 | 1,205 | 18 | 16,668 | 15,147 | 11 | 5373 | 47 | 20,578 | 37,246 |
| **1993** | 9,423 | 35 | 19 | 9,476 | 20,807 | 74 | 4261 | 51 | 25,194 | 34,670 |
| **1994** | 8,034 | 441 | 22 | 8,498 | 26,085 | 67 | 6723 | 67 | 32,941 | 41,439 |
| **1995** | 4,804 | 2 | 15 | 4,821 | 24,537 | 139 | 7714 | 89 | 32,479 | 37,300 |
| **1996** | 5,956 | 94 | 21 | 6,071 | 17,861 | 57 | 7285 | 135 | 25,338 | 31,409 |
| **1997** | 8,313 | 466 | - | 8,779 | 18,791 | 21 | 4213 | 133 | 23,158 | 31,937 |
| **1998** | 10,905 | 11 | - | 10,916 | 26,892 | 47 | 6269 | 85 | 33,293 | 44,209 |
| **1999** | 8,932 | 98 | 7 | 9,036 | 22,979 | 138 | 3321 | 67 | 26,505 | 35,541 |
| **2000** | 7,783 | 780 | 3 | 8,565 | 26,185 | 102 | 5489 | 136 | 31,913 | 40,478 |
| **2001** | 17,589 | 528 | 5 | 18,122 | 31,049 | 37 | 4614 | 194 | 35,894 | 54,016 |
| **2002** | 14,064 | 150 | 40 | 14,254 | 46,532 | 18 | 4424 | 112 | 51,085 | 65,340 |
| **2003** | 23,776 | 529 | 1 | 24,306 | 31,831 | 12 | 5083 | 137 | 37,062 | 61,368 |
| **2004** | 17,525 | 445 | - | 17,970 | 43,065 | 110 | 4086 | 124 | 47,385 | 65,356 |
| **2005** | 6,304 | 181 | 7 | 6,492 | 51,004 | 22 | 3483 | 130 | 54,639 | 61,131 |
| **2006** | 6,192 | 622 | 114 | 6,927 | 59,013 | 37 | 2264 | 83 | 61,397 | 68,324 |
| **2007** | * | * | * | * | * | * | * | * | * | * |

**TABLE A-7.** Estimated numbers of sets, by set type and vessel capacity category, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2007 are preliminary. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary.

**TABLA A-7.** Números estimados de lances, por tipo de lance y categoría de capacidad de buque, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de 2007 son preliminares. Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a la estimación de composición por especie, y son preliminares.

| | Number of sets—Número de lances | | | Retained catch—Captura retenida | | |
|---|---|---|---|---|---|---|
| | Vessel capacity—Capacidad del buque | | Total | YFT | SKJ | BET |
| | ≤363 t | >363 t | | | | |
| **DEL** | **Sets on fish associated with dolphins<br>Lances sobre peces asociados con delfines** | | | | | |
| **1990** | 31 | 10,997 | 11,028 | 173,894 | 1,351 | 0 |
| **1991** | 0 | 9,661 | 9,661 | 155,283 | 1,332 | 0 |
| **1992** | 26 | 10,398 | 10,424 | 165,647 | 1,262 | 0 |
| **1993** | 34 | 6,953 | 6,987 | 110,893 | 587 | 51 |
| **1994** | 5 | 7,804 | 7,809 | 125,345 | 1,106 | 1 |
| **1995** | 0 | 7,185 | 7,185 | 132,710 | 2,548 | 1 |
| **1996** | 14 | 7,472 | 7,486 | 138,466 | 1,761 | 57 |
| **1997** | 43 | 8,977 | 9,020 | 152,228 | 8,157 | 0 |
| **1998** | 0 | 10,645 | 10,645 | 154,528 | 4,998 | 6 |
| **1999** | 0 | 8,648 | 8,648 | 143,166 | 1,705 | 5 |
| **2000** | 0 | 9,235 | 9,235 | 147,744 | 538 | 15 |
| **2001** | 0 | 9,823 | 9,823 | 238,137 | 1,807 | 6 |
| **2002** | 0 | 12,446 | 12,446 | 301,474 | 3,178 | 2 |
| **2003** | 0 | 13,839 | 13,839 | 264,022 | 13,353 | 1 |
| **2004** | 0 | 11,783 | 11,783 | 175,877 | 10,795 | 3 |
| **2005** | 0 | 12,173 | 12,173 | 166,410 | 12,158 | 2 |
| **2006** | 0 | 8,923 | 8,923 | 91,962 | 4,814 | 0 |
| **2007** | 0 | 8,879 | 8,879 | 91,275 | 3,285 | 0 |
| **OBJ** | **Sets on fish associated with floating objects<br>Lances sobre peces asociados con objetos flotantes** | | | | | |
| **1990** | 719 | 2,558 | 3,277 | 35,527 | 35,571 | 3,995 |
| **1991** | 819 | 2,165 | 2,984 | 25,501 | 39,048 | 2,747 |
| **1992** | 868 | 1,763 | 2,631 | 15,010 | 49,145 | 2,048 |
| **1993** | 493 | 2,063 | 2,556 | 19,614 | 53,009 | 6,141 |
| **1994** | 668 | 2,770 | 3,438 | 20,843 | 51,125 | 33,960 |
| **1995** | 707 | 3,521 | 4,228 | 21,146 | 80,010 | 41,873 |
| **1996** | 1,230 | 4,007 | 5,237 | 27,842 | 69,614 | 58,371 |
| **1997** | 1,699 | 5,653 | 7,352 | 30,007 | 116,764 | 62,704 |
| **1998** | 1,198 | 5,481 | 6,679 | 26,286 | 110,297 | 41,909 |
| **1999** | 630 | 4,620 | 5,250 | 43,052 | 181,547 | 49,330 |
| **2000** | 504 | 3,916 | 4,420 | 42,695 | 120,381 | 92,339 |
| **2001** | 801 | 5,744 | 6,545 | 66,596 | 122,678 | 60,378 |
| **2002** | 857 | 5,781 | 6,638 | 37,806 | 116,584 | 55,919 |
| **2003** | 704 | 5,497 | 6,201 | 30,040 | 181,562 | 52,381 |
| **2004** | 613 | 5,083 | 5,696 | 27,586 | 117,532 | 66,079 |
| **2005** | 638 | 5,122 | 5,760 | 25,623 | 132,463 | 68,141 |
| **2006** | 1,164 | 7,137 | 8,301 | 34,095 | 192,154 | 82,271 |
| **2007** | 1,253 | 6,968 | 8,221 | 29,900 | 123,649 | 59,989 |

**TABLE A-7.** (continued)
**TABLA A-7** (continuación)

| | Number of sets—Número de lances | | | Retained catch—Captura retenida | | |
|---|---|---|---|---|---|---|
| | Vessel capacity—Capacidad del buque | | Total | YFT | SKJ | BET |
| | ≤363 t | >363 t | | | | |
| **NOA** | **Sets on unassociated schools<br>Lances sobre cardúmenes no asociados** | | | | | |
| **1990** | 3,683 | 5,397 | 9,080 | 53,832 | 37,447 | 1,926 |
| **1991** | 3,571 | 3,612 | 7,183 | 50,473 | 21,848 | 2,123 |
| **1992** | 4,010 | 4,079 | 8,089 | 47,464 | 33,876 | 5,131 |
| **1993** | 5,739 | 6,267 | 12,006 | 88,985 | 30,234 | 3,465 |
| **1994** | 5,440 | 5,064 | 10,504 | 62,220 | 17,895 | 938 |
| **1995** | 6,120 | 4,782 | 10,902 | 61,578 | 44,489 | 3,447 |
| **1996** | 5,807 | 5,118 | 10,925 | 72,299 | 32,598 | 2,883 |
| **1997** | 5,334 | 4,693 | 10,027 | 62,643 | 28,535 | 1,568 |
| **1998** | 5,700 | 4,631 | 10,331 | 73,145 | 25,336 | 2,214 |
| **1999** | 5,632 | 6,143 | 11,775 | 95,702 | 78,313 | 1,823 |
| **2000** | 5,439 | 5,482 | 10,921 | 64,792 | 83,388 | 2,286 |
| **2001** | 3,958 | 3,030 | 6,988 | 77,969 | 19,076 | 772 |
| **2002** | 4,923 | 3,409 | 8,332 | 73,227 | 33,541 | 1,519 |
| **2003** | 7,284 | 5,083 | 12,367 | 87,045 | 79,614 | 1,792 |
| **2004** | 4,949 | 5,698 | 10,647 | 66,134 | 70,337 | 1,510 |
| **2005** | 6,068 | 7,857 | 13,925 | 75,566 | 117,159 | 1,683 |
| **2006** | 6,167 | 8,466 | 14,633 | 40,273 | 100,440 | 1,707 |
| **2007** | 4,603 | 7,830 | 12,433 | 47,777 | 83,686 | 1,445 |
| **ALL** | **Sets on all types of schools<br>Lances sobre todos tipos de cardumen** | | | | | |
| **1990** | 4,433 | 18,952 | 23,385 | 263,253 | 74,369 | 5,921 |
| **1991** | 4,390 | 15,438 | 19,828 | 231,257 | 62,228 | 4,870 |
| **1992** | 4,904 | 16,240 | 21,144 | 228,121 | 84,283 | 7,179 |
| **1993** | 6,266 | 15,283 | 21,549 | 219,492 | 83,830 | 9,657 |
| **1994** | 6,113 | 15,638 | 21,751 | 208,408 | 70,126 | 34,899 |
| **1995** | 6,827 | 15,488 | 22,315 | 215,434 | 127,047 | 45,321 |
| **1996** | 7,051 | 16,597 | 23,648 | 238,607 | 103,973 | 61,311 |
| **1997** | 7,076 | 19,323 | 26,399 | 244,878 | 153,456 | 64,272 |
| **1998** | 6,898 | 20,757 | 27,655 | 253,959 | 140,631 | 44,129 |
| **1999** | 6,262 | 19,411 | 25,673 | 281,920 | 261,565 | 51,158 |
| **2000** | 5,943 | 18,633 | 24,576 | 255,231 | 204,307 | 94,640 |
| **2001** | 4,759 | 18,597 | 23,356 | 382,702 | 143,561 | 61,156 |
| **2002** | 5,780 | 21,636 | 27,416 | 412,507 | 153,303 | 57,440 |
| **2003** | 7,988 | 24,419 | 32,407 | 381,107 | 274,529 | 54,174 |
| **2004** | 5,562 | 22,564 | 28,126 | 269,597 | 198,664 | 67,592 |
| **2005** | 6,706 | 25,152 | 31,858 | 267,599 | 261,780 | 69,826 |
| **2006** | 7,331 | 24,526 | 31,857 | 166,330 | 297,408 | 83,978 |
| **2007** | 5,856 | 23,677 | 29,533 | 168,952 | 210,620 | 61,434 |

**TABLE A-8.** Types of floating objects on which sets were made. The 2007 data are preliminary.
**TABLA A-8.** Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2007 son preliminares.

| OBJ | Flotsam Naturales | | FADs Plantados | | Unknown Desconocido | | Total |
|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | |
| **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 | 84.3 | 53 | 0.9 | 5,653 |
| **1998** | 752 | 13.7 | 4,627 | 84.4 | 102 | 1.9 | 5,481 |
| **1999** | 833 | 18.0 | 3,758 | 81.4 | 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 | 102 | 1.8 | 5,744 |
| **2002** | 756 | 13.1 | 4,953 | 85.7 | 72 | 1.2 | 5,781 |
| **2003** | 713 | 13.0 | 4,744 | 86.3 | 40 | 0.7 | 5,497 |
| **2004** | 590 | 11.6 | 4,469 | 87.9 | 24 | 0.5 | 5,083 |
| **2005** | 578 | 11.3 | 4,439 | 86.7 | 105 | 2.0 | 5,122 |
| **2006** | 728 | 10.2 | 6,371 | 89.3 | 38 | 0.5 | 7,137 |
| **2007** | 607 | 8.7 | 6,290 | 90.3 | 71 | 1.0 | 6,968 |

**TABLE A-9.** Reported nominal longline fishing effort (E; 1000 hooks), and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only, by flag, in the EPO.

**TABLA A-9.** Esfuerzo de pesca palangrero nominal reportado (E; 1000 anzuelos), y captura (C; toneladas métricas) de atunes aleta amarilla, barrilete, patudo, aleta azul del Pacífico, y albacora solamente, por bandera, en el OPO.

| LL | CHN | | JPN | | KOR | | PYF | | TWN | | USA | | OTR[1] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | E | C | E | C | E | C | E | C | E | C | E | C | C |
| **1978** | 0 | 0 | 140,006 | 79,320 | 8,571 | 7,012 | 0 | 0 | 8,743 | 6,525 | 0 | 0 | 0 |
| **1979** | 0 | 0 | 137,769 | 67,932 | 5,021 | 2,305 | 0 | 0 | 3,138 | 2,293 | 0 | 0 | 0 |
| **1980** | 0 | 0 | 138,141 | 75,639 | 11,788 | 5,907 | 0 | 0 | 3,000 | 1,611 | 0 | 0 | 0 |
| **1981** | 0 | 0 | 131,275 | 59,226 | 19,731 | 6,539 | 0 | 0 | 5,952 | 2,949 | 0 | 0 | 0 |
| **1982** | 0 | 0 | 116,200 | 61,370 | 18,612 | 7,488 | 0 | 0 | 8,117 | 3,910 | 0 | 0 | 0 |
| **1983** | 0 | 0 | 127,176 | 69,563 | 14,675 | 6,479 | 0 | 0 | 4,850 | 2,311 | 0 | 0 | 49 |
| **1984** | 0 | 0 | 119,635 | 57,261 | 11,767 | 4,491 | 0 | 0 | 3,730 | 1,734 | 0 | 0 | 0 |
| **1985** | 0 | 0 | 106,758 | 74,348 | 19,785 | 10,508 | 0 | 0 | 3,126 | 1,979 | 0 | 0 | 2 |
| **1986** | 0 | 0 | 160,553 | 111,672 | 30,765 | 17,432 | 0 | 0 | 4,874 | 2,569 | 0 | 0 | 68 |
| **1987** | 0 | 0 | 188,393 | 104,053 | 36,436 | 19,405 | 0 | 0 | 12,267 | 5,335 | 0 | 0 | 273 |
| **1988** | 0 | 0 | 182,694 | 82,383 | 43,056 | 10,172 | 0 | 0 | 9,567 | 4,590 | 0 | 0 | 234 |
| **1989** | 0 | 0 | 170,373 | 84,961 | 43,365 | 4,879 | 0 | 0 | 16,360 | 4,962 | 0 | 0 | 9 |
| **1990** | 0 | 0 | 178,419 | 117,923 | 47,167 | 17,415 | 0 | 0 | 12,543 | 4,755 | 0 | 0 | 0 |
| **1991** | 0 | 0 | 200,365 | 112,337 | 65,024 | 24,644 | 0 | 0 | 17,969 | 5,862 | 0 | 0 | 173 |
| **1992** | 0 | 0 | 191,284 | 93,011 | 45,634 | 13,104 | 500 | 89 | 33,025 | 14,142 | 43 | 12 | 128 |
| **1993** | 0 | 0 | 159,955 | 87,977 | 46,375 | 12,843 | 2,605 | 79 | 18,064 | 6,566 | 325 | 106 | 227 |
| **1994** | 0 | 0 | 163,976 | 92,606 | 44,788 | 13,250 | 3,410 | 574 | 12,588 | 4,883 | 417 | 81 | 523 |
| **1995** | 0 | 0 | 129,598 | 69,435 | 54,979 | 12,778 | 3,452 | 559 | 2,910 | 1,639 | 302 | 25 | 562 |
| **1996** | 0 | 0 | 103,653 | 52,298 | 40,290 | 14,121 | 4,219 | 931 | 5,830 | 3,553 | 823 | 180 | 185 |
| **1997** | 0 | 0 | 96,383 | 59,325 | 30,493 | 16,663 | 5,490 | 1,941 | 8,720 | 5,673 | 507 | 182 | 752 |
| **1998** | 0 | 0 | 106,569 | 50,167 | 51,817 | 15,089 | 6,415 | 2,858 | 10,586 | 5,039 | 462 | 215 | 1,176 |
| **1999** | 0 | 0 | 80,958 | 32,886 | 54,269 | 13,294 | 9,190 | 4,446 | 23,247 | 7,865 | 1,020 | 406 | 1,157 |
| **2000** | 0 | 0 | 79,311 | 45,216 | 33,585 | 18,759 | 10,230 | 4,382 | 18,152 | 7,809 | 1,680 | 469 | 4,868 |
| **2001** | 13,056 | 5,162 | 102,219 | 54,775 | 72,261 | 18,201 | 11,200 | 5,086 | 53,224 | 20,060 | 1,076 | 204 | 15,612 |
| **2002** | 36,756 | 10,398 | 103,919 | 45,401 | 96,273 | 14,370 | 10,700 | 3,238 | 77,051 | 31,773 | 1,400 | 238 | 10,292 |
| **2003** | 43,289 | 14,548 | 101,227 | 36,187 | 71,006 | 15,551 | 14,048 | 4,101 | 74,322 | 28,328 | 236 | 139 | 11,595 |
| **2004** | 15,889 | 4,034 | 76,824 | 30,936 | 55,861 | 14,540 | 17,865 | 3,030 | 51,697 | 19,535 | 1,314 | 262 | 9,180 |
| **2005** | 16,895 | 3,681 | 66,065 | 26,103 | 15,798 | 12,284 | 13,359 | 2,515 | 38,345 | 12,229 | 1,040 | 166 | 5,443 |
| **2006** | * | 758 | 63,157 | 24,020 | * | 8,752 | 11,783 | 3,220 | 49,254 | 12,375 | 2,601 | 557 | 6,053 |

[1] Includes the catches of—Incluye las capturas de: Belize, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, México, Nicaragua, Panamá, Vanuatu

**TABLE A-10.** Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet, 1977-2007. The data for 2007 are preliminary.
**TABLA A-10.** Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO, 1977-2007. Los datos de 2007 son preliminares.

| | PS | | LP | | Total | |
|---|---|---|---|---|---|---|
| | **No.** | **Vol. ($m^3$)** | **No.** | **Vol. ($m^3$)** | **No.** | **Vol. ($m^3$)** |
| **1977** | 253 | 189,967 | 116 | 6,780 | 369 | 196,746 |
| **1978** | 271 | 192,259 | 118 | 6,736 | 389 | 198,995 |
| **1979** | 282 | 195,494 | 50 | 4,341 | 332 | 199,835 |
| **1980** | 270 | 196,476 | 50 | 4,186 | 320 | 200,662 |
| **1981** | 251 | 196,484 | 41 | 3,308 | 292 | 199,792 |
| **1982** | 223 | 178,234 | 40 | 3,016 | 263 | 181,250 |
| **1983** | 215 | 149,404 | 60 | 3,940 | 275 | 153,344 |
| **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 | 180,625 | 13 | 1,311 | 218 | 181,936 |
| **2001** | 205 | 189,966 | 10 | 1,259 | 215 | 191,225 |
| **2002** | 218 | 200,075 | 6 | 925 | 224 | 201,000 |
| **2003** | 215 | 202,674 | 3 | 338 | 218 | 203,012 |
| **2004** | 217 | 206,302 | 3 | 338 | 220 | 206,640 |
| **2005** | 222 | 213,286 | 4 | 498 | 226 | 213,784 |
| **2006** | 226 | 225,950 | 4 | 498 | 230 | 226,448 |
| **2007** | 227 | 226,508 | 4 | 380 | 231 | 226,888 |

**TABLE A-11a.** Estimates of the numbers and well volume (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2006, by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

**TABLA A-11a.** Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2006, por bandera y arte de pesca. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

| Flag Bandera | Gear Arte | Well volume —Volumen de bodega ($m^3$) | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | | <401 | 401-800 | 801-1300 | 1301-1800 | >1800 | No. | Vol. ($m^3$) |
| | | Number—Número | | | | | | |
| BOL | PS | 1 | - | - | - | - | 1 | 222 |
| COL | PS | 2 | 1 | 7 | 3 | - | 13 | 14,439 |
| ECU | PS | 36 | 20 | 17 | 4 | 8 | 85 | 58,580 |
| ESP | PS | - | - | - | - | 3 | 3 | 6,955 |
| GTM | PS | - | - | - | 1 | - | 1 | 1,475 |
| HND | PS | - | 1 | 2 | - | - | 3 | 2,729 |
| MEX | PS | 8 | 11 | 22 | 16 | - | 57 | 55,830 |
| | LP | 4 | - | - | - | - | 4 | 498 |
| NIC | PS | - | 1 | 4 | 2 | - | 7 | 8,308 |
| PAN | PS | 2 | 4 | 8 | 7 | 5 | 26 | 35,007 |
| SLV | PS | - | 1 | 1 | - | 3 | 5 | 8,184 |
| USA | PS | 1 | - | - | 1 | - | 2 | 1,763 |
| VEN | PS | - | - | 11 | 9 | 2 | 22 | 30,788 |
| VUT | PS | - | - | 1 | 1 | - | 2 | 2,163 |
| Grand total—Total general | PS | 50 | 38 | 73 | 44 | 21 | 226 | |
| | LP | 4 | - | - | - | - | 4 | |
| | PS + LP | 54 | 38 | 73 | 44 | 21 | 230 | |
| | | Well volume—Volumen de bodega ($m^3$) | | | | | | |
| Grand total—Total general | PS | 12,709 | 22,428 | 81,201 | 64,327 | 45,285 | | 225,950 |
| | LP | 498 | - | - | - | - | | 498 |
| | PS + LP | 13,207 | 22,428 | 81,201 | 64,327 | 45,285 | | 226,448 |

- : none—ninguno

**TABLE A-11b.** Estimates of the numbers and well volumes (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2007 by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

**TABLA A-11b.** Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2007, por bandera y arte de pesca. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

| Flag<br>Bandera | Gear<br>Arte | Well volume —Volumen de bodega ($m^3$) | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | | <401 | 401-800 | 801-1300 | 1301-1800 | >1800 | No. | Vol. ($m^3$) |
| | | Number—Número | | | | | | |
| BOL | PS | 1 | - | - | - | - | 1 | 222 |
| COL | PS | 3 | 1 | 7 | 3 | - | 14 | 14,689 |
| ECU | PS | 34 | 19 | 16 | 4 | 9 | 82 | 59,147 |
| ESP | PS | - | - | - | - | 3 | 3 | 6,955 |
| GTM | PS | - | - | - | 1 | - | 1 | 1,475 |
| HND | PS | 1 | 1 | 1 | - | - | 3 | 1,700 |
| MEX | PS | 8 | 10 | 23 | 17 | - | 58 | 57,859 |
| | LP | 4 | - | - | - | - | 4 | 380 |
| NIC | PS | - | - | 6 | - | - | 6 | 7,107 |
| PAN | PS | 1 | 4 | 9 | 10 | 4 | 28 | 36,782 |
| PER | PS | - | 1 | - | - | - | 1 | 542 |
| SLV | PS | - | - | 1 | - | 3 | 4 | 7,415 |
| UNK | PS | 2 | - | - | - | - | 2 | 494 |
| USA | PS | 1 | - | - | 2 | - | 3 | 3,288 |
| VEN | PS | - | - | 11 | 9 | 2 | 22 | 29,684 |
| VUT | PS | - | - | 1 | 2 | - | 3 | 3,609 |
| Grand total—Total general | PS | 50 | 36 | 74 | 46 | 21 | 227 | |
| | LP | 4 | - | - | - | - | 4 | |
| | PS + LP | 54 | 36 | 74 | 46 | 21 | 231 | |
| | | Well volume—Volumen de bodega ($m^3$) | | | | | | |
| Grand total—Total general | PS | 12,388 | 20,374 | 82,227 | 67,445 | 44,074 | | 226,508 |
| | LP | 380 | - | - | - | - | | 380 |
| | PS + LP | 12,768 | 20,374 | 82,227 | 67,445 | 44,074 | | 226,888 |

- : none—ninguno

**TABLE A-12.** Minimum, maximum, and average capacity, in thousands of cubic meters, of purse-seine and pole-and-line vessels at sea in the EPO during l997-2006 and in 2007, by month.
**TABLA A-12.** Capacidad mínima, máxima, y media, en miles de metros cúbicos, de los buques cerqueros y cañeros en el mar en el OPO durante 1997-2006 y en 2007 por mes.

| Month Mes | 1997-2006 | | | 2007 |
|---|---|---|---|---|
| | Min | Max | Ave.-Prom. | |
| 1 | 69.6 | 157.7 | 112.9 | 151.6 |
| 2 | 85.9 | 175.3 | 124.3 | 171.9 |
| 3 | 88.1 | 159.4 | 119.7 | 159.9 |
| 4 | 97.7 | 164.2 | 123.8 | 163.6 |
| 5 | 85.7 | 164.4 | 120.9 | 155.7 |
| 6 | 92.7 | 162.9 | 122.2 | 175.0 |
| 7 | 87.6 | 167.6 | 126.5 | 170.4 |
| 8 | 62.2 | 140.2 | 107.6 | 101.0 |
| 9 | 91.9 | 137.7 | 115.1 | 130.8 |
| 10 | 90.4 | 172.2 | 128.6 | 169.7 |
| 11 | 77.3 | 145.0 | 116.2 | 139.5 |
| 12 | 33.1 | 116.4 | 74.3 | 60.2 |
| **Ave.-Prom.** | 80.2 | 155.3 | 116.0 | 145.8 |

## B. YELLOWFIN TUNA

An age-structured, catch-at-length analysis (A-SCALA) was used to assess yellowfin tuna in the eastern Pacific Ocean (EPO). The methods of analysis are described in IATTC Bulletin, Vol. 22, No. 5, and readers are referred to that report for technical details. The stock assessment details are available on the IATTC web site, www.iattc.org.

The assessment reported here is based on the assumption that there is a single stock of yellowfin tuna in the EPO. Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. The purse-seine catches of yellowfin tuna are lower close to the western boundary (150ºW) of the EPO (Figure A-1). The movements of tagged yellowfin tuna are generally over hundreds, rather than thousands, of kilometers, and exchange between the eastern and western Pacific Ocean appears to be limited. This is consistent with the fact that the longline catch-per-unit-of-effort (CPUE) trends differ among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at a local level, although there is some genetic evidence for local isolation. Movement rates between the EPO and the western Pacific cannot be estimated with currently-available tagging data.

The stock assessment requires a substantial amount of information. This includes data on retained catch, discards, fishing effort, and the size compositions of the catches from several different fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure. Several inputs into the latest assessment differ from those used for 2006 (IATTC Fishery Status Report 5). Recent catch and effort data have been incorporated, and earlier data have been updated. The catches are shown in Figure B-1.

Significant levels of fishing mortality have been observed in the yellowfin tuna fishery in the EPO (Figure B-2). These levels are greatest for middle-aged yellowfin. Both recruitment (Figure B-3) and exploitation have had substantial impacts on the yellowfin biomass trajectory (Figure B-4). Most of the yellowfin catch is taken in sets associated with dolphins, and, accordingly, this fishery has the greatest impact on the yellowfin population (Figure B-4), although it has almost the least impact per weight captured of all fisheries. It appears that the yellowfin population has experienced two, or possibly three, different recruitment regimes (1975-1982, 1983-2001, and possibly 2002-2006) corresponding to low, high, and intermediate recruitments. The recruitment regimes correspond to regimes in biomass, with higher-recruitment regimes producing greater biomasses. The spawning biomass ratio (the ratio of the current spawning biomass to that for the unfished stock; SBR) of yellowfin in the EPO was below the level corresponding to the maximum sustainable yield (MSY) during the lower productivity regime of 1975-1982 (which corresponds to SBR levels in 1977-1984), but above that level during the following years, except for the most recent period (2005-2007, Figure B-5). The 1984 increase in the SBR is attributed to the regime change, and the recent decrease may be a reversion to an intermediate recruitment regime. The different productivity regimes may support two different MSY levels and associated SBR levels.

The current SBR is estimated to be above the SBR level at MSY (Figure B-5). However, there is substantial uncertainty in the most recent estimate of SBR, so there is a moderate probability that the current SBR is below the level that would support the MSY. The effort levels are estimated to be below those capable of supporting the MSY (Table B-1 based on the recent (2005-2007) distribution of effort among the different fisheries). However, there is substantial uncertainty in these estimates (Figure B-8). Future projections under the current effort levels and average recruitment indicate that the population will remain above the level corresponding to MSY (Figure B-5). These simulations were carried out using the average recruitment for the 1975-2007 period. Purse-seine catches of 2008 are expected to be greater than those of 2007, but longline catches are expected to remain the same (Figure B-6).

MSY has been stable during the assessment period (Figure B-7), which suggests that the overall pattern of selectivity has not varied a great deal through time.

The analysis indicates that strong cohorts entered the fishery in 1998-2000, and that these cohorts increased the size of the spawning stock during 1999-2001. However, these have been followed by weaker recruitments, so the size of the spawning stock decreased during 2002-2006. The biomass in 2005-2007 was at levels similar to those prior to 1985.

The overall average weights of yellowfin tuna that are caught have consistently been much less than those that would maximize the MSY, 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, unassociated, and pole-and-line fisheries capture younger, smaller fish than do the dolphin-associated and longline fisheries. The longline fisheries and the purse-seine sets in the southern area on yellowfin associated with dolphins capture older, larger yellowfin than do the coastal and northern dolphin-associated fisheries. The MSY calculations indicate that the yield levels could be increased if the fishing effort were diverted to the fisheries that catch larger yellowfin, or would be diminished if fishing effort were diverted to catching smaller fish. Any such changes would also affect the SBR levels in a similar way.

It is predicted that, with the current (2005-2007) level of fishing effort, the conservation measures imposed since 2004 under Resolutions C-04-09 and C-06-02 would maintain the stock above the MSY level, slightly higher than would otherwise have been the case.

The catches during 2006 and 2007 were markedly less than those of the same period of 2004 and 2005. The most likely causes of the lesser catches are declines in recruitment, effort in the dolphin-associated fisheries, and catchability.

A sensitivity analysis was carried out to estimate the effect of a stock-recruitment relationship and alternative average maximum lengths of yellowfin. The results suggest that the model with a stock-recruitment relationship fits the data slightly better than the base case, but this result could also be explained by a regime shift, since spawning biomass is low during the period of low recruitment and high during that of high recruitment. The results from the analysis with a stock-recruitment relationship are more pessimistic, suggesting that the effort level is greater than that corresponding to the MSY (Table B-1). The spawning stock is estimated to have been less than the biomass that would permit the MSY for most of the modeling period, except during 2000-2002.

**Summary**

1. The results are similar to those of the previous assessments, except that the current effort is less than that corresponding to the MSY.
2. There is uncertainty about recent and future recruitment and biomass levels.
3. The recent fishing mortality rates are about equal to those required to produce MSY.
4. Increasing the average weight of the yellowfin caught could increase MSY.
5. There have been two, and possibly three, different recruitment regimes, and the levels of MSY and the biomasses corresponding to the MSY may differ between the regimes. The population may have recently switched from the high to an intermediate recruitment regime.
6. The results are more pessimistic if a stock-recruitment relationship is assumed.

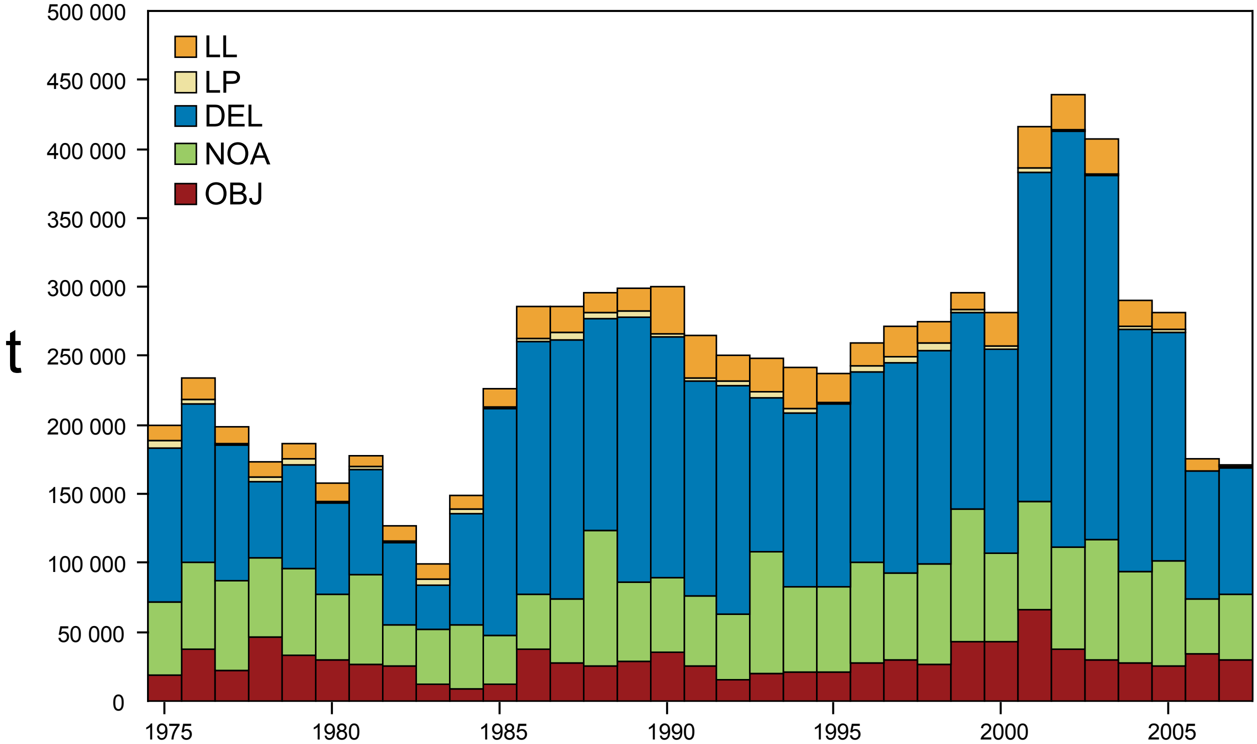


**FIGURE B-1.** Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2007. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2007 catch data are provisional.

**FIGURA B-1.** Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco, y capturas retenidas de las pesquerías cañera y palangreras, de atún aleta amarilla en el Océano Pacífico oriental, 1975-2007. Las capturas cerqueras están ajustadas a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de captura de 2007 son provisionales.

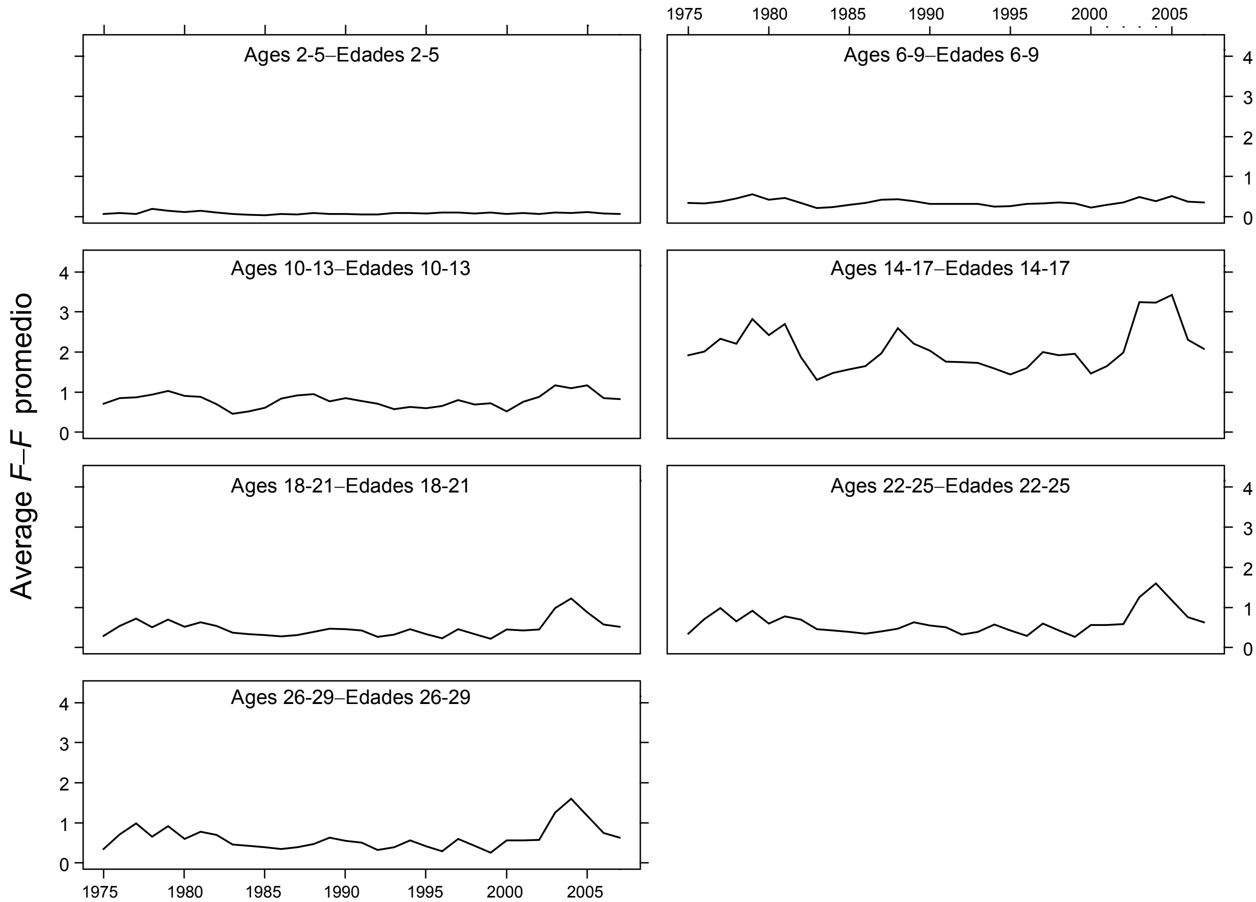


**FIGURE B-2.** Average total annual fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish of the age range indicated in the title of each panel. For example, the trend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

**FIGURA B-2.** Mortalidad por pesca anual total media de atún aleta amarilla reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores anuales 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 los peces de entre 2 y 5 trimestres de edad.

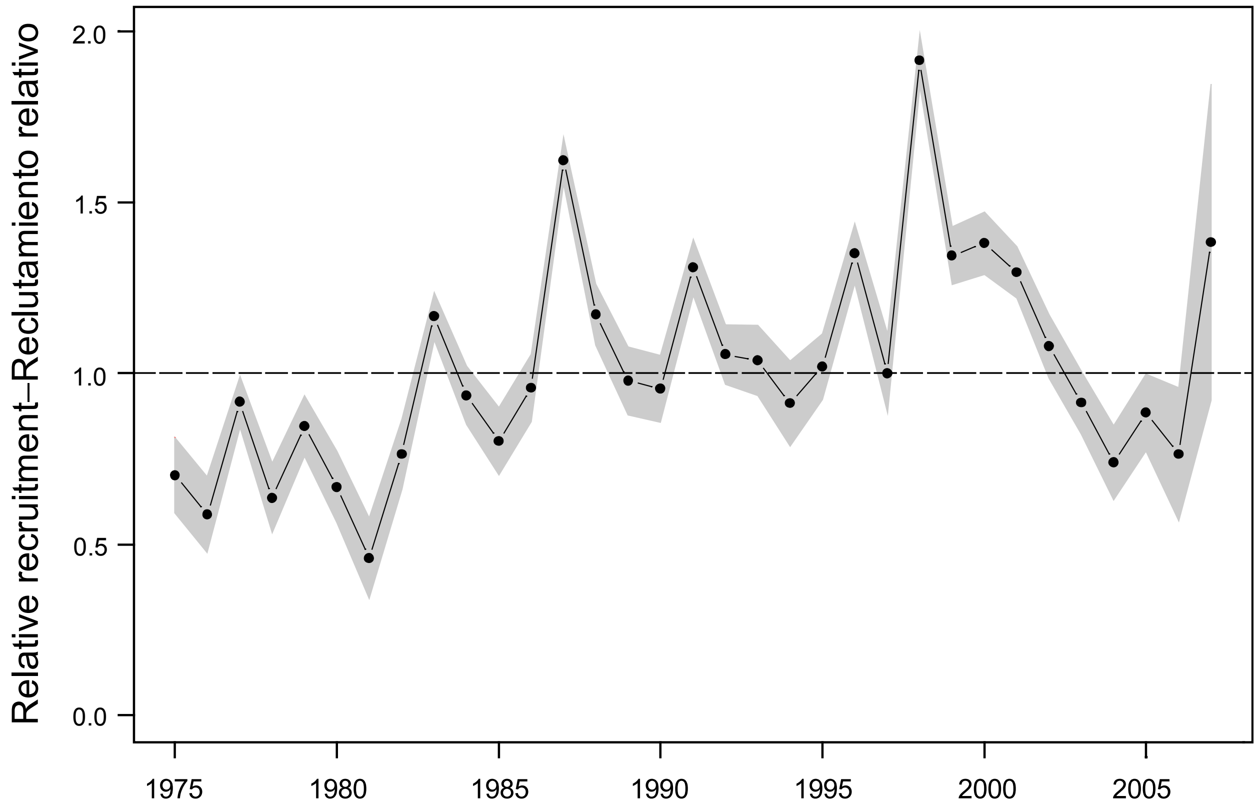


**FIGURE B-3.** Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.

**FIGURA B-3.** 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 sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

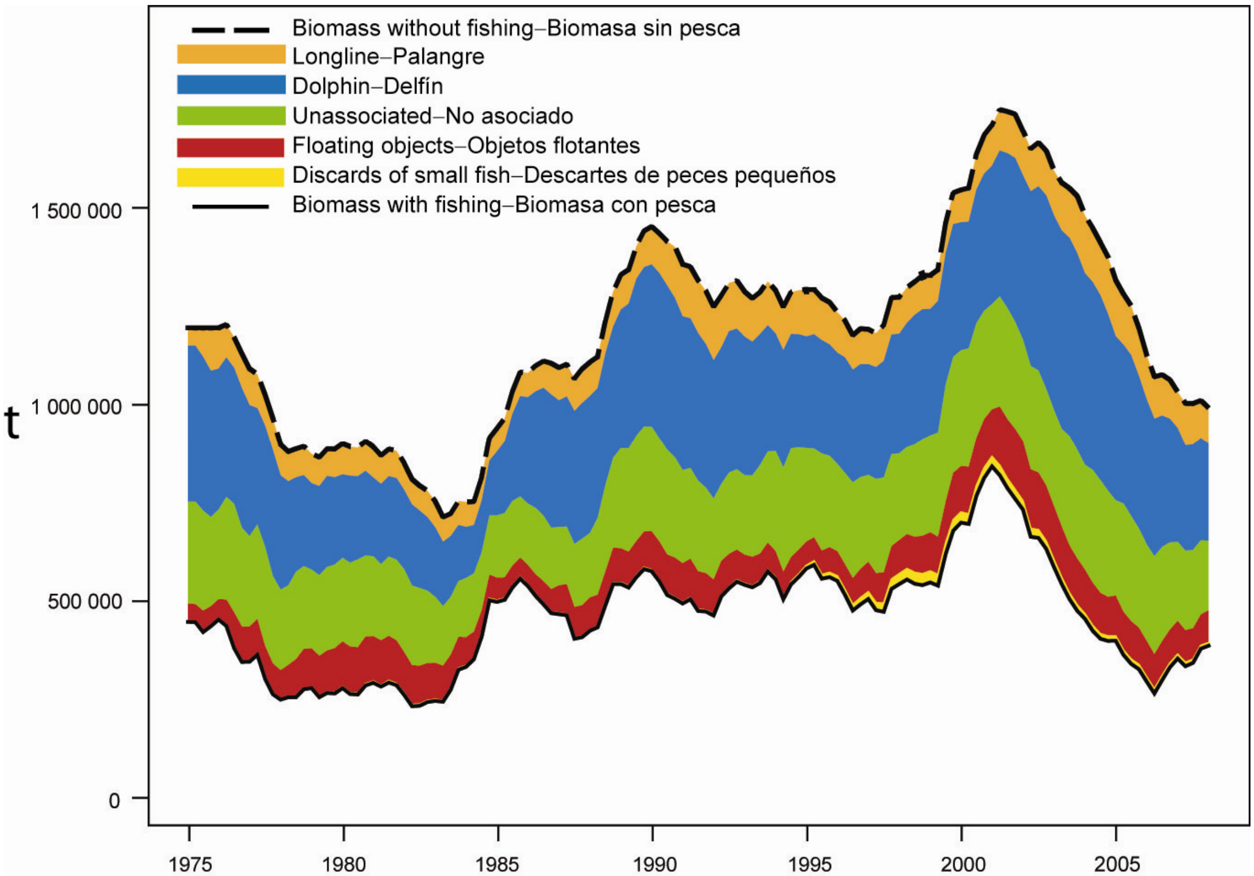


**FIGURE B-4.** Biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2007 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing method.
**FIGURA B-4.** Trayectoria de la biomasa de una población simulada de atún aleta amarilla no explotada durante 1975-2007 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas sombreadas entre las dos líneas represantan la porción del impacto de la pesca atribuida a cada método de pesca.

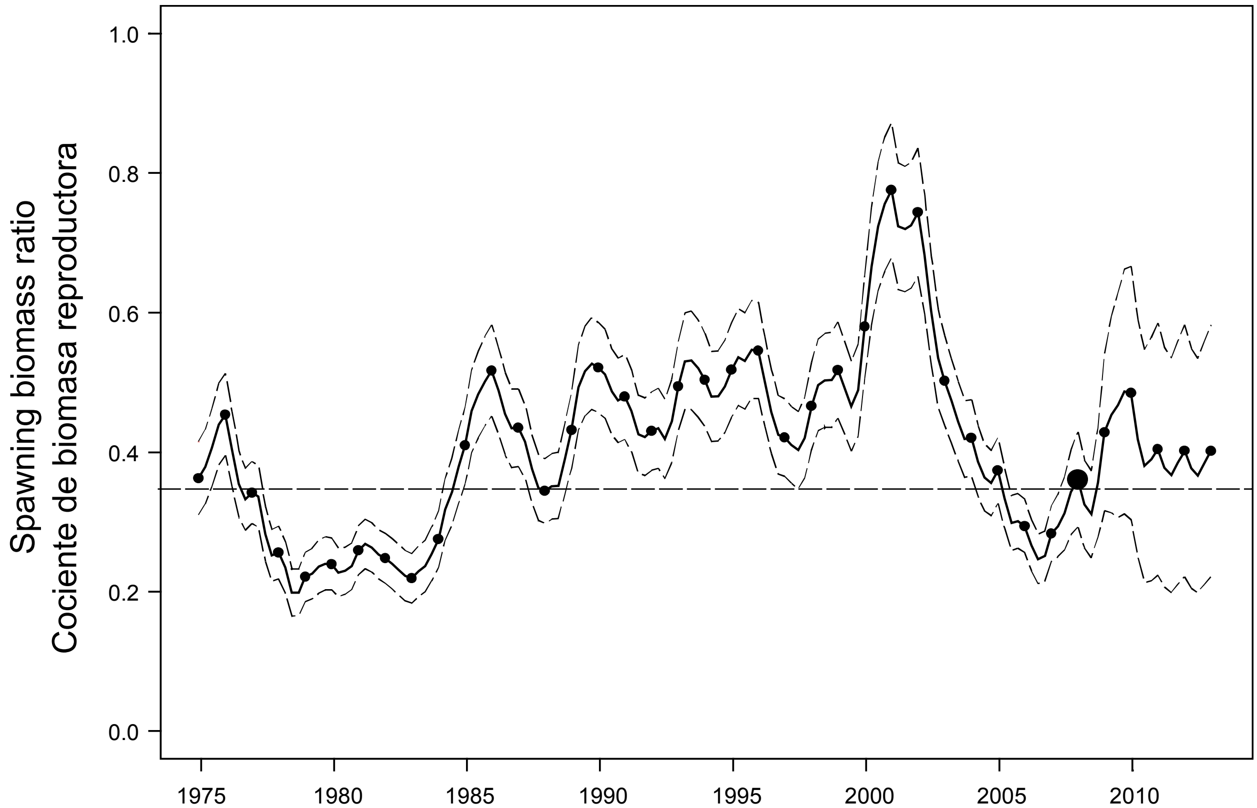


**FIGURE B-5.** Spawning biomass ratios (SBRs) for 1975-2007 and SBRs projected during 2008-2013 for yellowfin tuna in the EPO. The dashed horizontal line (at 0.34) identifies $SBR_{MSY}$. The shaded area represents the 95% confidence limits of the estimates. The estimates after 2008 (the large dot represents the start of the second quarter of 2008) indicate the SBR predicted to occur if effort continues at the current level (2005-2007), and average environmental conditions occur during the next five years.

**FIGURA B-5.** Cocientes de biomasa reproductora (SBR) de 1975-2007 y SBR proyectados durante 2008-2013 para el atún aleta amarilla en el OPO. La línea de trazos horizontal (en 0.34) identifica el $SBR_{RMS}$. El área sombreada representa los límites de confianza de 95% de las estimaciones. Las estimaciones a partir de 2008 (el punto grande representa el principio del segundo trimestre de 2008) señalan el SBR predicho si el esfuerzo continúa en el nivel actual (2005-2007), y ocurren condiciones ambientales medias en los cinco años próximos.

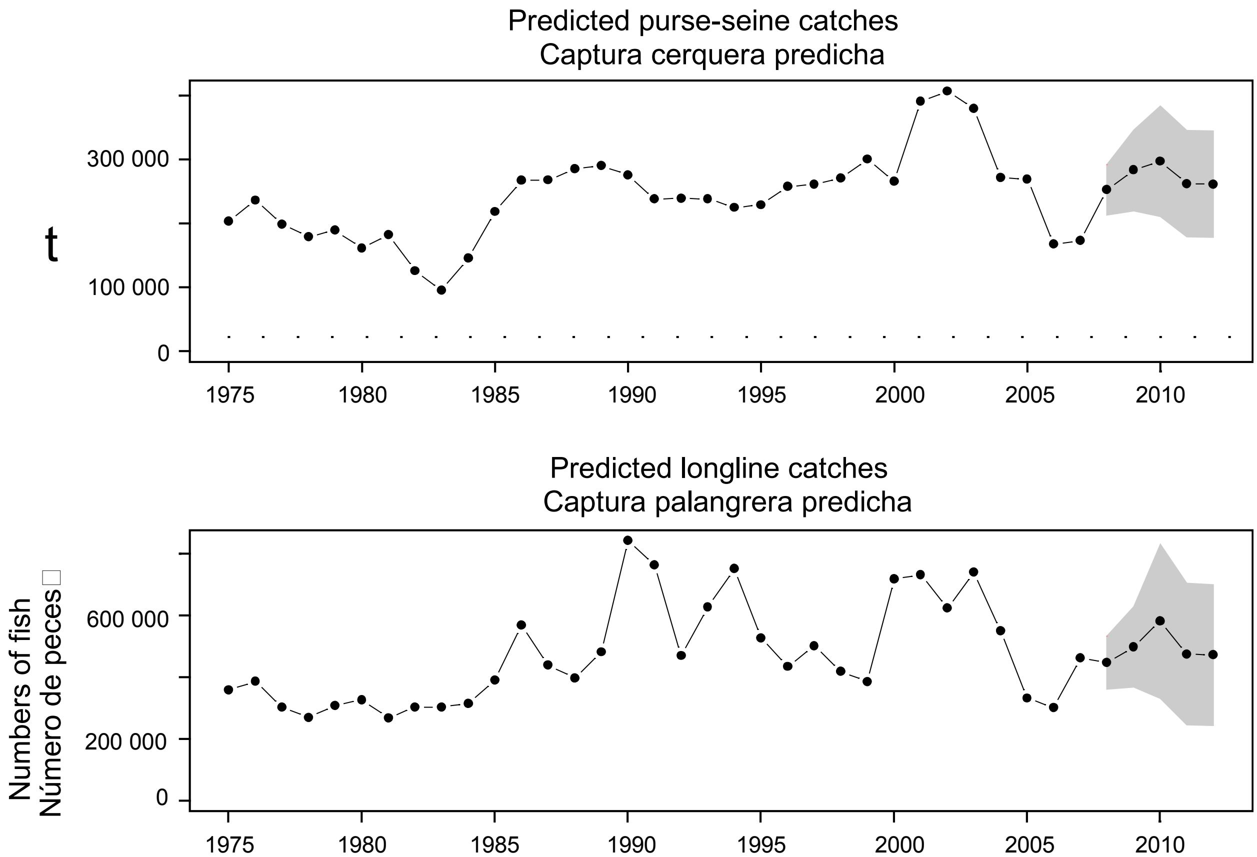


**FIGURE B-6.** Catches of yellowfin tuna during 1975-2007, and simulated catches of yellowfin tuna during 2008-2012, by the purse-seine and pole-and-line fleets (upper panel) and the longline fleet (lower panel). The shaded area represents the 95% confidence limits of the estimates.

**FIGURA B-6.** Capturas de atún aleta amarilla durante 1975-2007, y capturas simuladas de aleta amarilla durante 2008-2012, por las flotas de cerco y de caña (recuadro superior) y la flota palangrera (recuadro inferior). El área sombreada representa los límites de confianza de 95% de las estimaciones.

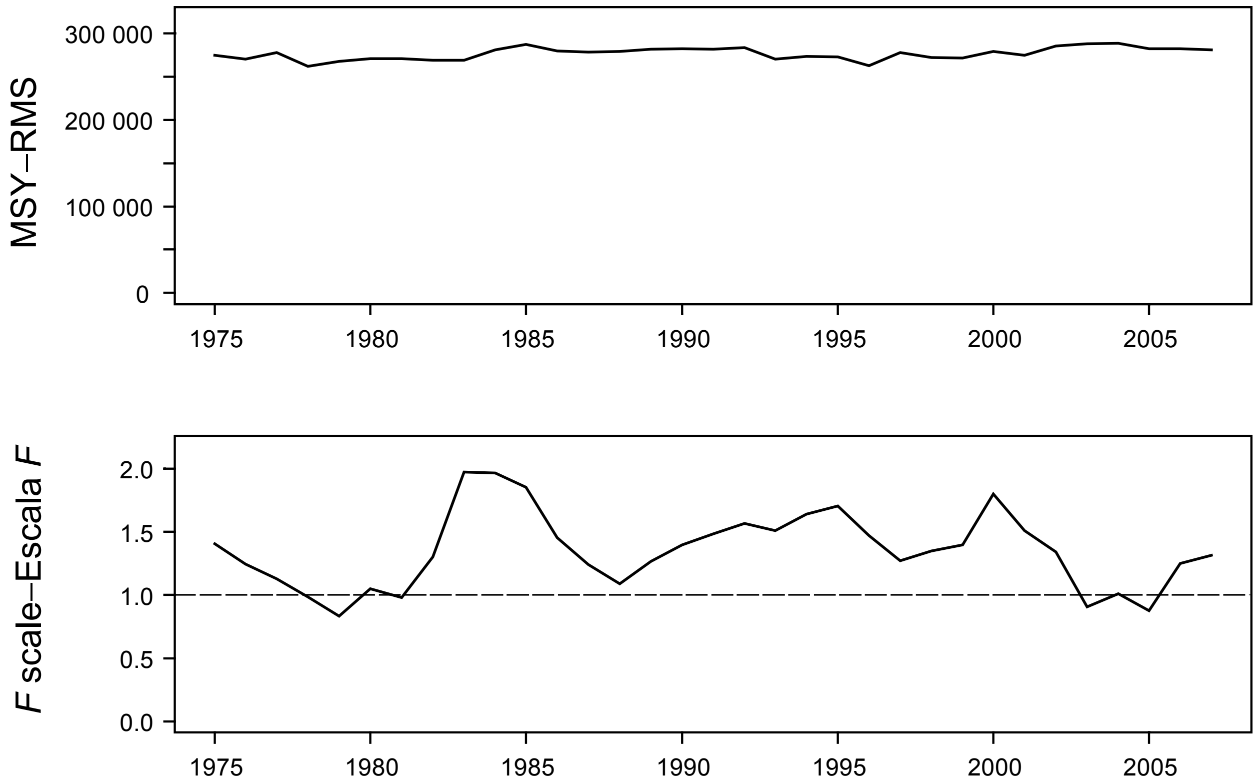


**FIGURE B-7.** MSY of yellowfin tuna, 1975-2007 (upper panel), and the change (increase or reduction) in the effort corresponding to the MSY (lower panel), estimated separately for each year, using the average age-specific fishing mortality for that year.
**FIGURA B-7.** RMS de atún aleta amarilla, 1975-2007 (recuadro superior), y cambio (aumento o reducción) del esfuerzo correspondiente al RMS (recuadro inferior), estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

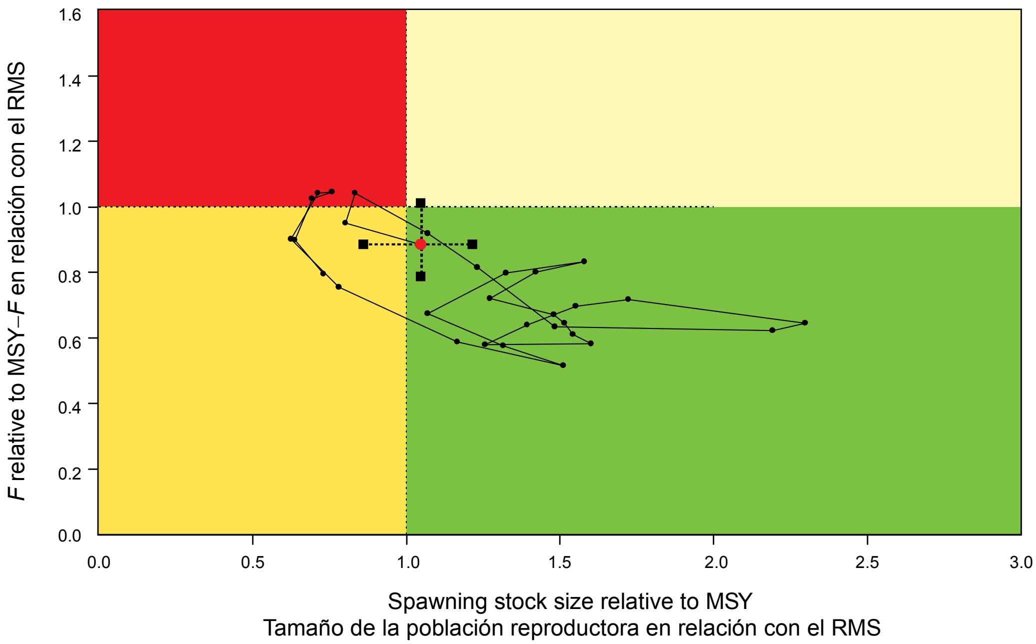


**FIGURE B-8.** Phase plot of the time series of estimates for stock size and fishing mortality of yellowfin tuna relative to their MSY reference points. Each dot is based on the average exploitation rate over three years; the large dot indicates the most recent estimate. The squares represent approximate 95% confidence intervals.

**FIGURA B-8.** Gráfica de fase de la serie de tiempo de las estimaciones del tamaño de la población y la mortalidad por pesca de atún aleta amarilla en relación con sus puntos de referencia de RMS. Cada punto se basa en la tasa de explotación media de tres años; el punto grande indica la estimación más reciente. Los puntos cuadrados representan los intervalos de confianza de 95% aproximados.

**TABLE B-1**. MSY and related quantities for the base case, the stock-recruitment relationship sensitivity analysis, and growth sensitivity analyses. All analyses are based on average fishing mortality for 2005-2007. $B_{recent}$ and $B_{MSY}$ are the biomass of yellowfin tuna 2+ quarters old at the start of 2008 and at MSY, respectively, and $S_{2008}$, $S_{MSY}$, and $S_{F=0}$ are indices of spawning biomass (relative number of eggs) at the start of 2008, at MSY, and without fishing, respectively. $C_{2007}$ is the estimated total catch in 2007.

**TABLA B-1**. El RMS y sus valores asociados para la evaluación del caso base y el análisis de sensibilidad que incluye una relación población-reclutamiento, y análisis de sensibilidad al crecimiento. Todos los análisis se basan en la mortalidad por pesca media de 2005-2007. $B_{reciente}$ y $B_{RMS}$ son la biomasa de atún aleta amarilla de 2+ trimestres de edad al principio de 2008 y en RMS, respectivamente, y $S_{2008}$, $S_{RMS}$, y $S_{F=0}$ son índices de la biomasa reproductora (número relativo de huevos) al principio de 2008, en RMS, y sin pesca, respectivamente. $C_{2007}$ es la captura total estimada en 2007.

| | **Base case<br>Caso base** | **h = 0.75** |
|---|---|---|
| MSY–RMS | 281,902 | 290,236 |
| $B_{MSY}$ –$B_{RMS}$ | 400,484 | 530,326 |
| $S_{MSY}$ —$S_{RMS}$ | 4,489 | 6,224 |
| $C_{2007}$/MSY—$C_{2007}$/RMS | 0.68 | 0.67 |
| $B_{recent}/B_{MSY}$ –$B_{reciente}/B_{RMS}$ | 0.96 | 0.72 |
| $S_{2008}/S_{MSY}$ –$S_{2008}/S_{RMS}$ | 1.04 | 0.74 |
| $S_{MSY}/S_{F=0}$ –$S_{RMS}/S_{F=0}$ | 0.34 | 0.40 |
| *F* multiplier—Multiplicador de *F* | 1.13 | 0.77 |

## C. SKIPJACK TUNA

An age-structured catch-at-length analysis (A-SCALA) has been used to assess skipjack tuna in the eastern Pacific Ocean (EPO). The methods of analysis are described in IATTC Bulletin, Vol. 22, No. 5, and readers are referred to that report for technical details. This method was used most recently for skipjack tuna in 2004 (IATTC Stock Assessment Report 5; available on the IATTC web site), and included data up to and including 2003. More recently, data- and model-based indicators have been used to evaluate the status of the stock.

The catches used in the assessment are presented in Figure C-1.

Yield-per-recruit analysis indicates that maximum yields are achieved with infinite fishing mortality because the critical weight (weight at which the gain to the total weight of a cohort due to growth is equal to the weight loss to that cohort due to natural mortality) is less than the average weight at recruitment to the fishery. However, this result is uncertain because of uncertainties in the estimates of natural mortality and growth.

The results of an analysis described in IATTC Stock Assessment Report 7, in which an index of relative abundance was developed from the ratio of skipjack to bigeye tuna in the floating-object fishery, were consistent with previous assessments, and suggest that there is no management concern for skipjack tuna, apart from the associated catch of bigeye in floating-object sets.

Eight data- and model-based indicators are shown in Figure C-2. The standardized effort, which is a measure of exploitation rate, is calculated as the sum of the effort, in days fished, for the floating-object (OBJ) and unassociated (NOA) fisheries. The floating-object effort is standardized to be equivalent to the unassociated effort by multiplying the floating-object effort by the ratio of the average floating-object CPUE to the average unassociated CPUE. The purse-seine catch has been increasing since 1985, and is currently above the upper reference level. Except for a large peak in 1999, the floating-object CPUE has generally fluctuated around an average level since 1990. The unassociated CPUE has been higher than average since about 2003. The standardized effort indicator, which is a measure of exploitation rate has been increasing since about 1991, and in 2007 was at the upper reference level. The average weight of skipjack has been declining since 2000, and the 2007 average weight is approaching the lower reference level. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years.

The main concern with the skipjack stock is the constantly increasing exploitation rate. However, the data- and model-based indicators have yet to detect any adverse consequence of this increase. The average weight is near its lower reference level, which can be a consequence of overexploitation, but it can also be caused by recent recruitments being stronger than past recruitments.

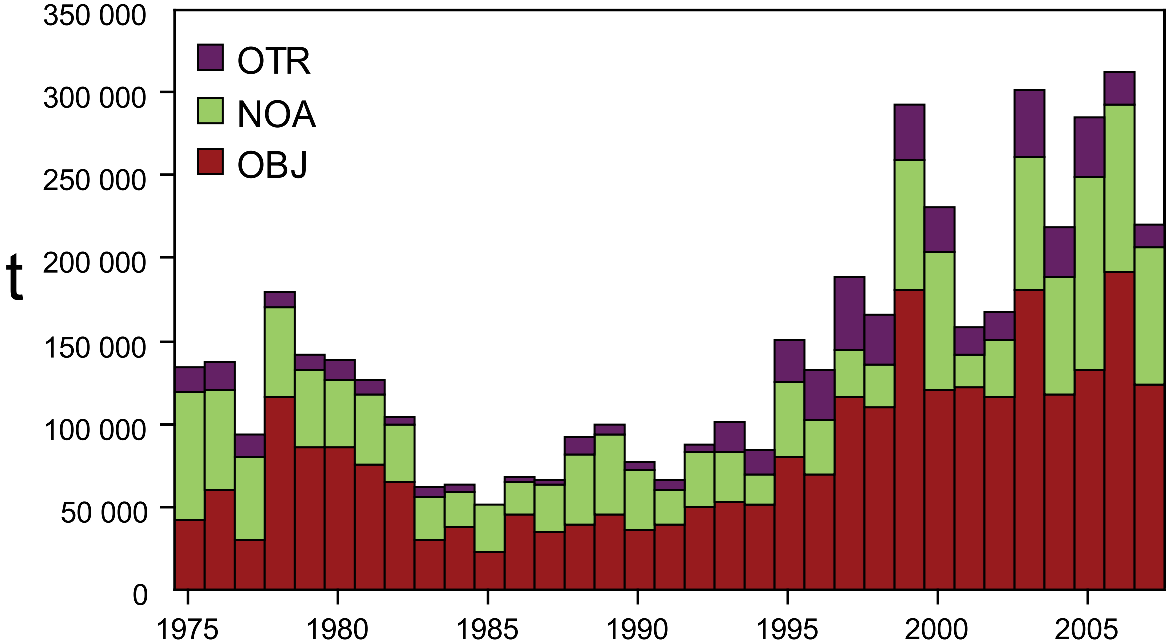


**FIGURE C-1.** Total catches (retained catches plus discards) of skipjack tuna by the purse-seine fisheries on floating objects and unassociated schools, and by other fisheries combined, in the eastern Pacific Ocean, 1975-2006. The purse-seine catches for 1975-2006 are adjusted to the species composition estimate.

**FIGURA C-1.** Capturas totales (capturas retenidas más descartes) de atún barrilete por las pesquerías de cerco sobre objetos flotantes y cardúmenes no asociados, y de las demás pesquerías combinadas, en el Océano Pacífico oriental, 1975-2006 Las capturas cerqueras de 1975-2006 fueron ajustadas a la estimación de composición por especies.

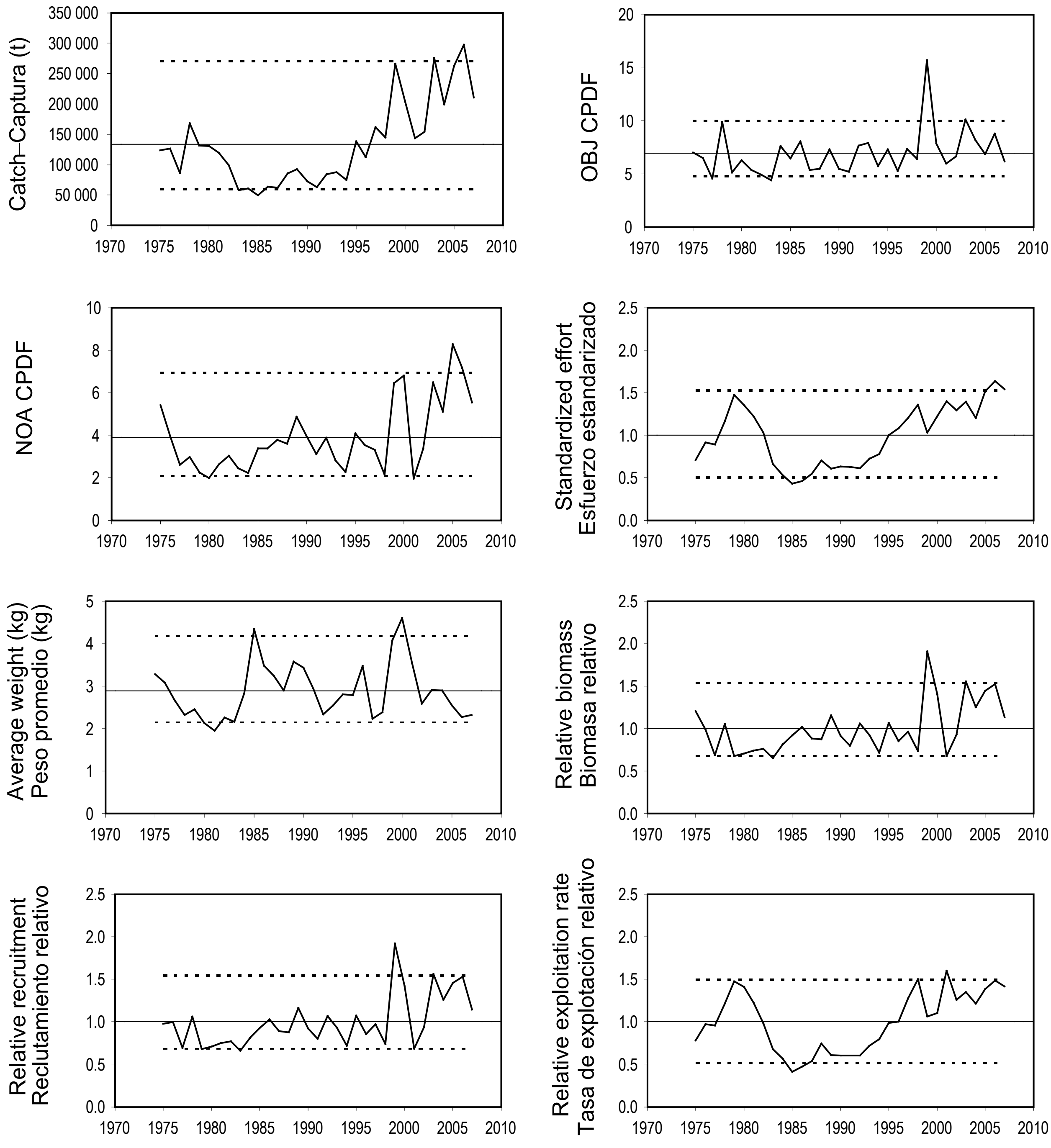


**FIGURE C-6.** Indicators of the stock status of skipjack tuna based on data and/or a simple stock assessment model. CPDF: catch per day fished.

**FIGURA C-6.** Indicadores de la condición de la población de atún barrilete basados en datos y/o en un modelo sencillo de evaluación de población. CPDF: captura por día de pesca

## D. BIGEYE TUNA

There have been substantial changes in the bigeye tuna fishery in the eastern Pacific Ocean (EPO) over the last 15 years. Initially, the majority of the bigeye catch was taken by longline vessels, but with the expansion of the fishery on fish associated with fish-aggregating devices (FADs) since 1993, the purse-seine fishery has taken an increasing proportion of the bigeye catch (Figure D-1). The FAD fishery captures smaller bigeye, and has therefore reduced the yield per recruit and the maximum sustainable yield (MSY). On average, the fishing mortality of bigeye less than about four and a half years old has increased substantially since 1993, and that of older fish has increased slightly (Figure D-2).

An age-structured catch-at-length model, Stock Synthesis II (SS2), was used in this assessment of the bigeye stock of the EPO. The details of the stock assessment are available on the IATTC web site[3].

Bigeye are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. The purse-seine catches of bigeye are substantially lower close to the western boundary (150ºW) of the EPO (Figure A-3); the longline catches are more continuous, but show lower levels between 160ºW and 180º (Figure A-4). Bigeye are not often caught by purse seiners in the EPO north of 10ºN (Figure A-3), but a substantial portion of the longline catches of bigeye in the EPO is made north of that parallel (Figure A-4). Bigeye tuna do not move long distances (95% of tagged bigeye showed net movements of less than 1000 nautical miles), and current information indicates little exchange between the eastern and western Pacific Ocean (Figure D-3). This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at local levels. The assessment reported here is conducted as if there were a single stock in the EPO. Its results are consistent with results of other analyses of bigeye tuna on a Pacific-wide basis. In addition, analyses have shown that the results are insensitive to the spatial structure of the analysis. Currently, there are not enough tagging data to provide adequate estimates of movement between the eastern and western Pacific Ocean.

Several inputs into the current assessment differ from that for 2007. Recent catch and CPUE data have been incorporated, and earlier data have been updated.

There are several important features in the estimated time series of bigeye recruitment (Figure D-4). The estimates of recruitment before 1993 are very uncertain, as the FAD fisheries, which catch small bigeye, were not operating. There was a period of above-average recruitment in 1994-1998, followed by a period of below-average recruitment in 1999-2000. Recruitment has been above average since 2001. The most recent recruitment is very uncertain, due to the fact that recently-recruited bigeye are represented in only a few length-frequency data sets. The extended period of relatively high recruitment during 1994-1998 coincided with the expansion of the fisheries that catch bigeye in association with floating objects.

The biomass of 3+-quarter-old bigeye increased during 1983-1985, and reached its peak of about 626,000 t in 1986, after which it decreased to an historic low of about 270,000 t at the beginning of 2007. Spawning biomass has generally followed a trend similar to that for the biomass of 3+-quarter-olds, but lagged by 1-2 years. The biomasses of both 3+-quarter-old fish and spawners are estimated to have increased slightly after 2005.

The estimated trajectory of the spawning biomass that would have occurred without fishing and that projected by the assessment model, together with an estimate of the impacts attributed to each fishing gear, are shown in Figure D-5.

At the beginning of 2008, the spawning biomass of bigeye in the EPO (Figure D-6) had recovered slightly from the lowest level previously seen. At that time the spawning biomass ratio (the ratio of current spawning biomass to biomass of spawners in the absence of fishing mortality; SBR) was estimated to be about 0.17, about 10% less than the level corresponding to the MSY ($SBR_{MSY}$).

[3] http://www.iattc.org/StockAssessmentReportsENG.htm

Recent spikes in recruitment are predicted to result in increased levels of SBR and longline catches for the next few years. However, high levels of fishing mortality are expected to subsequently reduce the SBR. Under current effort levels, the population is unlikely to remain at levels corresponding to MSY unless fishing mortality is greatly reduced or recruitment is above average for several consecutive years (Figure D-6).

In the base case assessment, recent catches are estimated to have been at about the MSY level (Table D-1). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the MSY is about 82% of the current (2005-2007) level of effort. The MSY 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 that are close to the critical weight. Before the expansion of the FAD fishery, beginning in 1993, the MSY was greater than the current MSY and the fishing mortality ($F$) was less than $F_{\mathrm{MSY}}$ (Figure D-8). The historical status of the stock is shown in Figure D-9. The two most recent estimates indicate that the bigeye stock in the EPO is overexploited ($S < S_{MSY}$) and that overfishing is taking place ($F > F_{MSY}$).

Analyses were carried out to assess the sensitivity of the stock assessment results to: 1) incorporating a stock-recruitment relationship; 2) using the CPUE data from the southern longline fishery only; 3) considering two time blocks for the size selectivities of the floating-object fisheries, separated by the implementation in 2001 of a resolution which prohibited discards of tuna in the EPO.

All of the three analyses conducted estimated that at the start of 2007 the spawning biomass was below the level corresponding to the MSY. MSY 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 for all the scenarios considered, fishing mortality is above the level corresponding to the MSY.

The estimates of recruitment and biomass were moderately sensitive to the steepness ($h$) of the stock-recruitment relationship. The current status and future projections are considerably more pessimistic, in terms of stock status relative to the levels that support MSY, if a stock-recruitment relationship ($h = 0.75$) exists.

The effects of Resolutions C-04-09 and C-06-02 are insufficient to maintain the stock at levels that will permit the MSY.

**Summary:**

1. Recent fishing mortality levels are about 20% greater than those corresponding to the MSY.
2. As a consequence, if the fishing effort is not reduced, the total biomass and spawning biomass will eventually decline to levels at least as low as that observed in 2004.
3. The current status and future projections are considerably more pessimistic in terms of stock status if a stock-recruitment relationship ($h = 0.75$) exists.
4. These conclusions are robust to all three alternative models and data formulations considered in this and previous analyses.

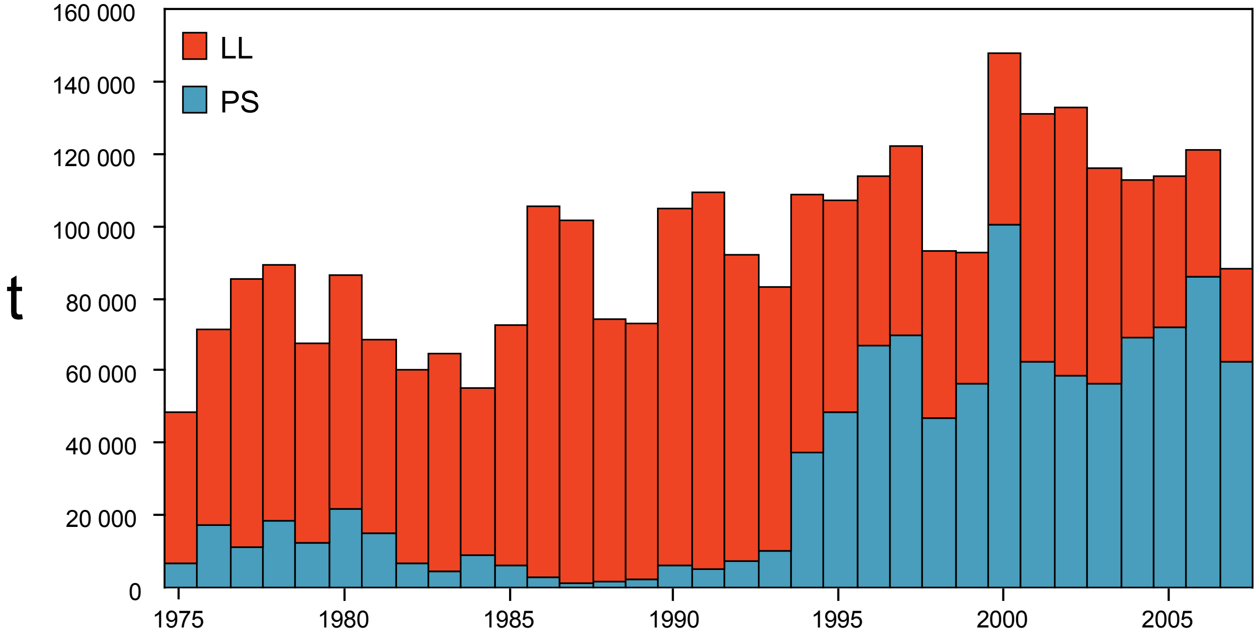


**FIGURE D-1.** Total catches (retained catches plus discards) of bigeye tuna by the purse-seine fisheries, and retained catches for the longline fisheries, in the eastern Pacific Ocean, 1975-2007. The purse-seine catches are adjusted to the species composition estimate. The 2007 catch data are provisional.

**FIGURA D-1.** Capturas totales (capturas retenidas más descartes) de atún patudo por las pesquerías de cerco, y capturas retenidas de las pesquerías palangreras en el Océano Pacífico oriental, 1975-2007. Las capturas cerqueras están ajustadas a la estimación de la composición por especie. Los datos de captura de 2007 son provisionales.

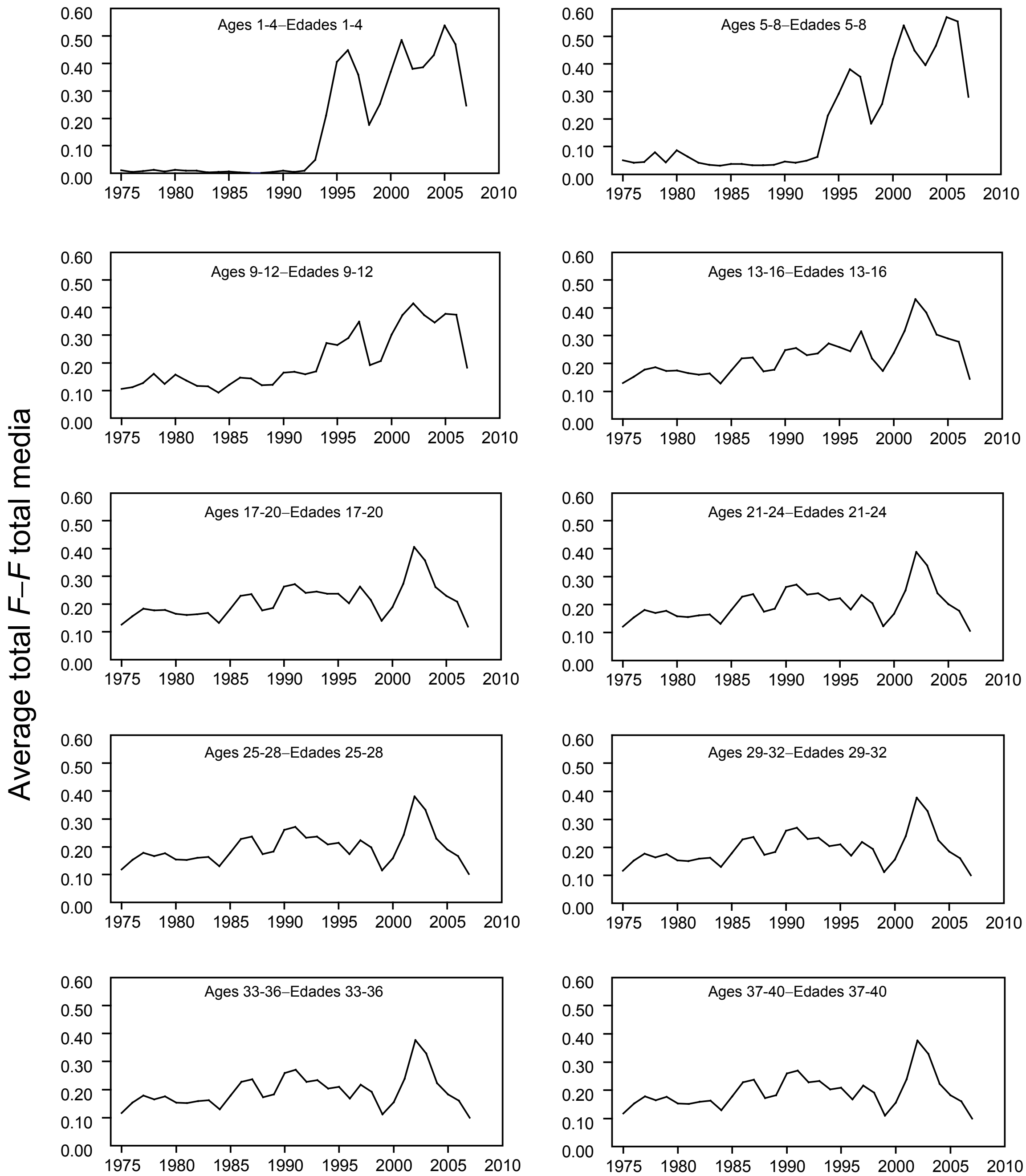


**FIGURE D-2.** Average annual fishing mortality, by all gears, of bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated in the upper left panel is an average of the fishing mortalities that affected fish that were 1-4 quarters old.

**FIGURA D-2.** Mortalidad por pesca anual media, por todas las artes, de atún patudo reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores anuales 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 1-4 trimestres de edad.

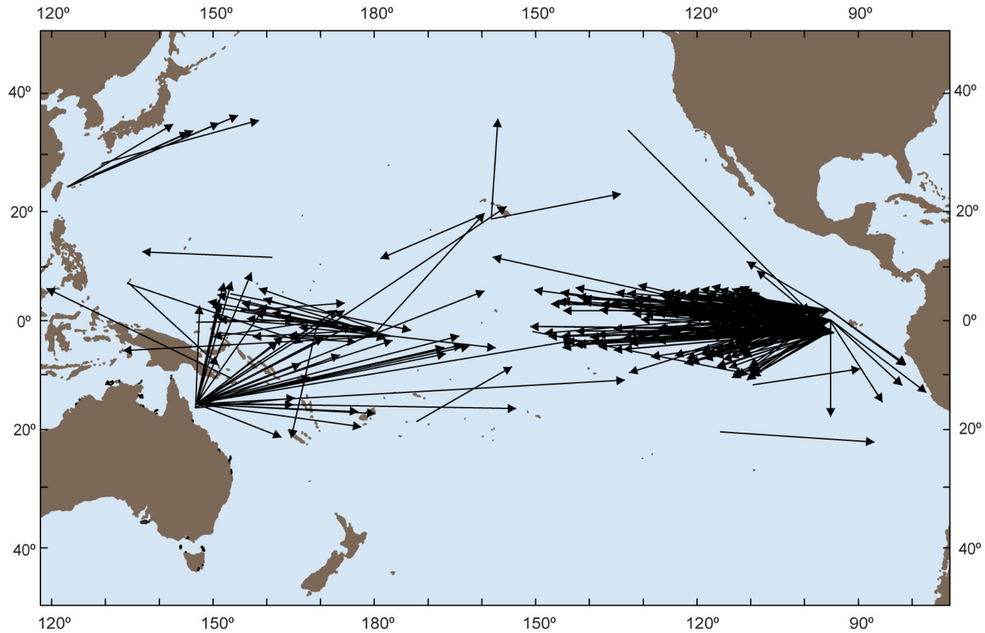


**FIGURE D-3.** Movements of more than 1000 nm by tagged bigeye tuna in the Pacific Ocean.
**FIGURA D-3.** Desplazamientos de más de 1000 mn de atunes patudo marcados en el Océano Pacífico.

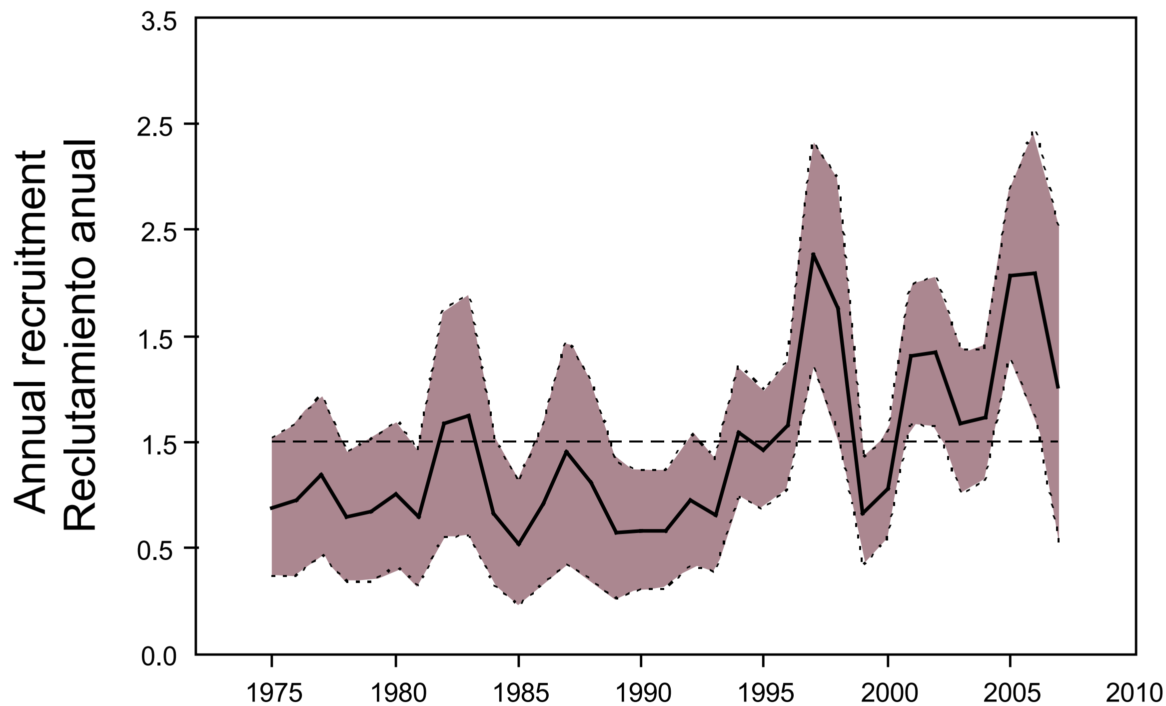


**FIGURE D-4.** Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The solid line shows the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.
**FIGURA D-4.** 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 sólida indica las estimaciones de reclutamiento de verosimilitud máxima, y el área sombreada indica los intervalos de

confianza de 95% aproximados de esas estimaciones.

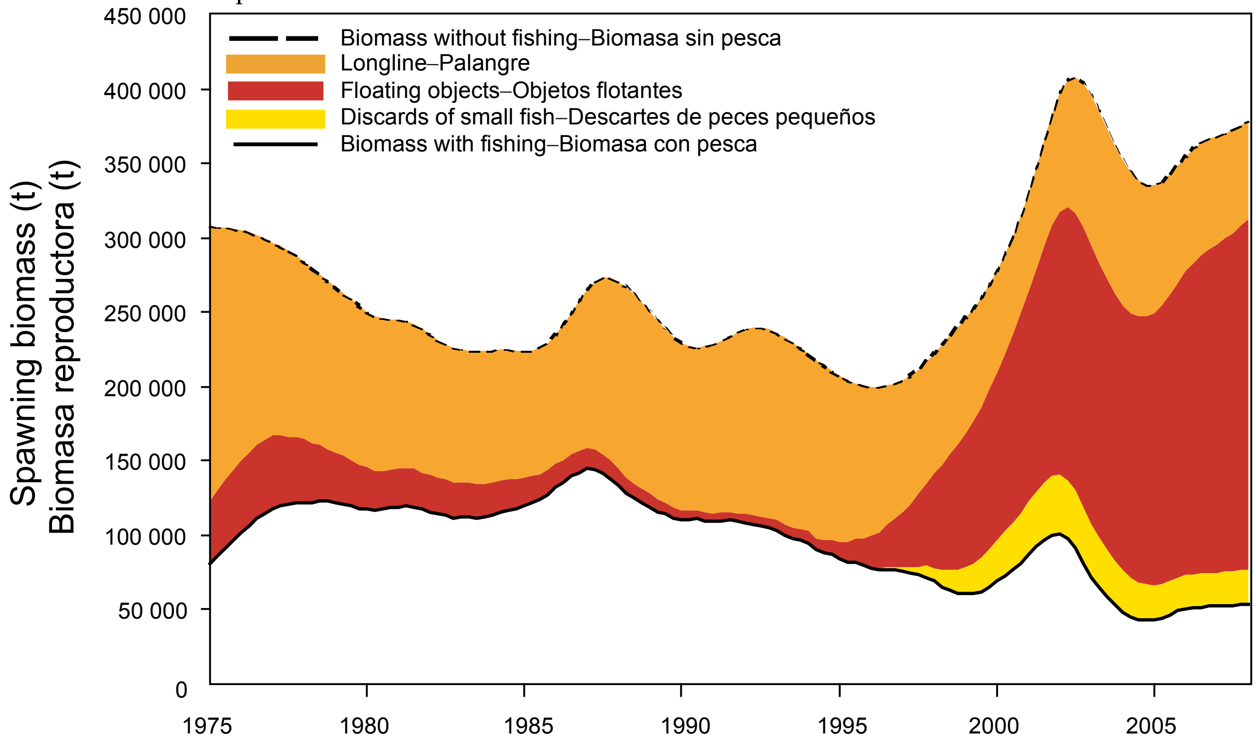


**FIGURE D-5.** Trajectory of the spawning biomass of a simulated population of bigeye tuna that was not exploited during 1975-2007 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishery.
**FIGURA D-5.** Trayectoria de la biomasa reproductora de una población simulada de atún patudo no explotada durante 1975-2007 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas sombreadas entre las dos líneas señalan la porción del impacto de la pesca atribuida a cada método de pesca.

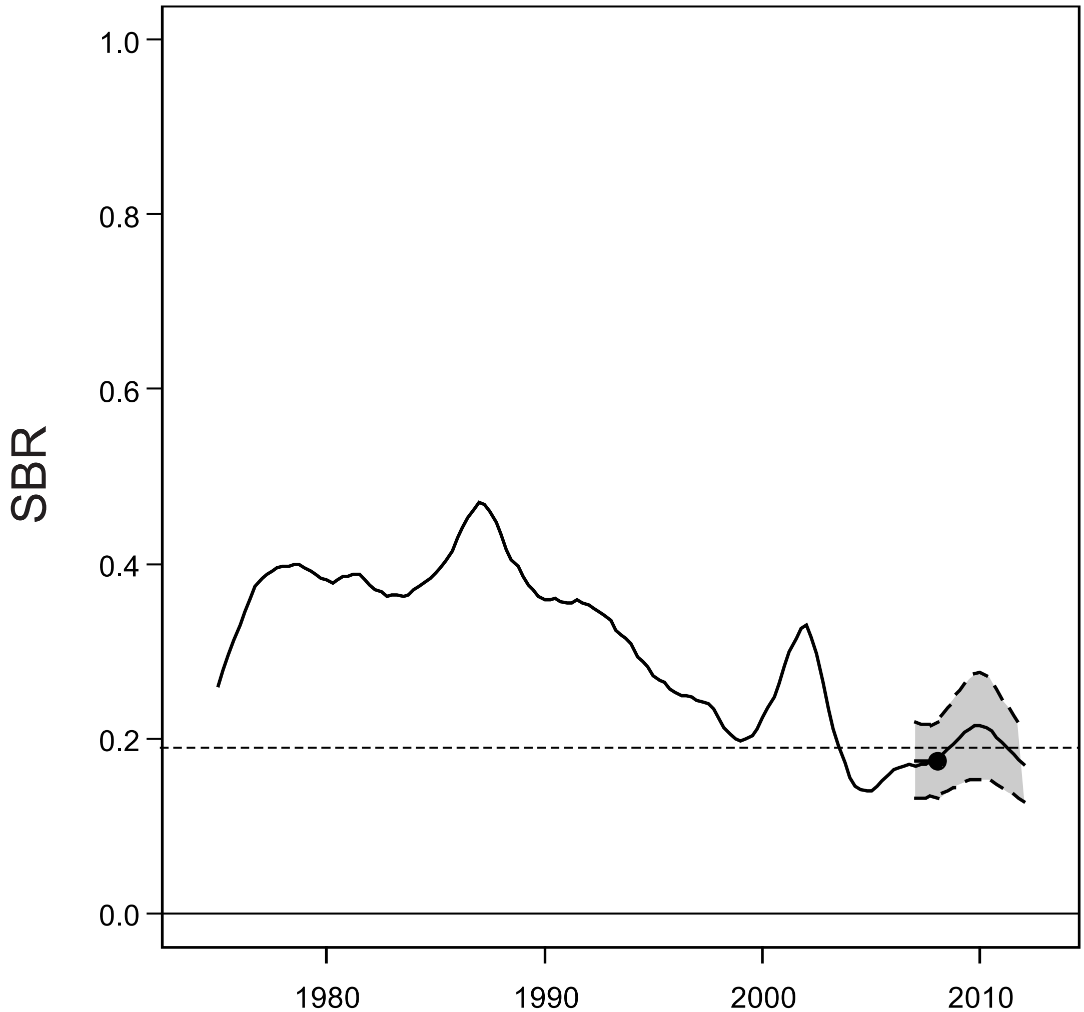


**FIGURE D-6.** Estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.19) identifies the SBR at MSY. The solid line shows the maximum likelihood estimate. The estimates after 2008 (the large dot) indicate the SBR predicted to occur if fishing mortality continues at the average for 2005-2007, and average environmental conditions occur during the next five years. The shaded area represents the 95% confidence limits of the estimates.

**FIGURA D-6.** Cocientes de biomasa reproductora (SBR) estimados del atún patudo en el OPO. La línea de trazos horizontal (en aproximadamente 0.19) identifica el SBR en RMS. La línea sólida señala las estimaciones de verosimilitud máxima. Las estimaciones a partir de 2008 (el punto grande) señalan el SBR predicho si la mortalidad por pesca continúa en el promedio de 2004-2007, y con condiciones ambientales promedio en los cinco próximos años. El área sombreada representa los límites de confianza de 95% de las estimaciones.

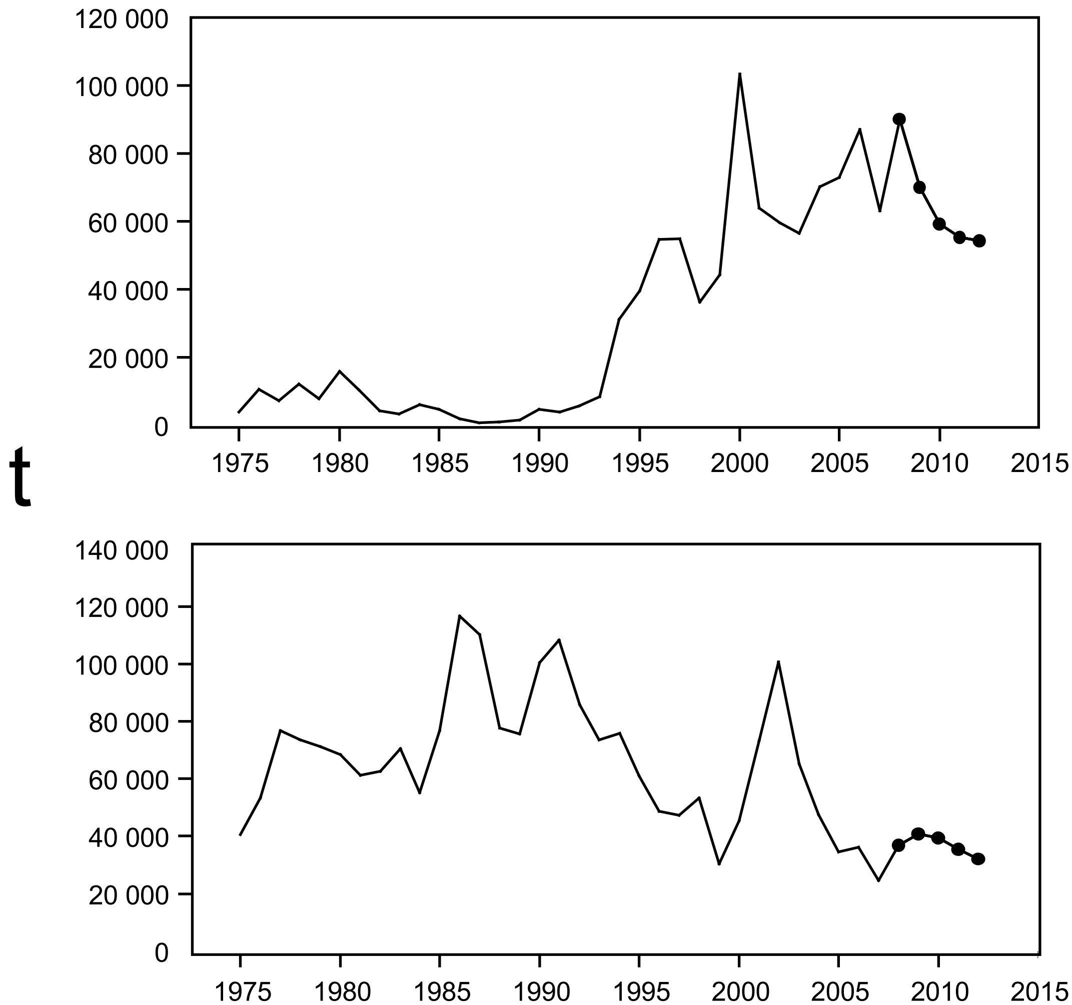


**FIGURE D-7.** Catches for 1975-2007, and predicted catches for 2008-2012, of bigeye tuna by the purse-seine and pole-and-line (upper panel) and longline (lower panel) fisheries. The predicted catches are based on average fishing mortality during 2005-2007.

**FIGURA D-7.** Capturas de atún patudo durante 1975-2007, y predichas para 2008-2012, por las pesquerías de cerco y de caña (recuadro superior) y de palangre (recuadro inferior). Las capturas predichas se basan en la mortalida por pesca promedio durante 2005-2007.

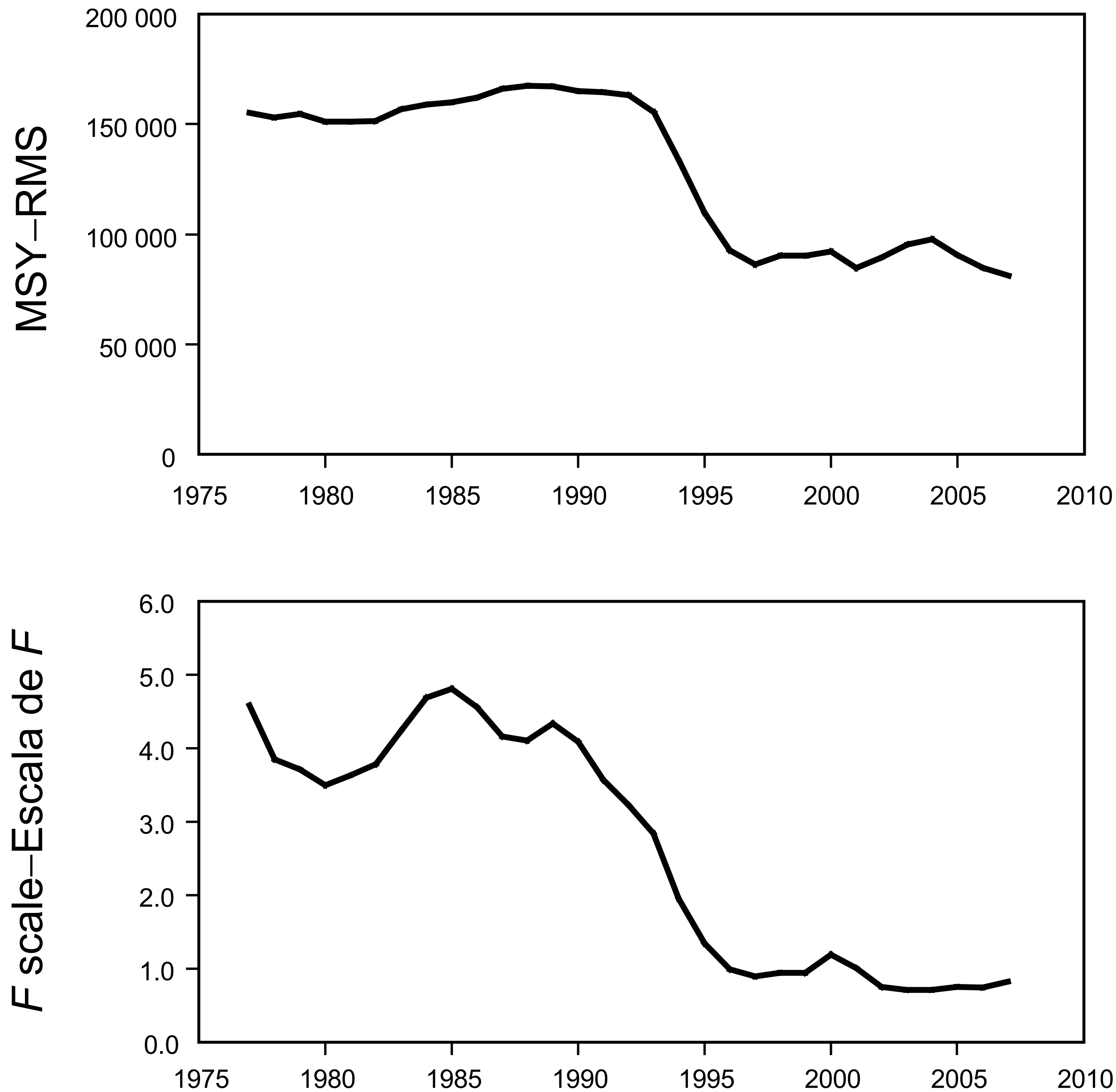


**FIGURE D-8.** MSY (upper panel), 1975-2007, and the change (increase or reduction) in the effort required to produce the MSY (lower panel) for bigeye tuna, estimated separately for each year, using the average age-specific fishing mortality for that year.

**FIGURA D-8.** RMS (recuadro superior), 1975-2007, y cambio (aumento o reducción) del esfuerzo necesario para producir el RMS (recuadro inferior), de atún patudo, estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

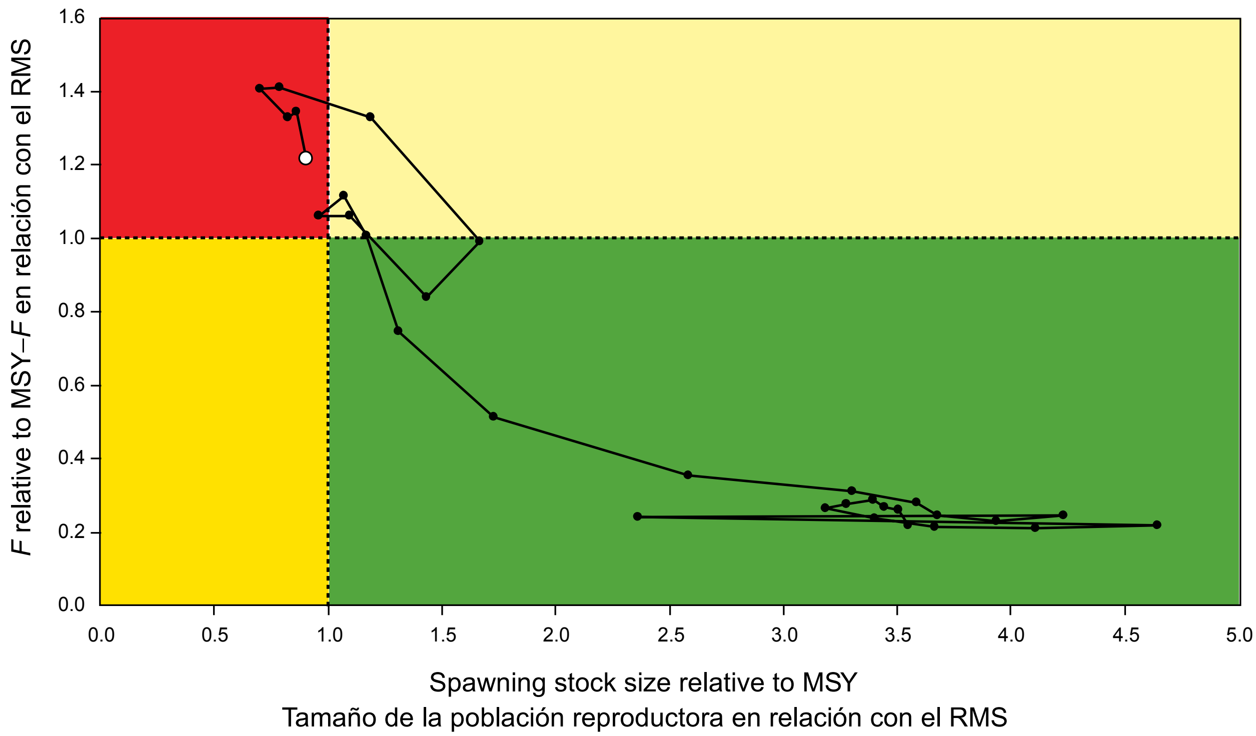


**FIGURE D-9.** Phase plot of the time series of estimates of stock size and fishing mortality of bigeye tuna relative to their MSY reference points. Each dot is based on the average exploitation rate over three years. The large dot indicates the most recent estimate.

**FIGURA D-9.** Gráfica de fase de la serie de tiempo de las estimaciones del tamaño de la población y la mortalidad por pesca de atún patudo en relación con sus puntos de referencia de RMS. Cada punto se basa en la tasa de explotación media de tres años. El punto grande indica la estimación más reciente.

**TABLE D-1.** Estimates of the MSY of bigeye tuna, and associated quantities for the base case assessment and the sensitivity analysis including a stock-recruitment relationship with steepness (*h*) of 0.75. All analyses are based on average fishing mortality for 2005-2007. $B_{2008}$, $B_{MSY}$, and $B_0$ are the biomass of bigeye 3+ quarters old at the start of 2008, at MSY, and without fishing, respectively, and $S_{2008}$, $S_{MSY}$, and $S_0$ are the spawning biomass at the start of 2008, at MSY, and without fishing, respectively. $C_{2007}$ is the estimated total catch in 2007.

**TABLA D-1.** Estimaciones del RMS de atún patudo y valores asociados para la evaluación del caso base y el análisis de sensibilidad que incluye una relación población-reclutamiento con una inclinación (*h*) de 0.75. Todos los análisis se basan en la mortalidad por pesca media de 2005-2007. $B_{2008}$, $B_{RMS}$, y $B_0$ son la biomasa de patudo de edad 3+ trimestres al principio de 2008, en RMS, y sin pesca, respectivamente, y $S_{2008}$, $S_{RMS}$, y $S_0$ son la biomasa reproductora al principio de 2008, en RMS, y sin pesca, respectivamente. $C_{2007}$ es la captura total estimada en 2007.

| | **Caso base**<br>**Basecase** | **Inclinación = 0.75**<br>**Steepness = 0.75** |
|---|---|---|
| MSY—RMS | 81,350 | 78,150 |
| $B_{MSY}$—$B_{RMS}$ | 287,912 | 500,357 |
| $S_{MSY}$—$S_{RMS}$ | 59,626 | 118,154 |
| $B_{MSY}/B_0$—$B_{RMS}/B_0$ | 0.26 | 0.34 |
| $S_{MSY}/S_0$—$S_{RMS}/S_0$ | 0.19 | 0.30 |
| $C_{2007}$/MSY—$C_{2007}$/RMS | 1.08 | 1.12 |
| $B_{2008}/B_{MSY}$—$B_{2008}/B_{RMS}$ | 1.15 | 0.74 |
| $S_{2008}/S_{MSY}$—$S_{2008}/S_{RMS}$ | 0.90 | 0.56 |
| *F* multiplier—Multiplicador de *F* | 0.82 | 0.57 |

## E. PACIFIC BLUEFIN TUNA

Tagging studies have shown that there is exchange of Pacific bluefin between the eastern and western Pacific Ocean. Larval, postlarval, and early juvenile bluefin have been caught in the WCPO but not in the 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 35°N. Ninety percent of the catch is estimated to have been between 60 and 100 cm in length, representing mostly fish 1 to 3 years of age. Aquaculture facilities for bluefin were established in Mexico in 1999, and some Mexican purse seiners began to direct their effort toward bluefin during that year. The catches are transported to holding pens, where the fish are held for fattening and later sale to sashimi markets. 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 WCPO from Taiwan 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 caught near the southeastern coast of Japan by longlining. The Chinese Taipei small-scale longline fishery, which has expanded since 1996, takes bluefin tuna over 180 cm in length from late April to June, when they are aggregated for spawning in the waters east of the northern Philippines and Taiwan.

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. Some fish apparently remain their entire lives in the WCPO, while others migrate to the EPO. These migrations begin mostly 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 WCPO.

Bluefin more than about 50 cm in length are most often found 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 WCPO 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 WCPO probably influence the portions of the juvenile fish there that migrate to the EPO, and also the timing of these migrations. Likewise, conditions in the EPO probably influence the timing of the return of the juvenile fish to the WCPO.

An index of abundance for the predominantly young bluefin in the EPO has been calculated, based on standardization of catch per vessel day using a generalized linear model, and including the variables latitude, longitude, SST, $SST^2$, month, and vessel identification number. The index is highly variable, but shows a peak in the early 1960s, very low levels for a period in the early 1980s, and some increase since that time.

A preliminary stock assessment carried out by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) has indicated that the biomass of the spawning stock had local peaks during the early 1960s, late 1970s and late 1990s, with a decline after the last peak. However, the relative strengths of these peaks are highly uncertain. The recruitment was estimated to be highly variable, with four to seven strong cohorts produced during the 1960-2003 period. A strong recruitment event that may have occurred in 2001 would maintain spawning stock biomass above recent levels until about 2010. Data collected more recently, however, indicate that the 2001 recruitment was not as strong as previously thought. Further work is necessary to provide a scientific basis for any management actions. A new bluefin stock assessment will be conducted by the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean in June 2008. The total catches of bluefin have fluctuated considerably during the last 50 years (Figure E-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.

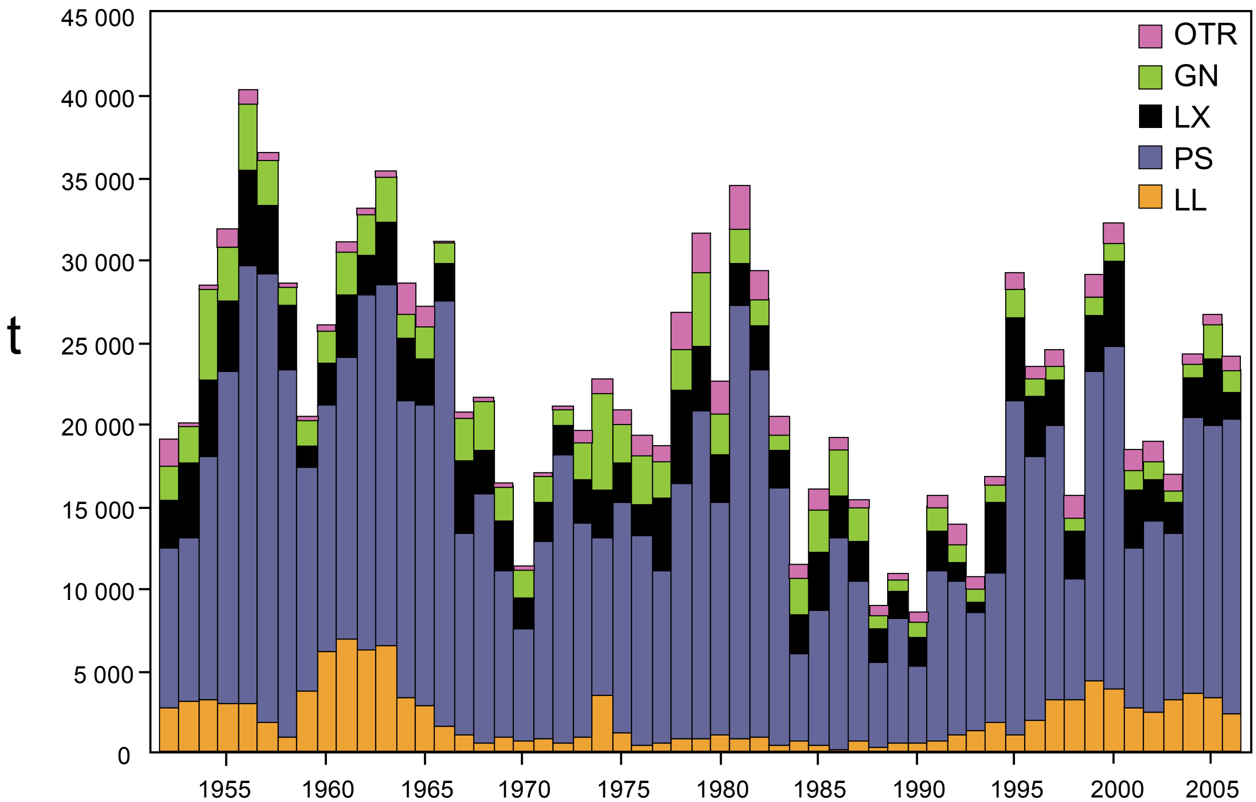


**FIGURE E-1**. Retained catches of Pacific bluefin, 1952-2006.
**FIGURA E-1**. Capturas retenidas de aleta azul del Pacífico, 1952-2006.

## F. ALBACORE TUNA

There are two stocks of albacore in the Pacific Ocean, one occurring in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longline gear in most of the North and South Pacific, but not often between about 10°N and 5°S, by trolling gear in the eastern and central North and South Pacific, and by pole-and-line gear in the western North Pacific. In the North Pacific about 60% of the fish are taken in pole-and-line and troll fisheries that catch smaller, younger albacore, whereas about 90% of the albacore caught in the South Pacific are taken by longline. The total annual catches of North Pacific albacore peaked in 1976 at about 125,000 t, and have declined since, reaching levels of about 85,000 t in 2005. The catches increased during the 1990s, reaching 121,500 t in 1999 (Figure F-1a). The total annual catches of South Pacific albacore have ranged between about 25,000 and 65,000 t since 1980 (Figure F-1b).

Juvenile and adult albacore are caught mostly in the Kuroshio Current, the North Pacific Transition Zone, and the California Current in the North Pacific and in the Subtropical Convergence Zone in the South Pacific, but spawning occurs in tropical and subtropical waters, centering around 20ºN and 20ºS latitudes. North Pacific albacore are believed to spawn between March and July in the western and central Pacific.

The movements of North Pacific albacore are strongly influenced by oceanic conditions, and migrating albacore tend to concentrate along oceanic fronts in the North Pacific Transition Zone. Most of the catches are made in water temperatures between 15º and 19.5ºC. Details of the migration remain unclear, but juvenile fish (2- to 5-year-olds) are believed to move into the eastern Pacific Ocean (EPO) in the spring and early summer, and return to the western and central Pacific, perhaps annually, in the late fall and winter, where they tend to remain as they mature. It has been hypothesized that there are two subgroups of North Pacific albacore, separated at about 40ºN in the EPO, with the northern subgroup more likely to migrate to the western and central Pacific Ocean.

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 tropical waters, 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 South and North Pacific stocks of albacore in 2003 and 2006, respectively.

The South Pacific assessment, carried out with MULTIFAN-CL by the Secretariat of the Pacific Community, incorporated catch and effort, length-frequency, and tagging data. The stock was estimated to be well above the level corresponding to the average maximum sustainable yield (MSY). The catches would continue to increase with further increases in effort, though the extent to which the sustainable yield could increase as total biomass decreases is not well determined. Although the recent recruitments are estimated to be slightly below average, there currently appears to be no need to restrict the fisheries for albacore in the South Pacific Ocean.

The most recent assessment of North Pacific albacore was conducted at a workshop of the Albacore Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), held in November-December 2006. The conclusions reached at this workshop were presented to the seventh plenary meeting of the ISC, held in July 2007. Among these were the following:

- The spawning stock biomass (SSB) in 2006 was estimated to be about 153 thousand t – 53% above the long-term average (Figure F-2);
- Retrospective analysis revealed a tendency to overestimate the abundance of albacore;
- Recruitment had fluctuated about a long-term average of roughly 28 million fish during the 1990s and

early 2000s;

- The current coefficient of fishing mortality (*F*) is about 0.75, which is high relative to several biological reference points to which Working Group compared its estimate for albacore;
- The SSB is forecast to decline to an equilibrium level of about 92 thousand t by 2015;
- The substantial decline in total catch during recent years is cause for concern;
- In conclusion, the Working Group recommended that all nations participating in the fishery observe precautionary-based fishing practices.

The next meeting of the Albacore Working Group will take place in December 2008.

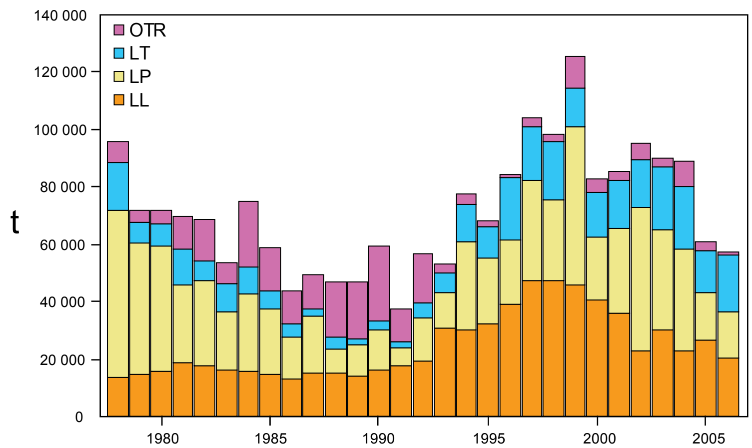


**FIGURE F-1a.** Retained catches of North Pacific albacore, 1978-2006.
**FIGURA F-1a.** Capturas retenidas de albacora del Pacífico norte, 1978-2006.

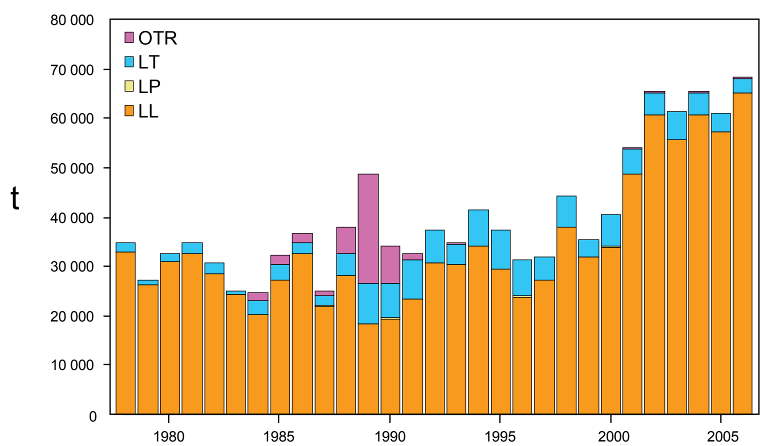


**FIGURE F-1b.** Retained catches of South Pacific albacore, 1978-2006.
**FIGURA F-1b.** Capturas retenidas de albacora del Pacífico sur, 1978-2006.

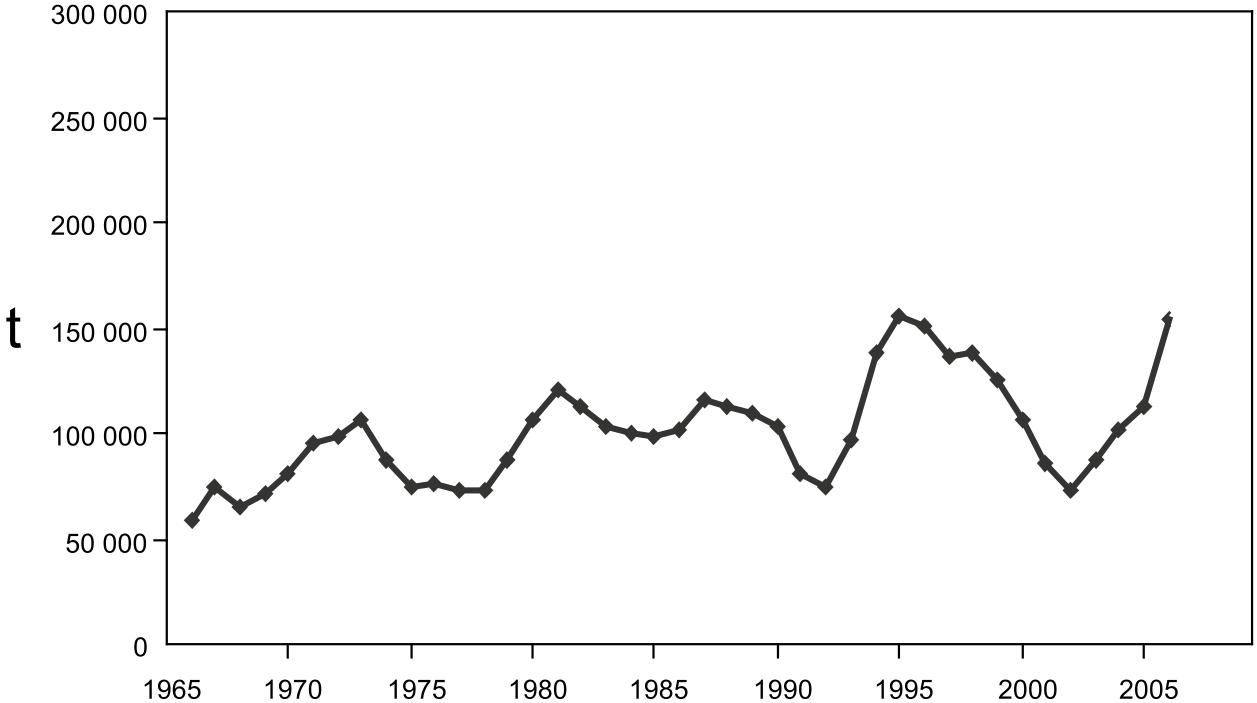


**FIGURE F-2.** Spawning stock biomass of North Pacific albacore tuna, from the North Pacific Albacore Workshop analysis of 2006

**FIGURA F-2.** Biomasa de la población reproductora del atún albacora del Pacífico Norte, de los análisis de la Reunión Técnica sobre el Albacora del Pacífico Norte de 2006.

## G. SWORDFISH

Swordfish 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. 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 harvest about 70% of the total swordfish catch taken in the region. All three have fisheries that target swordfish, though much of the swordfish taken in the Japanese fishery are incidental catches of a fishery that targets predominantly bigeye tuna. Other nations with fisheries known to target swordfish are Mexico and the United States.

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.

Swordfish tend to inhabit waters further below the surface during the day than at night, and they 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.

The best available scientific information from genetic and fishery data indicate that the swordfish of the northeastern Pacific Ocean and the southeastern Pacific Ocean (south of 5°S) constitute two distinct stocks. Also, there may be movement of a northwestern Pacific stock of swordfish into the EPO at various times.

The results of preliminary modeling with MULTIFAN-CL of a North Pacific swordfish stock in the area north of 10°N and west of 140°W indicate that, in recent years, the biomass level has been stable and well above 50% of the unexploited levels of stock biomass, indicating that these swordfish are not overexploited at current levels of fishing effort. A more recent analysis for the Pacific Ocean north of the equator, using a sex-specific age-structured assessment method, indicated that, at the current level of fishing effort, there is negligible risk of the spawning biomass decreasing to less than 40% of its unfished level.

The standardized catches per unit of effort of the longline fisheries in the northern region of the EPO and trends in relative abundance obtained from them do not indicate declining abundances. Attempts to fit production models to the data failed to produce estimates of management parameters, such as maximum sustainable yield (MSY), under reasonable assumptions of natural mortality rates, due to lack of contrast in the trends. This lack of contrast suggests that the fisheries in this region have not been of magnitudes sufficient to cause significant responses in the populations. Based on these considerations, and the long period of relatively stable catches in the northern region (Figure G-1), it appears that swordfish are not overfished in the northern region of the EPO.

An assessment of the southern stock of swordfish in the EPO was carried out with Stock Synthesis II (SS2: Ver.1.23b) with the following results. The population has undergone considerable changes in biomass, and is currently at a moderate level of depletion. There is strong evidence of one or two large cohorts entering the fishery recently, but their strengths are uncertain. The trend in spawning biomass ratio (the ratio of the spawning biomass of the current stock to that of the unfished stock; SBR) for this stock is estimated to have been between about 0.5 and 0.9 during the entire period of monitoring (1945-2003), and to have decreased to its lowest levels during the mid-1960s and again during the mid-1990s.

The MSY for the southern EPO swordfish stock is about 13,000-14,000 t, and the SBR at MSY is about 0.26. The current spawning biomass is estimated to be well above the biomass corresponding to the MSY.

The average annual catch from the this stock during 1993-2000 was about 7,000 t (range ~ 4,800-8,900 t). Since 2000, annual catches have averaged about 13,000 t, with catch in the most recent years on the order of 11,000-12,000 t (Figure G-1), which is about the estimated MSY catch. There have been indications of increasing efficiency at targeting of swordfish in the southern EPO, which has resulted in increased harvests of this stock. Some of the increased catch may have resulted from the above-average recruitment noted previously. It is not expected that further increases in the catch levels observed in recent years would be sustainable.

No attempts have been made to estimate the level of MSY that could be obtained by each fishery operating exclusively. However, it is likely that the fisheries that capture younger fish (*e.g.* the longline fisheries of Chile, Japan, and Spain) are less efficient at maximizing yield.

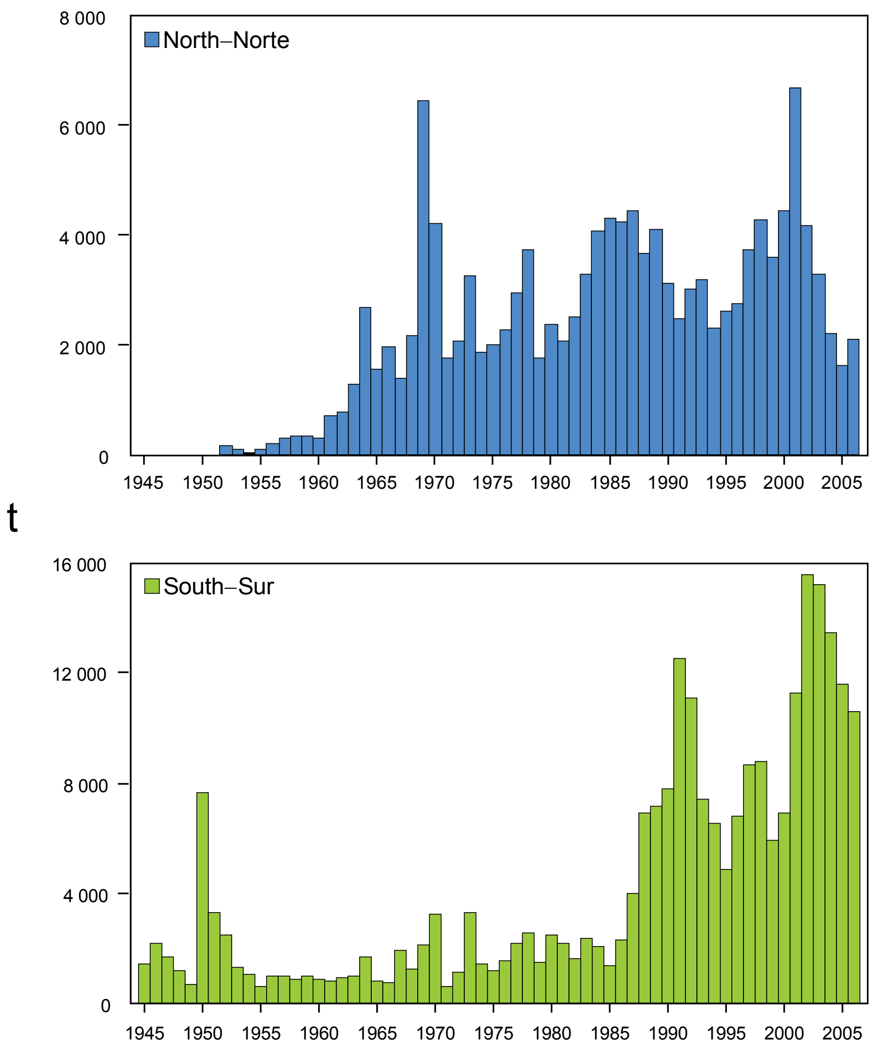


**FIGURE G-1.** Retained catches of swordfish in the eastern Pacific Ocean, 1945-2006 by stock (north and south).
**FIGURA G-1.** Capturas retenidas de pez espada en el Océano Pacífico oriental, 1945-2006 por población (norte y sur).

## H. BLUE MARLIN

The best knowledge currently available indicates that blue marlin 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 are compiled, and analyses of stock status are made, for the entire Pacific Ocean.

Blue marlin are taken mostly 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 other commercial 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 electronic tags and their activities monitored for short periods of time.

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 catches per unit of effort 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 corresponding to the maximum sustainable yield (MSY).

A more recent analysis of data from the same years, but using MULTIFAN-CL, was conducted to assess the status of blue marlin 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 MSY. 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.

Even though blue marlin are a single stock in the Pacific Ocean, it is important to know how the catches in the eastern Pacific Ocean (Figure H-1) have varied over time. The fisheries in the eastern Pacific Ocean (EPO) have historically captured about 10 to 18% of the total harvest of blue marlin from the Pacific Ocean, with average annual catch since 2002 of about 3,600 t.

A Pacific-wide assessment of blue marlin in collaboration with the Billfish Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) is planned for completion in 2010.

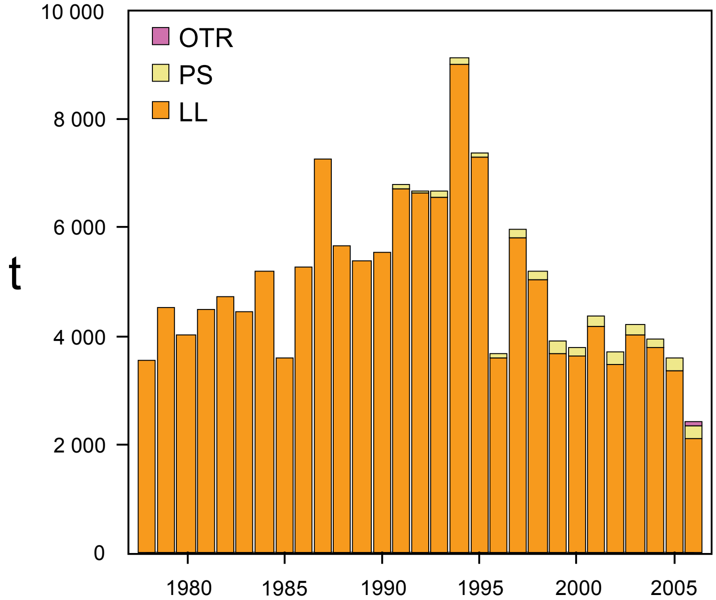


**FIGURE H-1.** Retained catches of blue marlin in the eastern Pacific Ocean, 1978-2006, by gear type.
**FIGURA H-1.** Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1978-2006, por arte de pesca.

## I. STRIPED MARLIN

Striped marlin 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 I-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 western and central Pacific Ocean, so it is considered that examinations of local depletions and independent assessments of the striped marlin of the EPO are meaningful. An analysis of trends in catches per unit of effort in several subareas suggested that the fish in the EPO may constitute a single stock. Genetic studies have suggested that there is significant structuring of striped marlin populations in the Pacific, with indications of separate populations at sampled regions in Ecuador and Mexico, as well as near Australia and Hawaii.

Few tagging data are available for striped marlin. Most recaptures of fish tagged with conventional tags and 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, north of New Zealand. Data on daily activities of striped marlin have been obtained by electronic tags. Most recently, pop-up satellite tags have been placed on individuals in selected areas. These tags have provided information on movements over periods up to nine months: in general the results show little or no mixing, or large displacements, among fish from the tagging regions.

Thus the conclusions reached for a EPO stock model, chosen on the basis of trends in catch rates, should be considered tentative.

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

An analysis of the status of a hypothesized stock of striped marlin spanning the North Pacific was conducted by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). The results of all assessment models indicated that the biomass has been reduced. For models that provided estimates of the current biomass relative to the unfished biomass, the results indicated that the population has declined to 10 to 45% of the initial biomass. In contrast, "splitting" the abundance series in the mid-1970s, and assuming that this represented a change in targeting, indicated a more optimistic view (current biomass greater than that corresponding to the MSY). While the results of these assessments are considered provisional, the ISC recommended that fishing mortality for striped marlin in the North Pacific not be permitted to exceed current levels.

The results of the EPO and North Pacific assessments of stocks are consistent. The stock of striped marlin in the EPO is probably in good condition, at or above the MSY level.

The catches and standardized fishing effort for striped marlin decreased in the EPO from 1990-1991 through 1998, and this decline has continued, with annual catches during 2002-2006 between about 1,600 and 2,200 t (averaging about 1,800 t), well below estimated MSY. This may result in a continued increase in the biomass of the stock in the EPO.

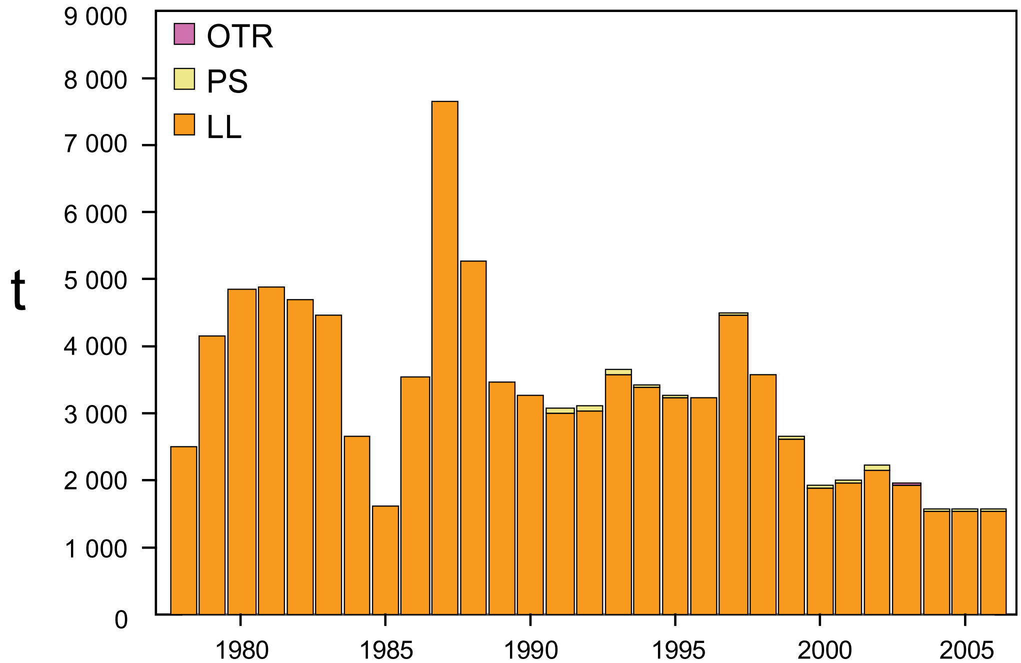


**FIGURE I-1**. Retained catches of striped marlin in the eastern Pacific Ocean, 1978-2006 by gear type.
**FIGURA I-1**. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1978-2006 por arte de pesca.

## J. 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 an ecosystem approach into fisheries management.

The IATTC has taken account of ecosystem issues in many of its decisions, and this report on the ecosystem that includes the tunas and billfishes has been available since 2003 to assist in making its management decisions. 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.

This review does not suggest objectives for the incorporation of ecosystem considerations into the management of tuna or billfish fisheries, nor any new management measures. Rather, its prime purpose is to offer the Commission the opportunity to ensure that ecosystem considerations are 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 almost 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 section, data on these bycatches are presented in the context of the effect of the fishery on the ecosystem. Unfortunately, while relatively good information is available for the tunas and billfishes, information for the entire fishery is not available. The information is comprehensive for large (carrying capacity greater than 363 metric tons) 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 large purse-seiners, and for some smaller ones. There is little information available on the bycatches and discards for other fishing vessels.

## 2. IMPACT OF CATCHES

### 2.1. Single-species assessments

This section provides a summary of current information on the effects of the tuna fisheries on the stocks of individual 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 IATTC documents. The section below frequently refers to comparisons with the estimated unexploited stock size. There are no direct measurements of the stock size before the fishery began, and, in any case, it would have varied from year to year. In addition, the unexploited stock size may be influenced by predator and prey abundance, which is not included in the single-species analyses.

### 2.2. Tunas

#### 2.2.1. Yellowfin

The yellowfin stock changed into a higher recruitment regime in about 1983, but may have recently moved back into an intermediate recruitment regime. During 2005-2007, the yellowfin stock has been below the level corresponding to the maximum sustainable yield (34% of its unexploited size). One estimate of the effect of this reduced stock size is that the predation by adult yellowfin on other parts of the ecosystem is reduced to about 36% of what it was in the absence of a fishery.

#### 2.2.2. Skipjack

Skipjack assessments are far less certain than those for yellowfin and bigeye, in part because the fishery in the EPO does not appear to be having much impact on the stock. However, it appears that fluctuations in recruitment cause large variations in stock size.

#### 2.2.3. Bigeye

Up to 1993, bigeye were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 34% 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. In 2005, after several years of poor recruitment and excessive levels of fishing mortality, the stock size was estimated to be at about 14% of its unexploited size. Due to recent spikes in recruitment, the current level has increased to 17%.

#### 2.2.4. Pacific bluefin

It is considered that there is a single stock of Pacific bluefin tuna in the Pacific Ocean, given that spawning apparently occurs only in the western Pacific Ocean. However, tagging studies have shown that there is exchange of bluefin between the eastern and western Pacific Ocean. A preliminary stock assessment, carried out by the International Scientific Committee for Tuna and Tuna-like species in the North Pacific (ISC) in 2005, has indicated that the biomass of the spawning stock had local peaks during the early 1960s, late 1970s, and late 1990s, with a decline after the last peak. It was previously hypothesized that a strong recruitment event that had occurred in 2001 would maintain spawning stock biomass above recent levels until 2010. Data collected more recently, however, indicate that the 2001 recruitment was not as strong as previously thought.

#### 2.2.5. 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. An assessment for South Pacific albacore, done by the Secretariat of the Pacific Community in 2003, showed that the South Pacific stock was at about 60% of its unexploited size. An assessment by the ISC North Pacific Albacore Working Group in 2006 indicated that the biomass of the North Pacific spawning stock in 2006 was about 53% above its time series average.

### 2.3. Billfishes

#### 2.3.1. Swordfish

The northeastern and southeastern Pacific Ocean stocks of swordfish are distinctly identifiable by genetics and fisheries analyses. Preliminary analyses of the status of the southeastern Pacific Ocean stock of swordfish indicate that the spawning biomass has declined over the 1945-2003 period, and is now at about twice the level (~0.26) that will support the maximum sustainable yield (MSY) of 13,000-14,000 metric tons (t)). Catches have increased substantially since 2001. Recent harvests are on the order of 12,000-16,000 t annually.

The variations in standardized catch per unit of effort (CPUE) of swordfish in the northern EPO show no trend, suggesting that the catches to date have not affected the stock significantly.

### 2.3.2. Blue marlin

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

### 2.3.3. Striped marlin

A genetics analysis suggested that there are multiple stocks of striped marlin in the Pacific Ocean. Assessments for an EPO stock by the IATTC suggested that the current stock size is about 50 to 70% of the unexploited stock size. An analysis by the ISC in 2007 of the status of an hypothesized single stock of striped marlin spanning the entire north Pacific indicated that the stock has declined to 10-45% of the initial biomass. There were, however, unresolved issues of stock structure and weighting the data from different regions in the modeling process. The stock in the EPO is considered in good condition, with current fishing effort less than $F_{\mathrm{MSY}}$.

### 2.3.4. Black marlin, sailfish, and shortbill spearfish

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

### 2.4. Summary

Preliminary estimates of the catches (including purse-seine discards), in metric tons, of tunas during 2007 and billfishes during 2006 in the EPO are as follows:

| | PS | | | LP | LL | OTR | Total |
|---|---|---|---|---|---|---|---|
| | OBJ | NOA | DEL | | | | |
| Yellowfin tuna | 31,221 | 48,797 | 91,297 | 894 | 961 | 243 | 173,413 |
| Skipjack tuna | 131,311 | 84,901 | 3,305 | 276 | 866 | 6 | 220,665 |
| Bigeye tuna | 61,189 | 1,459 | 0 | 0 | 25,560 | 0 | 88,208 |
| Pacific bluefin | 0 | 0 | 0 | 0 | 0 | 14 | 14 |
| Albacore tuna | 0 | 40 | 0 | 0 | 2,435 | 6,112 | 8,587 |
| Swordfish | <1 | 3 | 2 | 0 | 8,812 | 3,895 | 12,712 |
| Blue marlin | 193 | 18 | 10 | 0 | 2,093 | 105 | 2,419 |
| Striped marlin | 24 | 23 | 12 | 0 | 1,530 | 0 | 1,589 |
| Black marlin | 116 | 13 | 11 | 0 | 37 | 0 | 177 |
| Sailfish | 11 | 10 | 29 | 0 | 50 | 658 | 757 |
| Shortbill spearfish | <1 | <1 | <1 | 0 | 262 | 0 | 262 |

### 2.5. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis*), are frequently found associated 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 setting their nets around herds of dolphins and the associated schools of tunas, and then releasing the dolphins while retaining the tunas. The incidental mortality of dolphins in this operation was high during the early years of the fishery, and the populations of dolphins were reduced from their unexploited levels during the 1960s and 1970s. After the late 1980s the incidental mortality decreased precipitously, and there is now evidence that the populations are recovering. Preliminary mortality estimates of dolphins in the fishery in 2007 are as follows:

| Species and stock | Incidental mortality | |
|---|---|---|
| | Number | Metric tons |
| Offshore spotted dolphin | | |
| Northeastern | 190 | 12 |
| Western-southern | 112 | 7 |
| Spinner dolphin | | |
| Eastern | 174 | 8 |
| Whitebelly | 113 | 7 |
| Common dolphin | | |
| Northern | 57 | 4 |
| Central | 69 | 5 |
| Southern | 93 | 7 |
| Other dolphins[4] | 30 | 2 |
| **Total** | **838** | **52** |

Studies of the association of tunas with dolphins have been an important component of the staff's long-term approach to understanding key interactions in 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. Diet and stable isotope analyses of yellowfin tuna and spotted and spinner dolphins caught in multispecies aggregations by purse-seine vessels in the EPO demonstrate significant differences in food habits and trophic position of the three species, suggesting that the tuna-dolphin association is probably not maintained by feeding advantages. This conclusion is supported by radio tracking studies of spotted dolphins outfitted with time-depth recorders, which indicate that the dolphins feed primarily at night on organisms associated with the deep scattering layer, while food habits studies of yellowfin tuna show primarily daytime feeding.

During 2006, scientists of the U.S. National Marine Fisheries Service (NMFS) conducted the latest in a series of research cruises under the *Stenella* Abundance Research (STAR) project. 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. Data on cetacean distribution, herd size, and herd composition were collected to estimate dolphin abundance. The 2006 survey covered the same areas and used the same methods as past surveys. Data from the large-scale line-transect survey of 2003 produced abundance estimates for 10 dolphin species and/or stocks. The estimates for northeastern offshore spotted and eastern spinner dolphins for 2003 were somewhat greater than the estimates from the previous surveys in 1998-2000, and weighted linear regressions indicated a slight positive trend in the abundance over the 1979-2003 period. The estimates for western-southern offshore spotted, whitebelly spinner, striped (*S. coeruleoalba*), rough-toothed (*Steno bredanensis*), common, bottlenose (*Tursiops truncatus*), and Risso's (*Grampus griseus*) dolphins were generally similar to previous estimates obtained with the same methods.

Scientists of the NMFS have made estimates of the abundances of several other species of marine mammals based on data from research cruises made between 1986 and 2000 in the EPO. The STAR 2003 and 2006 cruises will provide further estimates of abundance of these mammals. Of the species not significantly affected by the tuna fishery, short-finned pilot whales (*Globicephala macrorhynchus*) 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

[4] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: striped dolphins 6 (0.4 t); Central American spinner dolphins (*Stenella longirostris centroamericana*) 14 (0.6 t); bottlenose dolphins 1 (0.1 t), Pacific whitesided dolphin (*Lagenorhynchus obliquidens*) 1 (0.1 t), coastal spotted dolphins 2 (0.2 t); unidentified dolphins 6 (0.3 t).

(*Balaenoptera edeni*) 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 (*Stenella coeruleoalba*) showed no clear trend in estimated abundance over time, and the estimates of abundance of sperm whales (*Physeter macrocephalus*) have tended to decrease in recent years.

Some marine mammals are adversely affected by reduced food availability during El Niño events, especially in coastal ecosystems. Examples that have been documented include dolphins, pinnipeds, and Bryde's whales off Peru, and pinnipeds around the Galapagos Islands. Large whales are able to move in response to changes in prey productivity and distribution.

### 2.6. Sea turtles

Sea turtles are caught on longlines when they take the bait on hooks, are snagged accidentally by hooks, or are entangled in the lines. Estimates of incidental mortality of turtles due to longline and gillnet fishing are few. At the 4th meeting of the IATTC Working Group on Bycatch in January 2004, it was reported that 166 leatherback (*Dermochelys coriacea*) and 6,000 other turtle species, mostly olive Ridley (*Lepidochelys olivacea*), were incidentally caught by Japan's longline fishery in the EPO during 2000, and that, of these, 25 and 3,000, respectively, were dead. At the 6th meeting of the Working Group in February 2007, it was reported that the Spanish longline fleet targeting swordfish in the EPO averaged 65 interactions and 8 mortalities per million hooks during 1990-2005. The mortality rates due to longlining in the EPO are likely to be similar for other fleets targeting bigeye tuna, and possibly greater for those that set their lines at shallower depths for albacore and swordfish. 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 artisanal longline vessels that fish for tunas, billfishes, sharks, and dorado (*Coryphaena* spp.) in the EPO. Since 2005, staff members of the IATTC and some other organizations, together with the governments of several coastal Latin American nations, have been engaged in a program to reduce the hooking rates and mortalities of sea turtles in these fisheries. Additional information on this program can be found in Section 8.2.

Sea turtles are occasionally caught in purse seines in the EPO tuna fishery. Most interactions occur when the turtles associate with floating objects, and are captured when the object is encircled. In other cases, nets set around unassociated schools of tunas or schools associated with dolphins may capture sea turtles that happen to be at those locations. The olive Ridley turtle is, by far, the species of sea turtle taken most often by purse seiners. It is followed by green sea turtles (*Chelonia mydas*), and, very occasionally, by loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles. Only one mortality of a leatherback turtle has been recorded during the 10 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 fish-aggregating devices (FADs) and drown. In some cases, they are entangled by the fishing gear and may be injured or killed. Preliminary estimates of the mortalities (in numbers) of turtles caused by large purse-seine vessels during 2007 are as follows:

| | Set type | | | Total |
|---|---|---|---|---|
| | **OBJ** | **NOA** | **DEL** | |
| Olive Ridley | 5.4 | 1.0 | 3.7 | 10.2 |
| Black or eastern Pacific green | 0.0 | 1.0 | 0.0 | 1.0 |
| Loggerhead | 0.0 | 0.0 | 0.0 | 0.0 |
| Hawksbill | 0.0 | 1.9 | 0.0 | 1.9 |
| Leatherback | 0.0 | 0.0 | 0.0 | 0.0 |
| Unidentified | 9.3 | 0.0 | 3.6 | 13.0 |
| **Total** | 14.8 | 3.9 | 7.4 | 26.1 |

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.

The populations of olive Ridley, black, and loggerhead turtles are designated as endangered, and those of the hawksbill and leatherback turtles as critically endangered, by the International Union for the Conservation of Nature.

### 2.7. Sharks and other large fishes

Sharks and other large fishes are taken by both purse-seine and longline vessels. Silky sharks (*Carcharhinus falciformis*) are the most commonly-caught species of shark in the purse-seine fishery, followed by oceanic whitetip sharks (*C. longimanus*). The longline fisheries also take significant quantities of silky sharks, and a Pacific-wide analysis of longline and purse-seine fishing is necessary to estimate the impact of fishing on the stock(s). Preliminary estimates of indices of relative abundance of silky sharks, based on data for purse-seine sets on floating objects, show a decreasing trend during 1994-2006; the trends in unstandardized bycatch per set are similar for the other two types of purse-seine sets (standardized trends are not yet available). The unstandardized average bycatch per set of oceanic whitetip sharks also shows decreasing trends for all three set types during the same period. It is not known whether these decreasing trends are due to incidental capture by the fisheries, changes in the environment (perhaps associated with the 1997-1998 El Niño event), or other factors. The decreasing trends do not appear to be due to changes in the density of floating objects.

Scientists at the University of Washington are conducting an analysis of the temporal frequency of areas of high bycatches of silky sharks in purse-seine sets on floating objects, which will be useful for determining the effectiveness of area-time closures as a means of mitigating shark bycatch. Results show that both model predictions and observed data tend to indicate that these bycatches occur most frequently north of 4°N and west of 100-105°W. However, due to large tuna catches south of 5°N, the greatest reduction in bycatch from sets on floating objects with the least loss of tuna catch would be achieved north of approximately 6°N.

A sampling project has been initiated by scientists of the IATTC and the NMFS to collect and archive tissue samples for sharks, rays, and other large fishes for future genetics analysis. Data from the archived samples will be used in studies of large-scale stock structure of these taxa in the EPO, information that is vital for stock assessments and is generally lacking throughout the Pacific Ocean.

A stock assessment for blue sharks (*Prionace glauca*) in the North Pacific Ocean has been conducted by scientists of the NMFS and the NRIFSF. Preliminary results provided a range of plausible values for maximum sustainable yield (MSY) of 1.8 to nearly 4 times the 2001 catch of blue shark per year.

Preliminary estimates of the discards (in metric tons) of sharks and other large fishes in the EPO during 2007, other than those discussed above, by large purse-seine vessels are as follows. Complete data are not available for small purse-seine, longline, and other types of vessels.

| | **Set type** | | | |
|---|---|---|---|---|
| | **OBJ** | **NOA** | **DEL** | **Total** |
| Sharks | 473 | 194 | 63 | 730 |
| Rays (Mobulidae and Dasyatidae) | 2 | 24 | 14 | 40 |
| Dorado (*Coryphaena* spp.) | 1,281 | 31 | 2 | 1,313 |
| Wahoo (*Acanthocybium solandri*) | 477 | 2 | <1 | 479 |
| Rainbow runner (*Elagatis bipinnulata*) and yellowtail (*Seriola lalandi*) | 357 | 93 | <1 | 451 |
| Black skipjack | 1,296 | 132 | 6 | 1,434 |
| Bonito | 2 | 686 | 0 | 687 |
| Unidentified tunas | 10,183 | 2,249 | 42 | 12,474 |
| Billfishes | 10 | 6 | 3 | 19 |
| Other large fishes | 21 | 12 | 2 | 35 |

Apart from the assessments of billfishes, summarized in Sections G, H, and I of this report, and blue shark, there are no stock assessments available for these species in the EPO, and hence the impacts of the bycatches on the stocks are unknown.

The catch rates of species other than tunas 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 (*Istiophorus platypterus*), manta rays (Mobulidae), and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets, and lowest in 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. The estimated numbers of purse-seine sets of each type in the EPO during 1990-2007 are shown in Table A-7.

In October 2006, the NMFS hosted a workshop on bycatch reduction in the EPO purse-seine fishery. The attendees agreed to support a proposal for research on methods to reduce bycatches of sharks by attracting them away from floating objects prior to setting the purse seine. A feasibility study has been planned. The attendees also supported a suite of field experiments on bycatch reduction devices and techniques; these would include FAD modifications and manipulations, assessing behavioral and physiological indicators of stress, and removing living animals from the seine and deck (*e.g.* sorting grids, bubble gates, and vacuum pumps). A third proposal, which was likewise supported by the attendees, involves using IATTC data to determine if spatial, temporal, and environmental factors can be used to predict bycatches in FAD sets and to determine to what extent time/area closures would be effective in reducing bycatches.

## 3. OTHER ECOSYSTEM COMPONENTS

### 3.1. Seabirds

There are approximately 100 species of seabirds in the tropical EPO. Some seabirds associate with epipelagic predators near the sea surface, 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 (flying fishes (Exocoetidae) and squids (Ommastrephidae)). 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. Feeding opportunities for some seabird species are dependent on the presence of tuna schools feeding near the surface.

Seabirds are affected by the variability of the ocean environment. During the 1982-1983 El Niño event, seabird populations throughout the tropical and northeastern Pacific Ocean experienced breeding failures and mass mortalities, or migrated elsewhere in search of food. Some species, however, are apparently not affected by El Niño episodes. In general, seabirds that forage in upwelling areas of the tropical EPO and Peru Current suffer reproductive failures and mortalities due to food shortage during El Niño events, while seabirds that forage in areas less affected by El Niño episodes may be relatively unaffected.

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 for a downward trend for the Tahiti petrel (*Pseudobulweria rostrata*), in the tropical EPO. Population status and trends are currently under review for waved (*Phoebastria irrorata*), black-footed (*P. nigripes*), and Laysan (*P. immutabilis*) albatrosses.

Some seabirds, especially albatrosses and petrels, are susceptible to being caught on baited hooks in pelagic longline fisheries. Satellite tracking and at-sea observation data have identified the importance of the IATTC area for waved, black-footed, Laysan, and black-browed (*Thalassarche melanophrys*) albatrosses, plus several other species that breed in New Zealand, yet forage off the coast of South America. There is particular concern for the waved albatross because it is endemic to the EPO and nests only in the Galapagos Islands. Observer data from artisanal vessels show no interactions with waved albatross during these vessels' fishing operations. Data from the US pelagic longline fishery in the northeastern Pacific Ocean indicate that bycatches of black-footed and Laysan albatrosses occur. Few comparable data for the longline fisheries in the central and southeastern Pacific Ocean are available. At the 6th meeting of the IATTC Working Group on Bycatch in February 2007, it was reported that the Spanish surface longline fleet targeting swordfish in the EPO averaged 40 seabird interactions per million hooks, virtually all resulting in mortality, during 1990-2005. In 2007, the IATTC Stock Assessment Working Group has identified areas of vulnerability to industrial longline fishing for several species of albatross and proposed mitigation measures. In an externally-funded study, the IATTC staff is currently investigating the population status of the black-footed albatross in the entire North Pacific Ocean, taking into account the effects of fisheries bycatch.

### 3.2. Forage

The forage taxa occupying the middle trophic levels in the EPO are obviously important components of the ecosystem, providing a link between primary production at the base of the food web and the upper-trophic-level predators, such as tunas and billfishes. Indirect effects on those predators caused by environmental variability are transmitted to the upper trophic levels through the forage taxa. 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 lantern fishes (Myctophidae), flying fishes (Exocoetidae), and some squids, in the tropical EPO during 1986-1990 and 1998-2000. Mean abundance estimates for all fish taxa and, to a lesser extent, for squids increased from 1986 through 1990. The 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 NMFS STAR 2003 and 2006 cruises, and are currently being analyzed.

The Humboldt or jumbo squid (*Dosidicus gigas*) populations in the EPO have increased in size and geographic range in recent years. In addition, in 2002 observers on tuna purse-seine vessels reported increased incidental catches of Humboldt squid caught with tunas, primarily skipjack, off Peru. Juvenile stages of these squid are common prey for yellowfin and bigeye tunas, and other predatory fishes, and they are also voracious predators of small fishes and cephalopods throughout their range. Large Humboldt squid have been observed attacking skipjack and yellowfin inside a purse seine. Not only have these squid impacted the ecosystems that they have expanded into, but they are also thought to have the capability of affecting the trophic structure in pelagic regions. Changes in the abundance and geographic range of Humboldt squid could affect the foraging behavior of the tunas and other predators, perhaps changing their vulnerability to capture. A recent sampling program by the IATTC staff, to examine possible changes in foraging behavior of yellowfin tuna, is described in Section 4.

Some 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.), for example, 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 (Section 7), frigate and bullet tunas comprise 10% or more of the diet of eight predator categories. Small quantities of frigate and bullet tunas are captured by purse-seine vessels on the high seas and by artisanal fisheries in some coastal regions of Central and South America. The vast majority of frigate and bullet tunas captured by tuna purse-seine vessels is discarded at sea. Preliminary estimates of the discards, in metric tons, of small fishes by large purse-seine vessels with observers aboard in the EPO during 2007 are as follows:

| | Set type | | | |
|---|---|---|---|---|
| | OBJ | NOA | DEL | Total |
| Triggerfishes (Balistidae) and filefishes (Monacanthidae) | 266 | <1 | <1 | 266 |
| Other small fishes | 21 | 10 | <1 | 30 |
| Frigate and bullet tunas (*Auxis* spp.) | 908 | 396 | 27 | 1,331 |

### 3.3. Larval fishes and plankton

Larval fishes have been collected by manta (surface) net tows in the EPO for many years by personnel of the NMFS Southwest Fisheries Science Center. Of the 314 taxonomic categories identified, 17 were found to be most likely to show the effects of environmental change. The occurrence, abundance, and distribution of these key taxa revealed no consistent temporal trends.

The phytoplankton and zooplankton populations in the tropical EPO are variable. For example, chlorophyll concentrations on the sea surface (an indicator of phytoplankton blooms) and the abundance of copepods were markedly reduced during the El Niño event of 1982-1983, especially west of 120°W. Similarly, surface concentrations of chlorophyll decreased during the 1986-1987 El Niño episode and increased during the 1988 La Niña event due to changes in nutrient availability.

The species and size composition of zooplankton is often more variable than the zooplankton biomass. When the water temperatures increase, warm-water species often replace cold-water species at particular locations. The relative abundance of small copepods off northern Chile, for example, increased during the 1997-1998 El Nino event, while the zooplankton biomass did not change.

Copepods often comprise the dominant component of secondary production in marine ecosystems. An analysis of the trophic structure among the community of pelagic copepods in the EPO was conducted by a student of the Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, La Paz, Mexico, using samples collected by scientists of the U.S. NMFS STAR project. The stable nitrogen isotope values of omnivorous copepods were used in a separate analysis of the trophic position of yellowfin tuna, by treating the copepods as a proxy for the isotopic variability at the base of the food web (see next section).

## 4. TROPHIC INTERACTIONS

Tunas and billfishes are wide-ranging, generalist predators with high energy requirements, and, as such, are key components of pelagic ecosystems. The ecological relationships among large pelagic predators, and between them and animals at lower trophic levels, are not well understood. Given the need to evaluate the implications of fishing activities on the underlying ecosystems, it is essential to acquire accurate depictions of trophic links and biomass flows through the food web in open-ocean ecosystems, and a basic understanding of the natural variability forced by the environment.

Knowledge of the trophic ecology of predatory fishes has historically been derived from stomach contents analysis. Large pelagic predators are considered efficient biological samplers of micronekton organisms, which are poorly sampled by nets and trawls. Diet studies have revealed many of the key trophic connections in the pelagic EPO, and have formed the basis for representing food-web interactions in an ecosystem model (IATTC Bulletin, Vol. 22, No. 3) to explore indirect ecosystem effects of fishing. The most common prey items of yellowfin tuna caught by purse seines offshore are frigate and bullet tunas, squids and argonauts (cephalopods), and flyingfishes and other epipelagic fishes. Bigeye tuna feed at greater depths than do yellowfin and skipjack, and consume primarily cephalopods and mesopelagic fishes. The most important prey of skipjack overall were euphausiid crustaceans in a study during the late 1950s, whereas the small mesopelagic fish *Vinciguerria lucetia* appeared dominant in the diet during the early 1990s. Tunas that feed inshore utilize different prey than those caught offshore. For example, yellowfin and skipjack caught off Baja California feed heavily on red crabs, *Pleuroncodes planipes*. More recently, diet studies have become focused on understanding entire food webs, initially by describing the inter-specific connections among the predator communities, comprising tunas, sharks, billfishes, dorado, wahoo (*Acanthocybium solandri*), rainbow runner (*Elagatis bipinnulata*), and others. In general, considerable resource partitioning is evident among the components of these communities, and researchers seek to understand the spatial scale of the observable trophic patterns, and also the role of climate variability in influencing the patterns.

While diet studies have yielded many insights, stable isotope analysis is a useful complement to stomach contents for delineating the complex structure of marine food webs. Stomach contents represent a sample of only the most-recent several hours of feeding at the time of day an animal is captured, and under the conditions required for its capture. Stable carbon and nitrogen isotopes, however, integrate information on all components of the diet into the animal's tissues, providing a recent history of trophic interactions and information on the structure and dynamics of ecological communities. A recent analysis of the spatial distribution of stable isotope values of yellowfin tuna in relation to those of omnivorous copepods showed that the trophic position of yellowfin tuna increased slightly from inshore to offshore in the EPO. Diet data also showed comparable variability in the trophic position of yellowfin, but did not show an inshore-offshore gradient in trophic position.

A short-term study was initiated during the fourth quarter of 2006 to examine the stomach contents of recently-captured yellowfin tuna to detect possible changes in their foraging behavior relative to previous years. Single-species stock assessments are not designed to consider the effect of trophic interactions (*e.g.* predation, competition, and changes in trophic structure) on the stock in question. Prey populations that feed the apex predators also vary over time (see 3.2 Forage), and some prey impart considerable predation pressure on animals that occupy the lower trophic levels (including the early life stages of large fishes). Stomach samples of a ubiquitous predator, such as yellowfin tuna, compared with prevous diet data, can be used to infer changes in prey populations by identifying changes in foraging behavior. Changes in foraging behavior could cause the tunas, for example, to alter the typical depth distributions while foraging, and this could affect their vulnerability to capture. Stomach samples of yellowfin tuna were collected from purse-seine sets made on fish associated with dolphins during the fourth quarter of 2006, and compared with samples from dolphin sets made during 2003-2005 in the same fishing area. Of special interest were the inter-annual differences in predation on the Humboldt or jumbo squid because of recent changes in its abundance and geographical range (see 3.2 Forage). The amount of fresh squid tissue in the yellowfin stomachs was very low, and there were no differences in the diet proportions by weight from year to year. Cephalopod mandibles (or beaks), however, are retained in the stomachs, and the percent occurrence of jumbo squid mandibles decreased by 21 percent between 2004 and 2006. Interannual differences in predation on other diet components were small. *Auxis* spp. were eaten in significantly greater quantities ($p<0.05$) in 2005 and 2006 compared to 2003 and 2004, and significantly more Pacific flatiron herring (*Harengula thrissina*) and chub mackerel (*Scomber japonicus*) were eaten in 2006 than in the previous three years. Overall, there is no convincing evidence of substantial changes in the trophic structure having taken place during 2003-2006, based on the food habits of yellowfin tuna caught in association with dolphins.

## 5. PHYSICAL ENVIRONMENT[5]

Environmental conditions affect marine ecosystems, the dynamics and catchability of tunas and billfishes, and the activities of the fishermen. Tunas and billfishes are pelagic during all stages of their lives, and the physical factors that affect the tropical and sub-tropical Pacific Ocean can have important effects on their distribution and abundance. Environmental conditions are thought to cause considerable variability in the recruitment of tunas and billfishes. Stock assessments by the IATTC have often included the assumption that oceanographic conditions might influence recruitment in the EPO.

Different types of climate perturbations may impact fisheries differently. It is thought that a shallow thermocline in the EPO contributes to the success of purse-seine fishing for tunas, perhaps by acting as a thermal barrier to schools of small tunas, keeping them near the sea surface. When the thermocline is deep, as during an El Niño event, tunas seem to be less vulnerable to capture, and the catch rates have declined. Warmer- or cooler-than-average sea-surface temperatures (SSTs) can also cause these mobile fishes to move to more favorable habitats.

The ocean environment varies on a variety of time scales, from seasonal to interannual, decadal, and longer (*e.g.* climate phases or regimes). The dominant source of variability in the upper layers of the EPO

[5] Much of the information in this section is from Fiedler, P.C. 2002. Environmental change in the eastern tropical Pacific Ocean: review of ENSO and decadal variability. Mar. Ecol. Prog. Ser. 244: 265-283.

is often called the El Niño-Southern Oscillation (ENSO). The ENSO is an irregular fluctuation involving the entire tropical Pacific Ocean and global atmosphere. It results in variations of the winds, rainfall, thermocline depth, circulation, biological productivity, and the feeding and reproduction of fishes, birds, and marine mammals. El Niño events occur at 2- to 7-year intervals, and are characterized by weaker trade winds, deeper thermoclines, and abnormally-high SSTs in the equatorial EPO. El Niño's opposite phase, often called La Niña, is characterized by stronger trade winds, shallower thermoclines, and lower SSTs. Research has documented a connection between the ENSO and the rate of primary production, phytoplankton biomass, and phytoplankton species composition. Upwelling of nutrient-rich subsurface water is reduced during El Niño episodes, leading to a marked reduction in primary and secondary production. ENSO also directly affects animals at middle and upper trophic levels. Researchers have concluded that the 1982-1983 El Niño event, for example, deepened the thermocline and nutricline, decreased primary production, reduced zooplankton abundance, and ultimately reduced the growth rates, reproductive successes, and survival of various birds, mammals, and fishes in the EPO. In general, however, the ocean inhabitants recover within short periods because their life histories are adapted to respond to a variable habitat.

The IATTC reports monthly average oceanographic and meteorological data for the EPO, including a summary of current ENSO conditions, on a quarterly basis. In 2006, weak El Niño conditions developed during the third quarter and continued during the rest of the year. Oceanographic and meteorological data indicated a transition from weak El Niño conditions to La Niña (or anti-El Niño) conditions from October 2006 to March 2007. Anti-El Niño conditions intensified during the second, third, and fourth quarters of 2007.

Variability on a decadal scale (*i.e.* 10 to 30 years) also affects the EPO. During the late 1970s there was a major shift in physical and biological states in the North Pacific Ocean. This climate shift was also detected in the tropical EPO by small increases in SSTs, weakening of the trade winds, and a moderate change in surface chlorophyll levels. Some researchers have reported another major shift in the North Pacific in 1989. Climate-induced variability in the ocean has often been described in terms of "regimes," characterized by relatively stable means and patterns in the physical and biological variables. Analyses by the IATTC staff have indicated that yellowfin tuna in the EPO have experienced regimes of lower (1975-1982) and higher (1983-2001) recruitment, and possibly intermediate (2002-2006) recruitment. The increased recruitment during the latter period is thought to be due to a shift to a higher productivity regime in the Pacific Ocean. Decadal fluctuations in upwelling and water transport are simultaneous to the higher-frequency ENSO pattern, and have basin-wide effects on the SSTs and thermocline slope that are similar to those caused by ENSO, but on longer time scales.

There is evidence that the North Pacific Ocean is currently in a cool regime, while no such evidence is apparent for the equatorial Pacific.

Environmental variability in the tropical EPO is manifested differently in different regions in which tunas are caught. For example, SST anomalies in the tropical EPO warm pool (5° to 20°N, east of 120°W) have been about one-half the magnitude and several months later than those in the equatorial Pacific NIÑO3 area (5°S to 5°N, 90° to 150°W).

## 6. AGGREGATE INDICATORS

Recognition of the consequences of fishing for marine ecosystems has stimulated considerable research in recent years. Numerous objectives have been proposed to evaluate fishery impacts on ecosystems and to define over-fishing from an ecosystem perspective. Whereas reference points 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 mortality 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, trophic spectra of catches, 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 properties exists. Ecosystem-level metrics are not yet commonly used for managing fisheries.

New methods of ordination, developed by scientists at the Institute of Statistical Mathematics in Tokyo, Japan, have produced indices of association related to different groupings of catch and bycatch species for floating-object sets of the purse-seine fishery. The preliminary indices show clear large-scale spatial patterns, and relationships to environmental variables, such as SST, chlorophyll-a density, and mixed layer depth. Information on relationships between indices of species association and environmental characteristics may help to guide the development of approaches for bycatch reduction.

Ecologically-based approaches to fisheries management place renewed emphasis on achieving accurate depictions of trophic links and biomass flows through the food web in exploited systems. The structure of the food web and the interactions among its components have a demonstrable role in determining the dynamics and productivity of ecosystems. Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms, to facilitate estimates of energy or mass flow through communities, and for elucidating trophodynamics aspects of ecosystem functioning. A simplified food-web diagram, with approximate TLs, of the pelagic tropical EPO, is shown in Figure J-1. Toothed whales (Odontoceti, 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 (average TL 4.8), and seabirds (average TL 4.5) occupy slightly lower TLs. Smaller epipelagic fishes (*e.g. Auxis* spp. and flyingfishes, average TL 3.2), cephalopods (average TL 4.4), and mesopelagic fishes (average TL 3.4) 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 micro-zooplankton (TL 2) feed on the producers, phytoplankton and bacteria (TL 1).

In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as apex predators in the ecosystem. Over time, fishing can cause the overall size composition of the catch to decrease, and, in general, the TLs of smaller organisms are lower than those of larger organisms. The mean TL of the organisms taken by a fishery is a 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, according to FAO landings statistics, the mean TL of the fishes and invertebrates landed globally had declined between 1950 and 1994, which was hypothesized by the authors of that study to be detrimental to the ecosystems. Some ecosystems, however, have changed in the other direction, from lower to higher TL communities. Given the potential utility of this approach, TLs were estimated for a time series of annual catches and discards by species from 1993 to 2007 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The estimates were made by applying the TL values from the EPO ecosystem model (see Section 7), weighted by the catch data by fishery and year for all model groups from the IATTC tuna, bycatch, and discard data bases. The TLs from the ecosystem model were determined by average diet estimates for all species groups. The TLs of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year, varying by less than 0.1 TL (Figure J-2: Average PS+LP), and there is no indication of declining trends over the 15-year period. The catches of large yellowfin (≥90 cm, TL 4.66), skipjack (TL 4.57), small yellowfin (<90 cm, TL 4.57), and large bigeye (≥80 cm, TL 5.17) contributed 36, 34, 19, and 6 percent, respectively, to the overall TL (4.63) during 1993-2006. The retained and discarded catches of all other species and groups contributed less than 5 percent of the overall TL of the catches, including small bigeye (4.7%, TL 4.53) and all the bycatch species. In general, the TLs of the unassociated sets and the pole-and-line fishery were below average and those of the dolphin sets were above average for most years (Figure J-2). The TLs of the floating-object sets varied more than those of the other set types and fisheries, primarily due to the inter-annual variability in the size of bigeye and the amount of skipjack caught in those sets. The TLs of floating-object sets were positively related to the percentage of the total catch comprised of large bigeye ($p<0.001$) and negatively related to the percentage of the catch comprised of skipjack ($p<0.001$) (Figure J-3).

The TLs were also estimated separately for the time series of retained and discarded catches of the purse-seine fishery each year from 1993 to 2007 (Figure J-4). The discarded catches were much less than the retained catches, and thus the TL patterns of the total (retained plus discarded) catches (Figure J-2) were determined primarily by the retained catches (Figure J-4). The TLs of the discarded catches varied more year-to-year than those of the retained catches, and did not decline over time. The greatest variation occurred for sets on fish associated with floating objects, and those sets also had the greatest bycatch species diversity. The lowest TL of the discarded catches occurred for both unassociated and floating objects sets in 1998. For unassociated sets, the marked reduction in TL during 1998 was due to increased bycatches of rays (TL 3.68), which feed on plankton and other small animals that occupy low TLs, and a reduction in the catches of large sharks (TL 4.93). From 1998 to 2001, the discarded catches of rays gradually declined in unassociated sets and those of large sharks and small yellowfin increased, resulting in a gradually increasing TL of the discarded catches over that interval. For floating-object sets, the discards of small epipelagic fishes (*e.g.* Clupeiformes, Nomeidae, Tetraodontiformes, and others; TL 3.19) increased and of large bigeye decreased from 1996 to 1998, lowering the TL over that interval. The TL increase in floating-object sets from 1998 to 2000 resulted from a reduction in the bycatch of small epipelagic fishes and an increase in discarded dorado (TL 4.66) and large bigeye.

## 7. ECOSYSTEM MODELING

It is clear that the different components of an ecosystem interact. Ecosystem-based fisheries management is facilitated through the development of multi-species, ecosystem models that represent ecological interactions among species or guilds. Our understanding of the complex maze of connections in open-ocean ecosystems 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 flying fishes), 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, and purse-seine sets on tunas associated with dolphins, with floating objects, and in unassociated schools. 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, and 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 proxies 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.

## 8. ACTIONS BY THE IATTC AND THE AIDCP ADDRESSING ECOSYSTEM CONSIDERATIONS

Both the IATTC convention and the 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:

### 8.1. 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. The incidental mortalities of all stocks of dolphins have been limited to levels that are insignificant relative to stock sizes.

### 8.2. Sea turtles

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

b. In June 2003 the IATTC adopted a Recommendation on Sea Turtles, which contemplates "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." In January 2004, the Working Group on Bycatch drew up a detailed program that includes all these elements, and urges all nations with vessels fishing for tunas in the EPO to 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. Resolution C-04-07 on a three-year program to mitigate the impact of tuna fishing on sea turtles was adopted by the IATTC in June 2004; it includes requirements for data collection, mitigation measures, industry education, capacity building, and reporting.

c. Resolution C-04-05 REV 2, adopted by the IATTC in June 2006, contains provisions on releasing and handling of sea turtles captured in purse seines. The resolution also prohibits vessels from disposing of plastic containers and other debris at sea, and instructs the Director to study and formulate recommendations regarding the design of FADs, particularly the use of netting attached underwater to FADs.

d. Resolution C-07-03, adopted by the IATTC in June 2007, contains provisions on implementing observer programs for fisheries under the purview of the Commission that may have impacts on sea turtles and are not currently being observed. The resolution requires fishermen to foster recovery and resuscitation of comatose or inactive hard-shell sea turtles before returning them to the water. CPCs with purse-seine and longline vessels fishing for species covered by the IATTC Convention in the EPO are directed to avoid encounters with sea turtles, to reduce mortalities using a variety of techniques, and to conduct research on modifications of FAD designs and longline gear and fishing practices.

e. In response to a request made by the Subsecretaría de Recursos Pesqueros of Ecuador, a program was established by the World Wildlife Fund, the IATTC, and the government of the United States to mitigate the incidental capture and reduce the mortality of sea turtles due to longline fishing. A key element of this program is the comparison of catch rates of tunas, billfishes, sharks, and dorado caught with J hooks to the catch rates using circle hooks. Circle hooks do not hook as many turtles as the J hooks, which are traditionally used in the longline fishery, and the chance of serious injury to the sea turtles that bite the circle hooks is reduced because they are wider and they tend to hook the lower jaw, rather than the more dangerous deep hookings in the esophagus and other areas, which are more common with the J hooks. Improved procedures and instruments to release hooked and entangled sea turtles have also been disseminated to the longline fleets of the region.

Through 2007, observers have recorded data on more than 1,100 fishing trips of the vessels that are testing the different hooks. The program was actively running in Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Panama, and Peru and under development in Mexico and Nicaragua. The program in Ecuador is being carried out in partnership with the government and the Overseas Fishery Cooperation Foundation of Japan, while those in other countries are currently funded by U.S. agencies. Initial results show that, in the fisheries that target tunas, billfishes, and sharks, there was a significant reduction in the hooking rates of sea turtles with the circle hooks, and fewer hooks lodged in the esophagus or other areas detrimental to the turtles. The catch rates of the target species are, in general, similar to the catch rates with the J-hooks. An experiment was also carried out in the dorado fishery using smaller circle hooks. There were reductions in turtle hooking rates, but the reductions were not as great as for the fisheries that target tunas, billfishes, and sharks. In addition, workshops and presentations were conducted by IATTC staff members and others in all of the countries participating in the program.

### 8.3. Seabirds

a. Resolution C-05-01, adopted by the IATTC in June 2005, recommends that IATTC Parties and cooperating non-Parties, fishing entities, and regional economic integration organizations implement, if appropriate, the International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries; collect and provide information to the Commission on interactions with seabirds; and for the Working Group on Stock Assessment to present to the Commission an assessment of the impact of incidental catches of seabirds resulting from the activities of all the vessels fishing for tunas and tuna-like species in the EPO. This assessment should include an identification of the geographic areas in which there could be interactions between longline fisheries and seabirds.

b. The sixth meeting of the IATTC Working Group on Bycatch recommended that the Stock Assessment Working Group suggest possible mitigation measures in areas in which seabird distributions and longline effort overlap, and that the IATTC consider mitigation measures at its June 2007 meeting. It also recommended that seabird bycatch data be collected from all tuna longliners in the EPO.

c. A population model for black-footed albatross is being developed to assess whether past and present levels of bycatch are likely to significantly affect their populations and to generate a protected species model that can be applied to multiple species and used to provide management advice. IATTC purse-seine observer data are being used also to plot seabird distributions.

### 8.4. Other species

a. In June 2000, the IATTC adopted a resolution on live release of sharks, rays, billfishes, dorado, and other non-target species.

b. Resolution C-04-05, adopted by the IATTC in June 2006, instructs the Director 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 estimate the survival rates of released billfishes, sharks, and rays.

### 8.5. All species

a. Data on the bycatches of large purse-seine vessels are being collected, and governments are urged to provide bycatch information for other vessels.

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.

## 9. FUTURE DEVELOPMENTS

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.

It is important to continue studies of the ecosystems in the EPO. The power to resolve issues related to fisheries and the ecosystem will increase with the number of habitat variables, taxa, and trophic levels studied and with longer time series of data.

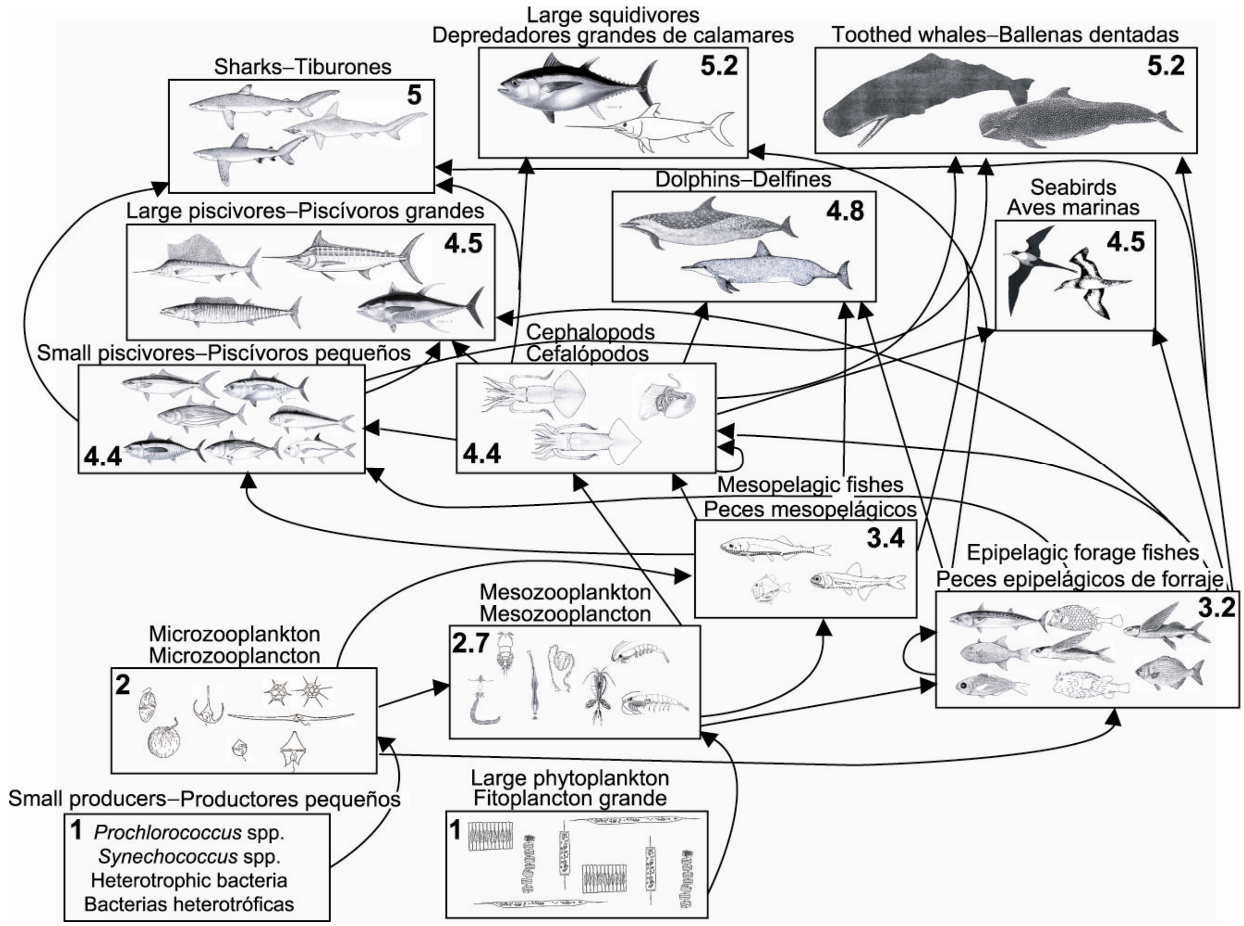


**FIGURE J-1.** Simplified food-web diagram of the pelagic ecosystem in the tropical EPO. The numbers inside the boxes indicate the approximate trophic levels of each group.
**FIGURA J-1.** Diagrama simplificado de la red trófica del ecosistema pelágico en el OPO tropical. Los números en los recuadros indican el nivel trófico aproximado de cada grupo.

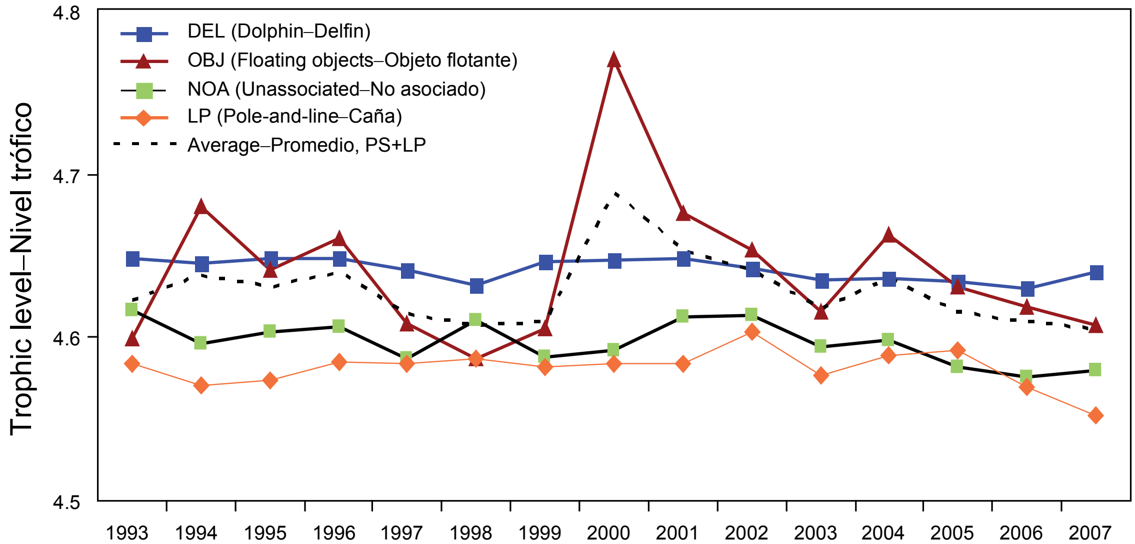


**FIGURE J-2.** Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine and pole-and-line fisheries in the tropical EPO, 1993-2007.
**FIGURA J-2.** Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de las pesquerías cerquera y cañera en el OPO tropical, 1993-2007.

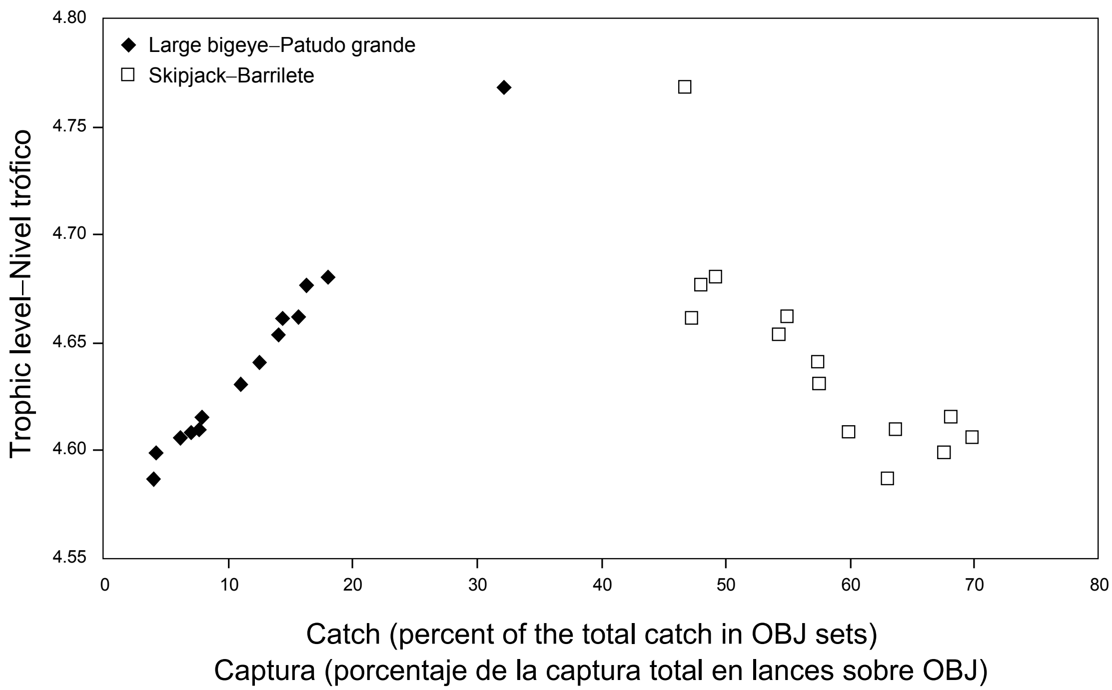


**FIGURE J-3.** Estimates of the trophic levels of the retained catches of large bigeye and of skipjack in floating-object sets (OBJ) in the tropical EPO, 1993-2006, versus the catches of large bigeye and of skipjack calculated as percentages of the total catches in floating-object sets each year.
**FIGURA J-3.** Estimaciones de los niveles tróficos de las capturas retenidas y descartadas en lances sobre objetos flotantes (OBJ) en el OPO tropical, 1993-2006, relativas a las capturas de patudo grande y barrilete, calculadas como porcentajes de las capturas totales en lances sobre objetos flotantes cada año.

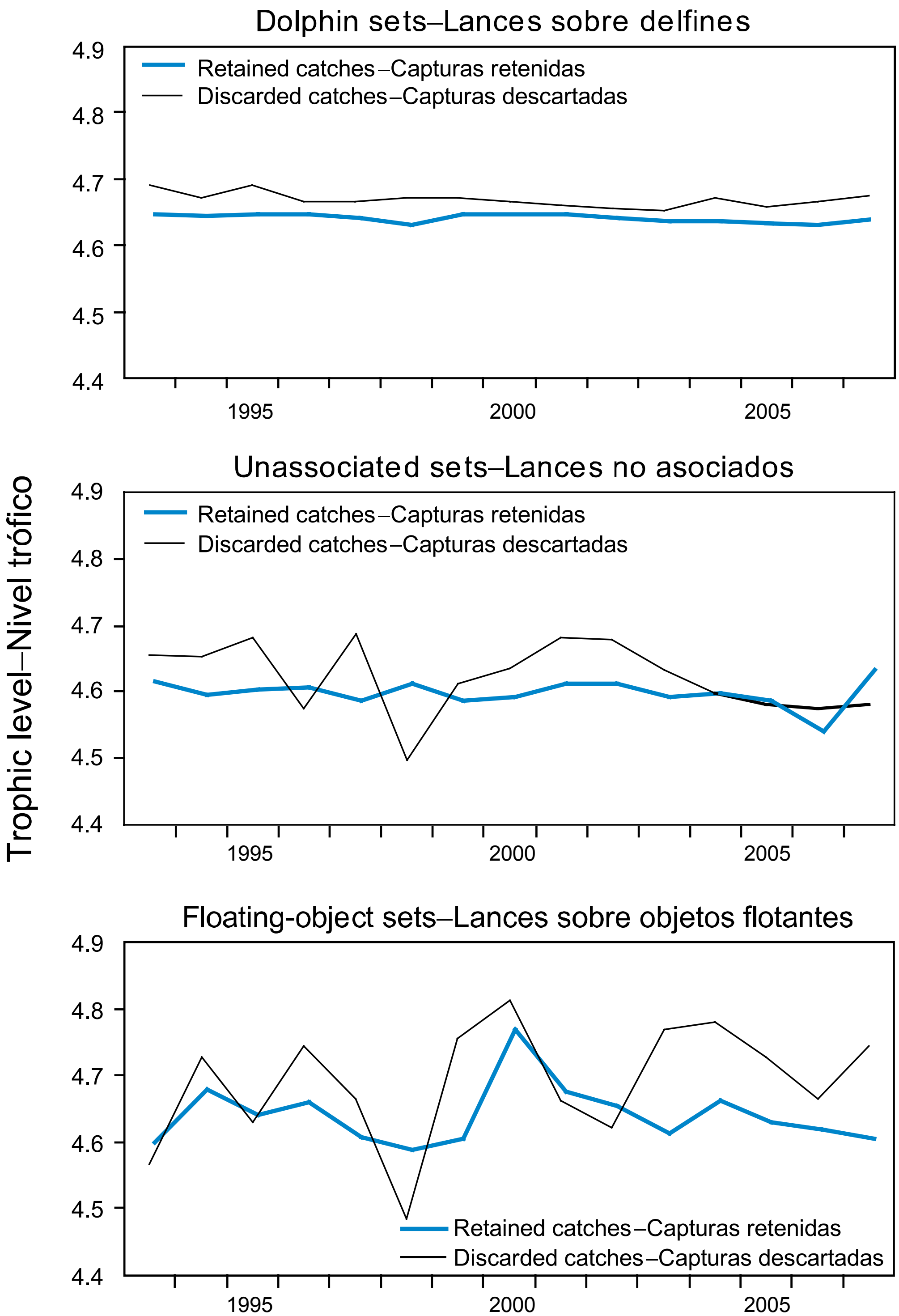


**FIGURE J-4.** Trophic level estimates of the retained catches and discarded catches by purse-seine fishing modes in the tropical EPO, 1993-2007.

**FIGURA J-4.** Estimaciones del nivel trófico de las capturas retenidas y descartadas por modalidad de pesca cerquera en el OPO tropical, 1993-2007.