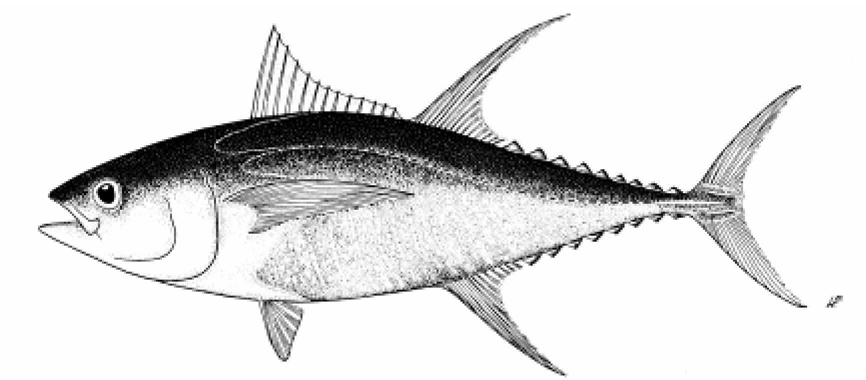
Western and Central Pacific Fisheries Commission

WCPFC–SC1 **FR WP–3**

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

Tunas and billfishes in the Eastern Pacific Ocean in 2004



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IATTC. Inter-American Tropical Tuna Commission. La Jolla, California, USA.

August 2005

INTER-AMERICAN TROPICAL TUNA COMMISSION
COMISIÓN INTERAMERICANA DEL ATÚN TROPICAL

DRAFT 25-JUL-05; NOT TO BE CITED

FISHERY STATUS REPORT 3

TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN IN 2004

INTRODUCTION

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

The report is based on data available to the IATTC staff in March 2005. In Section E (Pacific bluefin tuna), and the three sections on billfishes (G, H, I), only the catch information and/or figures have been updated from IATTC Fishery Status Report 2, published in 2004.

All weights of catches and discards are in metric tons (t). The following abbreviations are used:

Species:

ALB	Albacore tuna (*Thunnus alalunga*)
BET	Bigeye tuna (*Thunnus obesus*)
BIL	Unidentified billfishes
BKJ	Black skipjack (*Euthynnus lineatus*)
BLM	Black marlin (*Makaira indica*)
BUM	Blue marlin (*Makaira nigricans*)
BZX	Bonito (*Sarda* spp.)
CGX	Carangids
DOX	Dorados
MLS	Striped marlin (*Tetrapturus audax*)
MZZ	Unidentified marine fishes
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*)

Fishing gears:

FX	Unknown
HAR	Harpoon
GO	Gillnet
LL	Longline
LP	Pole-and-line
LT	Troll
PS	Purse seine
RO	Recreational
TX	Trawl

Flags:

BLZ	Belize
BOL	Bolivia
CAN	Canada
CHN	People’s Republic of China
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
USA	United States of America
VEN	Venezuela
VUT	Vanuatu

Set types:

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

Ocean areas:

EPO	Eastern Pacific Ocean
WCPO	Western and Central Pacific Ocean

Miscellaneous:

AMSY	Average maximum sustainable yield
OTR	Other
UNK	Unknown

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 fish 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 and mackerels. The principal species of tunas caught are yellowfin, skipjack, and bigeye, with lesser catches of Pacific bluefin and albacore tunas; other scombrids, such as black skipjack, bonito, wahoo, and frigate and bullet tunas, are also caught.

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

The most complete data are available for the purse-seine and pole-and-line fisheries (surface fisheries); data for the longline, artisanal and recreational fisheries are less complete.

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 purse-seine or 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, and for some fleets contains records for large (>24 m) longline vessels that fish in other areas or in any ocean.

Purse-seine vessels are grouped into six size classes, by carrying capacity in cubic meters (m^3) of well volume, as follows:

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

The data in this report are derived from several sources, including vessel logbooks, observer data, unloading records, export and import records, samples of landings, reports from governments and other entities, and published reports.

In the tables, 0: effort or catch < 1t; blank: no data collected; *: data missing or not available.

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

Estimates of the catches and landings of tunas, mainly yellowfin, skipjack, bigeye, and Pacific bluefin, by the purse-seine and pole-and-line fleet of the EPO come from several sources, including logbooks kept by the fishermen, data recorded by observers aboard the vessels, unloading data provided by canneries and other processors, export and import records, and estimates derived from the species composition sampling program. Estimating the total catch for a fishery is difficult, for various reasons. Some fish are discarded at sea, and data for some gear types are often incomplete. Data for fish discarded at sea by Class-6 purse-seine vessels have been collected by observers since 1993. This information 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 retained catch) are based principally on data from unloadings. Beginning in this report, 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 species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-2004 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 recorded catches of bigeye and decrease those of yellowfin and/or skipjack. These adjustments are all preliminary, and may be improved in the future. All the purse-seine and pole-and-line data for 2004 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 gears that fish for tunas, billfishes, 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 longline data and data for other gears for 2003 and 2004 are preliminary.

The data from all of the above sources are compiled in a database by IATTC staff and summarized in this report. In recent years, the IATTC staff has put effort towards summarizing 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 1975-2004 are shown in Table A-2. The catches of scombrids by all gears during 2000-2004 are broken down by gear and flag in Tables A-3a-e, and the purse-seine and pole-and-line catches of scombrids during 2003-2004 are summarized by flag in Tables A-4a-b. There were no restrictions on fishing for tunas in the EPO during 1988-1997, but catches of most species have been affected by restrictions on fishing during some or all of the last six months of 1998-2004. 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 further in Section 3.

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 detrimental effect on the longline catches. Yellowfin recruitments tend to be larger 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 1975-2004 are shown in Table A-1 and Figure B-1. Overall, catches in both the EPO and WCPO have increased during this period. In the EPO, the El Niño of 1982-1983 led to a reduction in catches in those years, whereas catches in the WCPO were not affected. Although the El Niño of 1997-1998 was greater in scope, it did not have the same effect on yellowfin catches. In the WCPO, catches of yellowfin reached 350 thousand metric tons (t) in 1990, peaked at 466 thousand t in 1998, and remained high through 2003 (2004 data for the WCPO are not yet available). Catches throughout the Pacific Ocean were high during 2001-2003. In the EPO, the catch of yellowfin in 2002, 440 thousand t, was the greatest on record, but in 2004 catches decreased substantially.

The average annual retained catch of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1989-2003 was 276 thousand (t) (range: 212 to 413 thousand t). The preliminary estimate of the retained catch of yellowfin in 2004, 270 thousand t, was 29% less than in 2003, and 2% less than the average for 1989-2003. The average amount of yellowfin discarded at sea during 1993-2004 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 from the EPO by longliners during 1975-2004 are shown in Table A-2a. During 1989-2003 they remained relatively stable, averaging about 22 thousand t (range: 11 to 35 thousand t), or about 7% of the total retained catches of yellowfin. Yellowfin are also caught by recreational vessels, as incidental catch by gillnetters, and by artisanal fisheries. Estimates of these catches are shown in Table A-2a, under "Other gears" (OTR); during 1989-2003 they averaged about 2 thousand t.

Further information on yellowfin tuna is presented in Section B of this report.

1.1.2. Skipjack tuna

The annual catches of skipjack during 1975-2004 are shown in Table A-1 and Figure C-1. The catches in the WCPO have increased substantially, and account for a much greater proportion of the total catch of skipjack in the Pacific Ocean than the EPO. The greatest reported catch in the WCPO, 1.3 million t, occurred in 1998, while the greatest reported catch in the EPO, 296 thousand t, occurred in 2003.

During 1989-2003 the annual retained catch of skipjack from the EPO by purse-seine and pole-and-line vessels averaged 138 thousand t (range 64 to 276 thousand t). The preliminary estimate of the retained catch of skipjack in 2004, 197 thousand t, is 43% greater than the average for 1989-2003, but 28% less than the catch in 2003. The average amount of skipjack discarded at sea during 1993-2004 was about 11% of the total catch of skipjack (range: 7 to 19%) (Table A-2a).

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

Further information on skipjack tuna is presented in Section C of this report.

1.1.3. Bigeye tuna

The annual catches of bigeye during 1975-2004 are shown in Table A-1 and Figure D-1. Overall, catches in both the EPO and WCPO have increased, but with many fluctuations. Catches in the EPO reached 100 thousand t in 1986, and have fluctuated between about 70 and 125 thousand t since, with the greatest reported catch in 2000. In the WCPO catches of bigeye increased to over 85 thousand t during the late 1970s, decreased in the 1980s, then increased, with smaller fluctuations, until 1999, when catches reached over 110 thousand t. The greatest reported catch of bigeye in the WCPO, about 115 thousand t, occurred in 2002.

Prior to 1994, the average annual retained catch of bigeye taken by purse-seine vessels in the EPO was about 9 thousand t (range 1 to 22 thousand t). 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 44 to 64 thousand t during 1995-1999, to a record high of 94 thousand t in 2000. A preliminary estimate of the retained catch in the EPO in 2004 is 67 thousand t (Table A-2a). The average amount of bigeye discarded at sea during 1993-2004 was about 5% of the purse-seine catch of bigeye (range: 1 to 9%). Small amounts of bigeye are caught by pole-and-line vessels, as shown in Table A-2a.

During 1975-1993, prior to the increased use of FADs and the resulting greater catches of bigeye by purse-seine vessels, the longline fisheries accounted for about 88%, on average, of the retained catches of this species from the EPO. During 1994-2003 the annual retained catches of bigeye by the longline fisheries ranged from about 36 to 73 thousand t (average: 56 thousand t), or an average of 48% of the total catch of bigeye in the EPO (Table A-2a). The preliminary estimate of catch in the EPO in 2004 is 40 thousand t (Table A-2a).

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

Further information on bigeye tuna is presented in Section D of this report.

1.1.4. Bluefin tuna

Table A-5 and Figure E-1 show the catches of Pacific bluefin in the entire Pacific Ocean, by flag and gear. The data are taken from the International Scientific Committee for the North Pacific (ISC), and are reported by fishing nation or entity, regardless of the area of the Pacific Ocean in which the fish were caught.

Table A-2a shows the catches of Pacific bluefin in the EPO during 1974-2004, by gear. During 1989-2003 the annual retained catch of bluefin from the EPO by purse-seine and pole-and-line vessels averaged 2 thousand t (range 400 t to 8 thousand t). The preliminary estimate of the retained catch of bluefin in 2004, 9 thousand t, is four times the average for 1989-2003. Small amounts of bluefin are discarded at sea by purse-seine vessels (Table A-2a).

Further information on Pacific bluefin tuna is presented in Section E of this report.

1.1.5. Albacore tuna

Tables A-6a-b and Figures F-1a-b show the catches of albacore in the entire Pacific Ocean, by gear, and area (north and south of the equator (table and figure), and east and west of 150°W (table only)), and Table A-2a shows the catches of albacore in the EPO, by gear. A significant portion of the albacore catch is taken by trollers, included under "Other gears" (OTR) in Table A-2a. The catches are compiled from IATTC data for the EPO and from SPC data for the WCPO.

Further information on albacore tuna is presented in Section F of this report.

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 fleet in the EPO, other scombrids 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 1975-2004 are presented in Table A-2a. 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 scombrid species by these fisheries was about 1 thousand t in 2004, which is less than the 1989-2003 annual average retained catch of about 4 thousand t (range: 1 to 15 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. Swordfish and billfishes

Catch data for swordfish and billfishes (blue marlin, black marlin, striped marlin, shortbill spearfish, and sailfish) are shown in Table A-2b and in Figures G-1, H-1 and I-1.

Swordfish are fished in the EPO with longline gear (coastal, offshore, and distant water), gillnets, harpoons, and occasionally with recreational gear and by artisanal vessels. The average annual longline catch of swordfish during 1989-2003 was 9 thousand t, but during 2001-2003 was over 15 thousand t. It is not clear whether this is due to increasing effort towards swordfish.

Billfishes are caught with longline, recreational gear, and by artisanal vessels. The average annual longline catch of blue marlin and striped marlin during 1989-2003 was 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 swordfish and billfishes, but they are believed to be substantially less than the commercial catches for all species.

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

Further information on swordfish, blue marlin, and striped marlin is presented in Sections G-I of this report.

1.1.8. Other species

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

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

1.2. Distribution of catches of tunas

1.2.1. Purse-seine catches

The average annual distributions of the catches of yellowfin, skipjack, and bigeye, by set type, for purse-seine and pole-and-line vessels in the EPO during 1989-2003 (1994-2003 for bigeye), are shown in Figures A-1a, A-2a, and A-3a, and preliminary estimates for 2004 are shown in Figures A-1b, A-2b, and A-3b. The catches of yellowfin were significantly less in the northern areas off Mexico and Central America in 2004. The distribution of the skipjack catches in 2004 were similar to those of 1989-2003, although the catches in the nearshore areas off Mexico were greater, possibly due to changes in fishing strategy due to the poor yellowfin fishing. Bigeye are not often caught north of about 7°N. The distribution of the catches of bigeye during 2004 indicated a reduction in the catches in the nearshore areas off South America. With the development of the fishery for tunas associated with FADs, described above, the relative importance of the nearshore areas has decreased, while that of the offshore areas has increased.

1.2.2. Longline catches

Data on the spatial and temporal distributions of catches by distant-water longline fleets of China, Chinese Taipei, French Polynesia, Japan, Korea, Spain, the United States, and Vanuatu are held in databases of the IATTC. Bigeye and yellowfin tunas make up the majority of the catches by most of these vessels. The distribution of the catches of bigeye and yellowfin tunas in the Pacific Ocean by the Japanese longline fleet during 1999-2003 is shown in Figure A-4.

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 population 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 all of its Annual Reports since that for 1954, and in its Stock Assessment Reports.

Length-frequency samples of yellowfin, skipjack, bigeye, Pacific bluefin, and, occasionally, black skipjack from 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 Report 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 1999-2004 period are presented in this report. Two sets of length-frequency histograms are presented for each species, except bluefin; the first shows the data by stratum (gear type, set type, and area) for 2004, and the second shows the combined data for each year of the 1999–2004 period. For bluefin, the histograms show the 1999-2004 catches by commercial and recreational gear combined. Samples from 496 wells (including 10 from recreational vessels) were taken during 2004. Only a small amount of catch was recorded from pole-and-line vessels in 2004, and only one sample was taken from these vessels.

There are ten yellowfin surface fisheries defined for stock assessments: four associated with floating-objects, two unassociated school, three associated with dolphins, and one pole-and-line (Figure A-5). The last fishery includes all 13 sampling areas. Of the 496 wells sampled, 379 contained yellowfin. The estimated size compositions of the fish caught during 2004 are shown in Figure A-6a. The majority of the yellowfin catch was taken by sets on schools associated with dolphins. The larger yellowfin (>100 cm) were caught mostly during the first half of 2004, while those <100 cm were caught mostly during the second half of that year. However, a mode of smaller yellowfin (<60 cm) was evident in the Southern unassociated fishery during the second quarter. These smaller fish were also present in the Northern unassociated fishery and in all of the floating-object fisheries. Small amounts of yellowfin were caught in the floating-object fisheries throughout the year. The catches by pole-and-line vessels were negligible.

The estimated size compositions of the yellowfin caught by all fisheries combined during 1999-2004 are shown in Figure A-6b. The average weights of the yellowfin caught in 2004 were the lowest since 1999. The majority of yellowfin >10 kg in weight were caught during the first half of 2004. The mode between 80 and 100 cm was the most prevalent size group during all of the quarters except the second.

There are eight skipjack fisheries defined for stock assessments: four associated with floating-objects, two unassociated school, one associated with dolphins, and one pole-and-line (Figure A-5). The last two fisheries include all 13 sampling areas. Of the 496 wells sampled, 328 contained skipjack. The estimated size compositions of the fish caught during 2004 are shown in Figure A-7a. The majority of the skipjack catch during the first half of 2004 was taken in unassociated and floating-object sets in the Southern area. During the second quarter, however, the catches of skipjack increased in the Northern area. During the third quarter, the majority of skipjack were caught in the Northern area, although the catches increased in the Equatorial floating-object fishery as well. The catches of skipjack in latter fishery continued to increase during the fourth quarter, and fish were also caught again in the two Southern fisheries. The three modes of fish evident in the Northern unassociated fishery were caught in three different quarters: the largest fish in the third quarter, the smallest fish in the fourth quarter, and the medium-sized fish in the second quarter. The skipjack caught in the fishery for schools associated with dolphins were taken mostly during the second 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 1999-2004 are shown in Figure A-7b. The smaller fish (40 to 50 cm) were caught primarily during the first and fourth quarters of 2004, and the larger ones (>55 cm) primarily during the second quarter that year.

There are seven bigeye surface fisheries defined for stock assessments: four associated with floating-objects, one unassociated school, one associated with dolphins, and one pole-and-line (Figure A-5). The last three fisheries include all 13 sampling areas. Of the 496 wells sampled, 118 contained bigeye. The estimated size compositions of the fish caught during 2004 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 2004 nearly equal amounts of bigeye were taken in the Northern, Equatorial, and Southern floating-object fisheries. Negligible amounts of bigeye were caught in sets on unassociated schools, in floating-object sets in the

Inshore area, and in sets on schools associated with dolphins. 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 1999-2004 are shown in Figure A-8b. The average weight of the fish was greatest in 2000, when the greatest catch of bigeye was taken. Since 2002 the average weights of bigeye have been fairly constant. The smaller bigeye (40-60 cm) were caught mainly during the latter half of 2004, while the majority of the larger fish were caught during the fourth quarter.

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 2004 bluefin were caught between 26°N and 31°N from May through August. The majority of the catches of bluefin by both commercial and recreational vessels were taken during July and August. In the past, commercial and recreational catches have been reported separately. In 2004, however, only 10 samples were taken from recreational vessels and only 14 from commercial vessels (from the total of 496 samples for 2004), making it infeasible to estimate the catches and size compositions separately. Therefore, the commercial and recreational catches of bluefin were combined for each year of the 1999-2004 period. The estimated size compositions are shown in Figure A-9. The commercial catch (8,548 t) of bluefin far exceeded the recreational catch (53 t), but the estimate for the latter is very preliminary.

Black skipjack are caught incidentally by fishermen who direct their effort toward yellowfin, skipjack, and bigeye tuna. The demand for this species is low, so most of the catch is discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. Because only one sample of black skipjack was taken from the 496 wells sampled during 2004, length-frequency histograms for this species are not presented in this report.

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 1999-2003 are shown in Figures A-10 and A-11. The average weights of both yellowfin and bigeye taken by that fishery have remained about the same throughout its existence. Additional information on the size compositions of those fish is available in IATTC Bulletins describing the Japanese longline fishery.

1.4. Catches of scombrids, by flag and gear

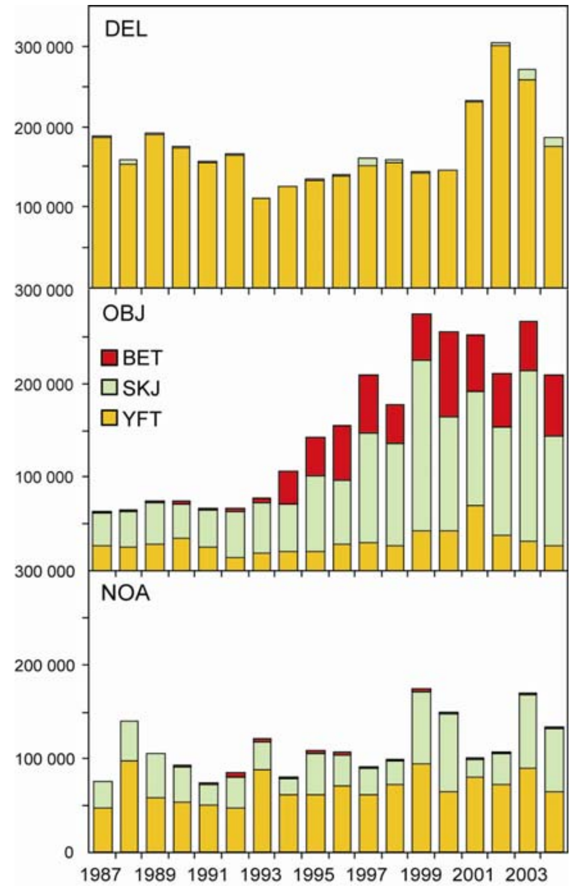
The annual retained catches of scombrids in the EPO during 2000-2004, by flag and gear, are shown in Tables A-3a-e. These tables include all of the known catches of tunas compiled from records gathered from governments, fish-processing companies, logbooks, and import-export records. Similar information on scombrids prior to 2000, and historic data for tunas, billfishes, sharks, mackerels, dorados, and miscellaneous fishes will be available on the IATTC website (www.iattc.org). The purse-seine and pole-and-line catches of scombrids in 2003 and 2004, by flag, are summarized in Tables A-4a-b (top panels).

1.5. Landings 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 2003 and 2004 (Tables A-4a-b, lower panels) indicate that, of the 563 thousand t of tunas landed in 2004, 49% was landed in Ecuador and 25% in Mexico. Other countries with significant landings of tunas caught in the EPO included Colombia (11%), and Costa Rica and Venezuela (4% each). 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.

1.6. Purse-seine catches per cubic meter of well volume

The total retained catch per cubic meter of well volume (C/m^3) for the purse-seine vessels that fish for tunas in the EPO are presented in Table A-7 for the EPO and for all ocean fishing areas from which those vessels harvested fish, by vessel size group, area, and species, for 2000-2004. To provide more detail in this index than would be available if the IATTC's historical six classes of vessel capacity classification were used, the vessels are assigned to eight size groups. Yellowfin, skipjack, and bigeye contribute the most to the C/m^3 for the larger vessels, while other species of tuna, such as black skipjack, make up an important part of the C/m^3 of the smaller vessels in many years.



Purse-seine catches of tunas, by species and set type, 1987-2004

2. EFFORT

2.1. Purse seine

Tunas are caught by purse-seine vessels in three types of schools, associated with dolphins, associated with floating objects, such as flotsam or FADs, and associated only with other fish (unassociated schools). Estimates of the numbers of purse-seine sets of each type in the EPO during the 1987-2004 period, and the retained catches of these sets, are shown in Table A-8 and in the figure on this page. The estimates for Class-1 to -5 vessels were calculated from logbook data in the IATTC statistical data base, and those for Class-6 vessels were calculated from the observer data bases of the IATTC, Ecuador, the European Union, Mexico, the United States, and Venezuela. The greatest numbers of sets on schools associated with floating objects and on unassociated schools of tuna were made from the mid-1970s to the early 1980s. Despite opposition to fishing for tunas associated with dolphins and the refusal of U.S. canners to accept tunas caught during trips during which sets were made on dolphin-associated fish, the numbers of sets made on fish associated with dolphins decreased only moderately during the mid-1990s, and in 2003 were the greatest recorded.

There are two types of floating objects, flotsam and FADs. The occurrence of the former is unplanned from the point of view of the fishermen, whereas the latter are constructed by fishermen specifically for the purpose of attracting fish. FADs have been in use for about ten years, and their relative importance has increased during this period, while that of flotsam has decreased, as shown by the data in Table A-9.

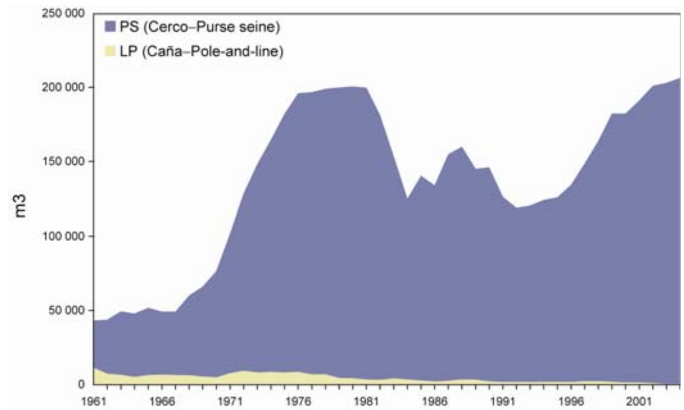
2.2. Longline

The reported annual effort, in total number of hooks, regardless of the target species, and catches of the predominant tuna species by longline vessels in the EPO are shown in Table A-10. Data for China, Chinese Taipei, French Polynesia, Japan, the Republic of Korea (1987-2003 only), and the United States are representative of total catch and effort, whereas those of Mexico, Panama, the Republic of Korea (1975-1986), and Vanuatu were compiled from logbook data, and do not represent the totals.

3. THE FLEET

3.1. The purse-seine and pole-and-line fleet

The IATTC 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 these four species.



Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2004

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

For the past several years the IATTC has used well volume, in cubic meters (m^3), instead of weight, in metric tons, to measure the carrying capacities of the vessels. Since a well can be loaded with different densities of fish, measuring carrying capacity in weight is subjective, as a load of fish packed into a well at a higher density weighs more than a load of fish packed at a lower density. Using volume as a measure of capacity eliminates this problem.

The 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.

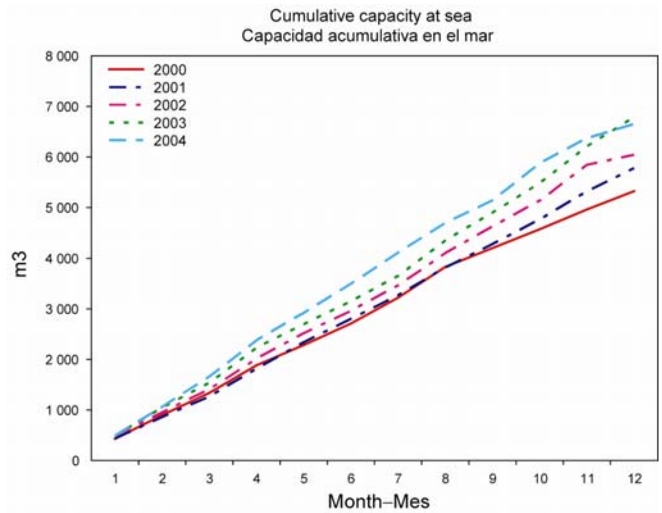
Until about 1960 fishing for tunas in the EPO was dominated by pole-and-line vessels operating in coastal regions and in the vicinity of offshore islands and banks. During the late 1950s and early 1960s most of the larger pole-and-line vessels were converted to purse seiners, and by 1961 the EPO surface fleet was dominated by these vessels. From 1961 to 2004 the number of pole-and-line vessels decreased from 93 to 3, and their total well volume from about 11 thousand to about 3 hundred cubic meters (m^3). During the same period the number of purse seiners increased from 125 to 215, and their total well volume from about 32 thousand to about 206 thousand m^3, an average of about 958 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 693 m^3 per vessel (Table A-11; figure on this page).

The catch rates in the EPO were low during 1978-1981 due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 125 thousand m^3. In early 1990 the U.S. tuna-canning industry adopted a policy of not purchasing tunas caught during trips during which sets on tunas associated with dolphins were made. This caused many U.S.-flag vessels to leave the EPO, with a consequent reduction in the fleet to about 119 thousand m^3 in 1992. With increases in participation of vessels of other nations in the fishery, the total well volume has increased steadily since 1992, and in 2004 was 206 thousand m^3.

The 2003 and preliminary 2004 data for numbers and total well volumes of purse seiners and pole-and-line vessels that fished for tunas in the EPO are shown in Tables A-12a-b. The fleet was dominated by vessels operating under the Mexican and Ecuadorian flags during 2004. The Mexican fleet had about 25% of the total well volume during 2004, Ecuador about 24%, Venezuela and Panama about 15 and 13%, respectively, and Colombia, Spain, and the USA about 4% each.

Class-6 vessels made up about 91% of the total well volume of the purse-seine fleet operating in the EPO during 2004. The cumulative capacity at sea during 2004 is compared to those of the previous four years in the figure on the next page.

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 1994-2003, and the 2004 values, are shown in Table A-13. 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 1998-2004, so the VAS values for September-December 2004 are not comparable to the average VAS values for those months of 1994-2003. The VAS values for 2004 exceeded the maximum VAS values for 1994-2003 for every month. The average VAS values for 1994-2003 and 2004 were 96 thousand m^3 (58% of total capacity) and 129 thousand m^3 (63% of total capacity), respectively.



Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 1999-2004

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 website. The Register is incomplete for small vessels, and for some fleets contains records for large (>24 m) longline vessels that fish in other areas or in any ocean.

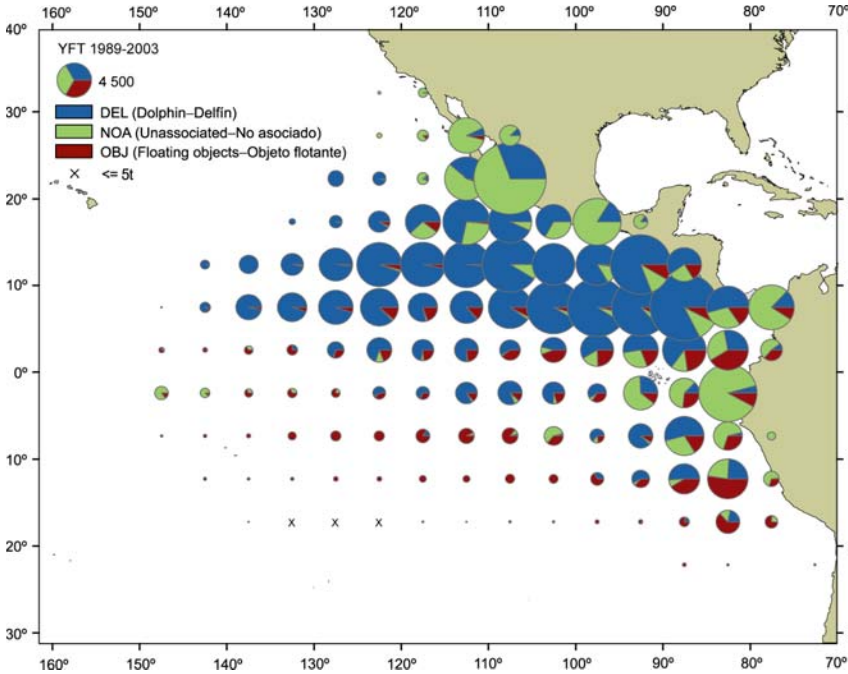


FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 1989-2003. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 1989-2003. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la zona de 5° x 5° correspondiente.

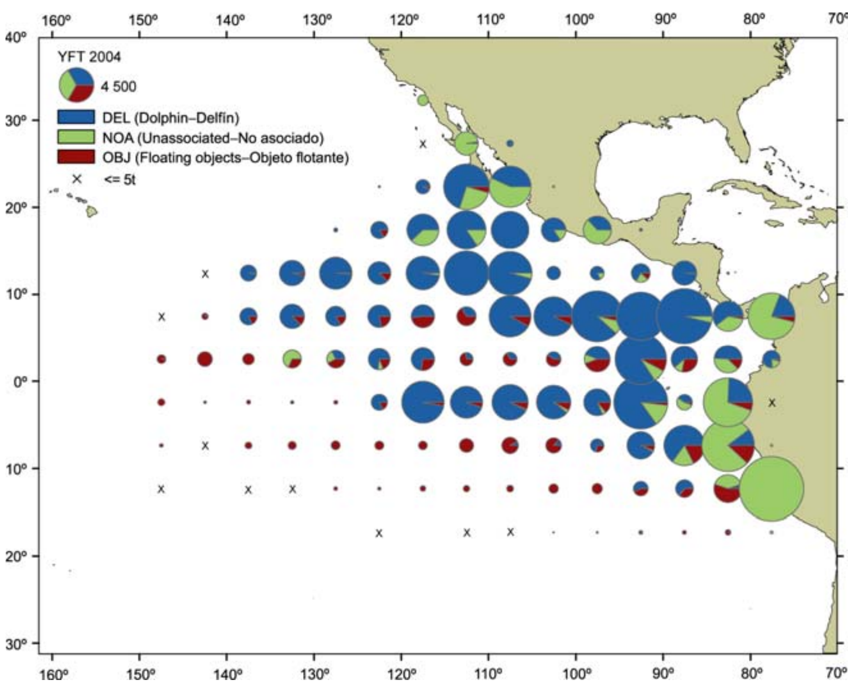


FIGURE A-1b. Average annual distributions of the purse-seine catches of yellowfin, by set type, 2004. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2004. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la zona de 5° x 5° correspondiente.

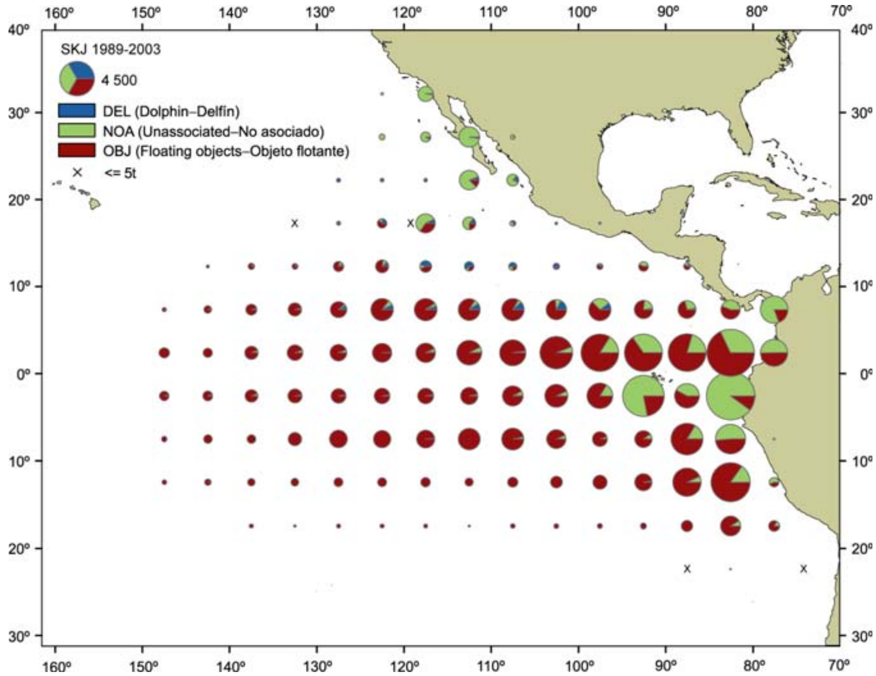


FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 1989-2003. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 1989-2003. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la zona de 5° x 5° correspondiente.

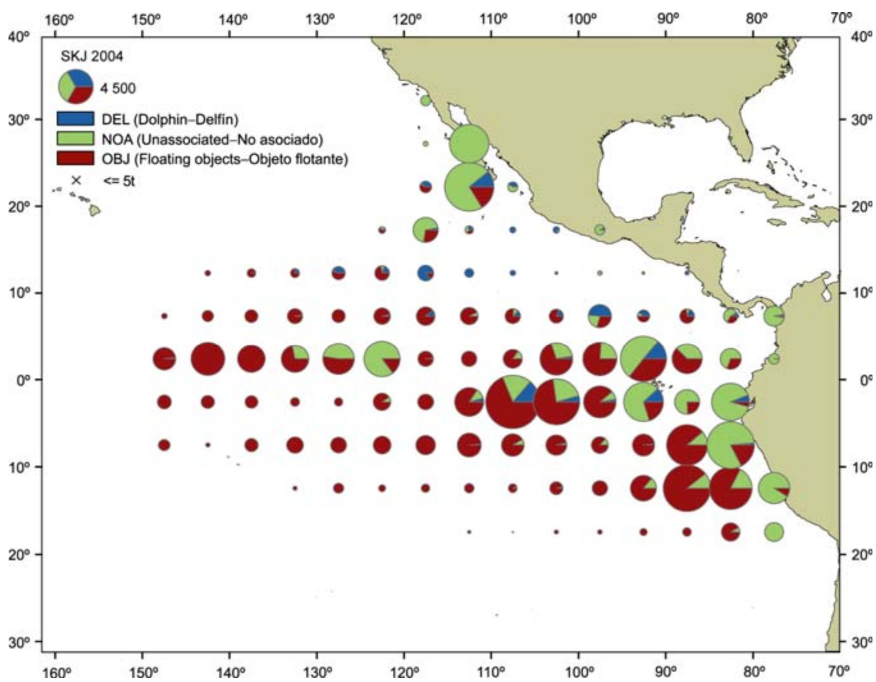


FIGURE A-2b. Average annual distributions of the purse-seine catches of skipjack, by set type, 2004. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2b. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 2004. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la zona de 5° x 5° correspondiente.

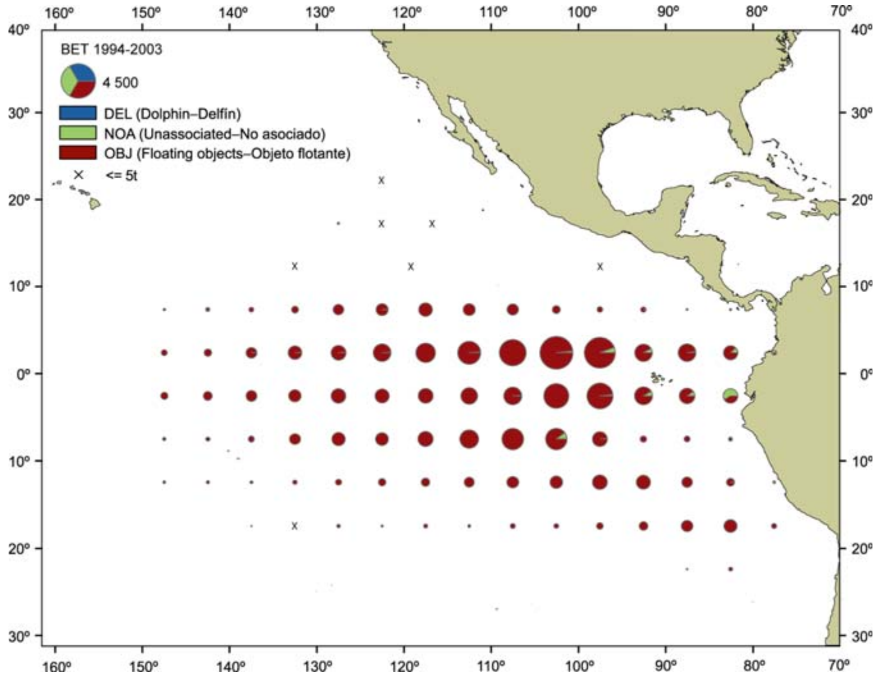


FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 1994-2003. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 1994-2003. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la zona de 5° x 5° correspondiente.

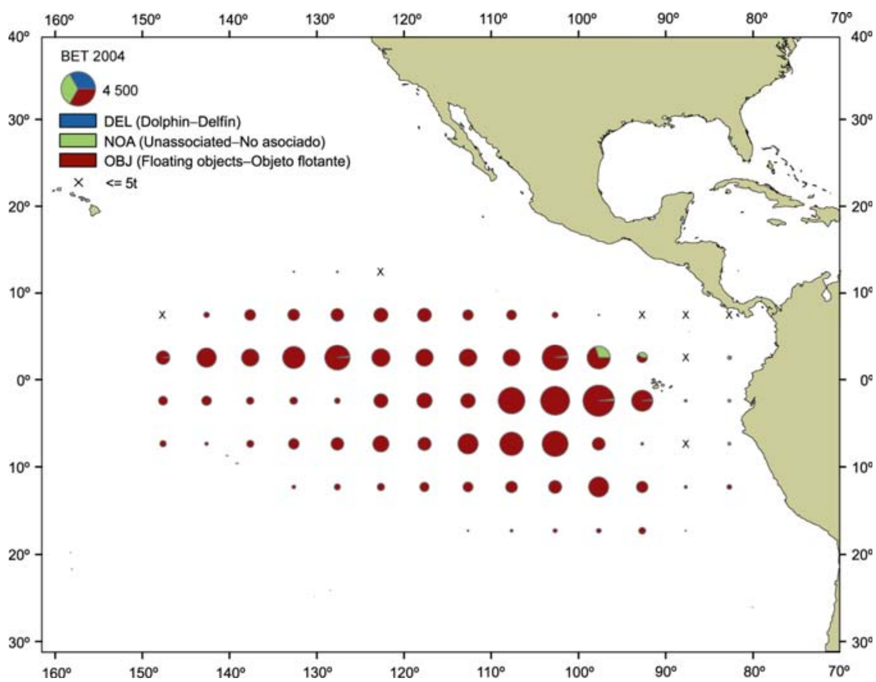


FIGURE A-3b. Average annual distributions of the purse-seine catches of bigeye, by set type, 2004. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3b. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 2004. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la zona de 5° x 5° correspondiente.

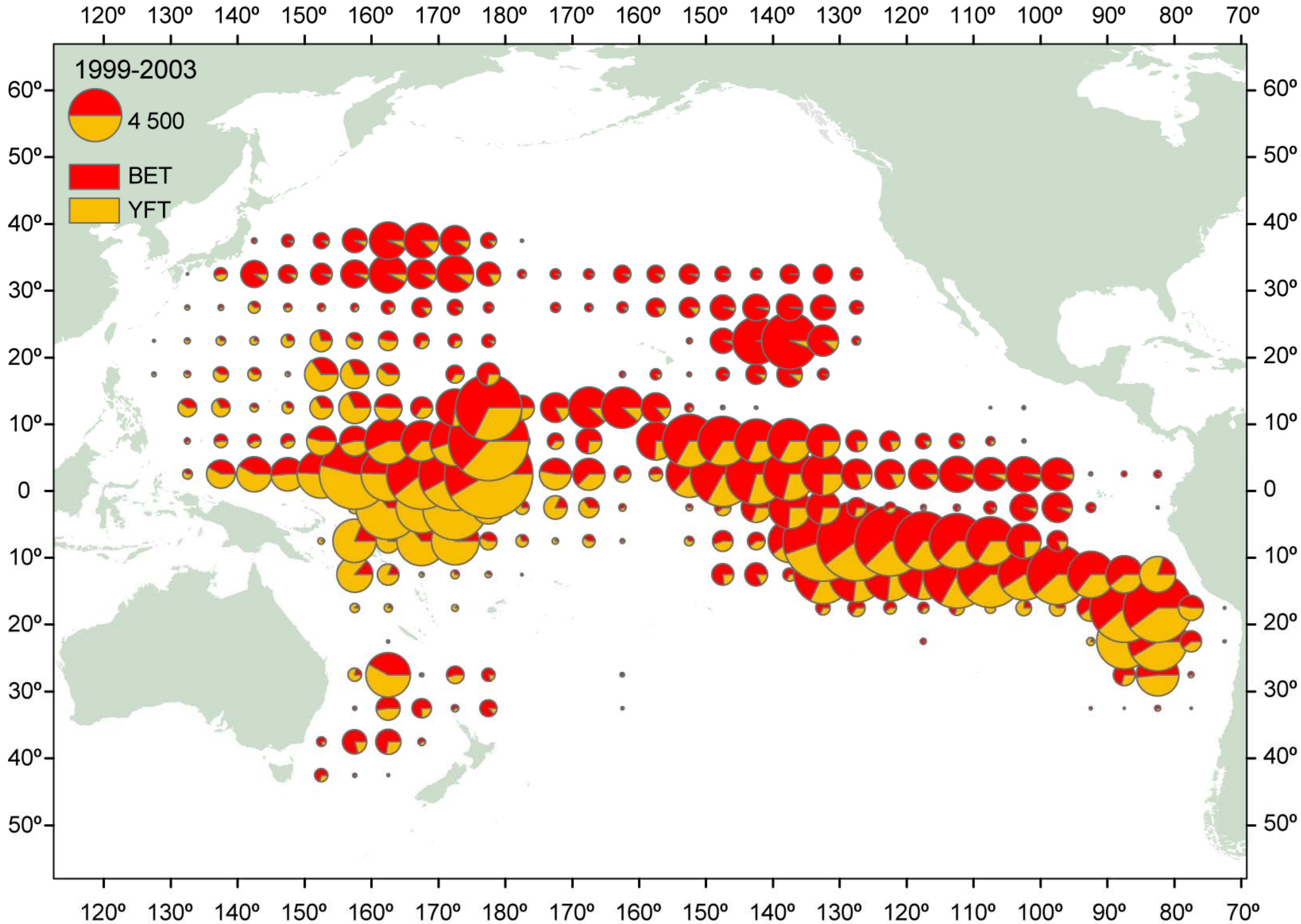


FIGURE A-4. Distribution of the catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by the Japanese longline fleet, 1999-2003. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.

FIGURA A-4. Distribución de las capturas de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por la flota palangrera japonesa, 1999–2003. El tamaño de cada círculo es proporcional a las cantidades de patudo y aleta amarilla capturado en la zona de 5° x 5° correspondiente.

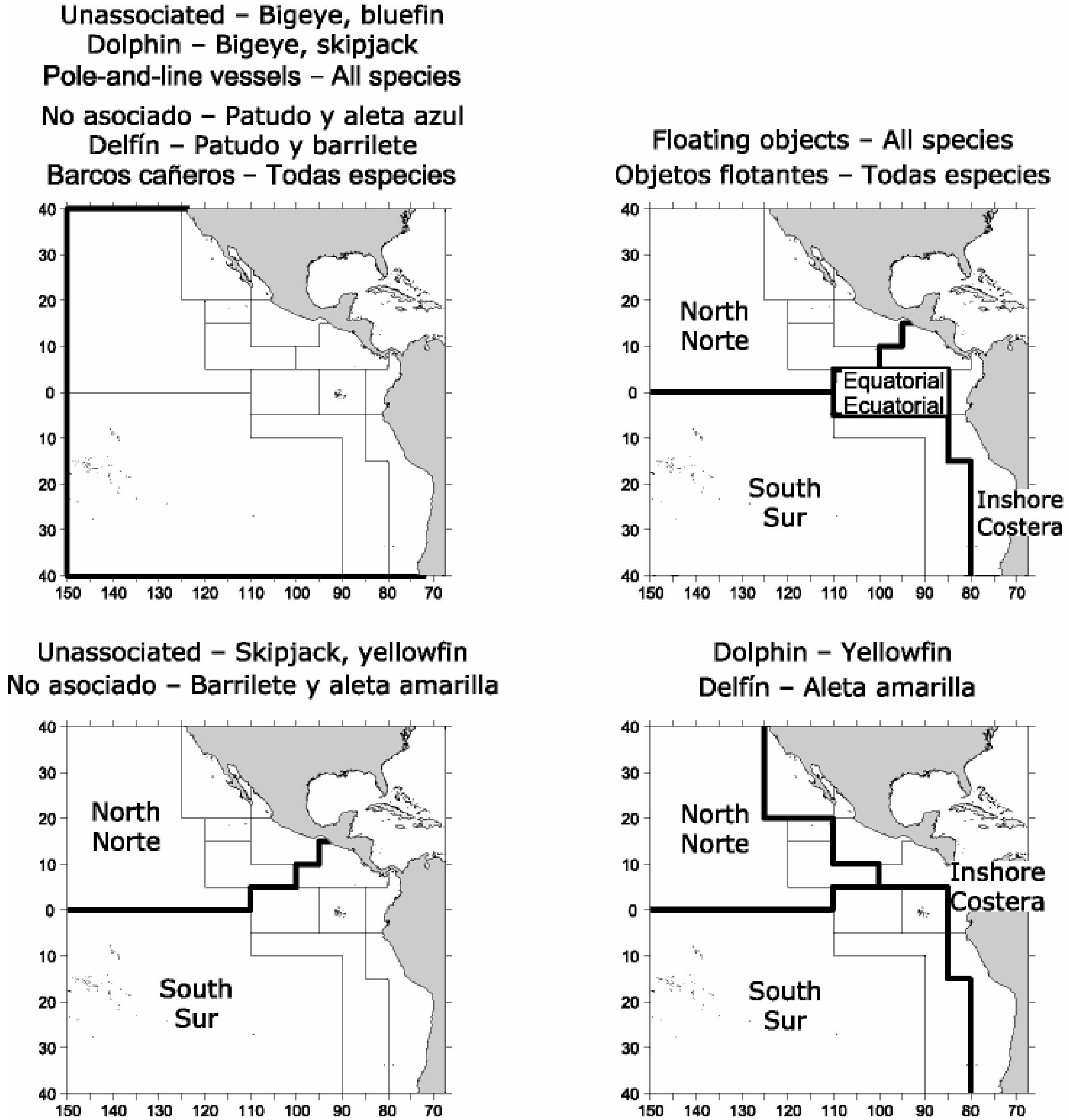


FIGURE A-5. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

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.

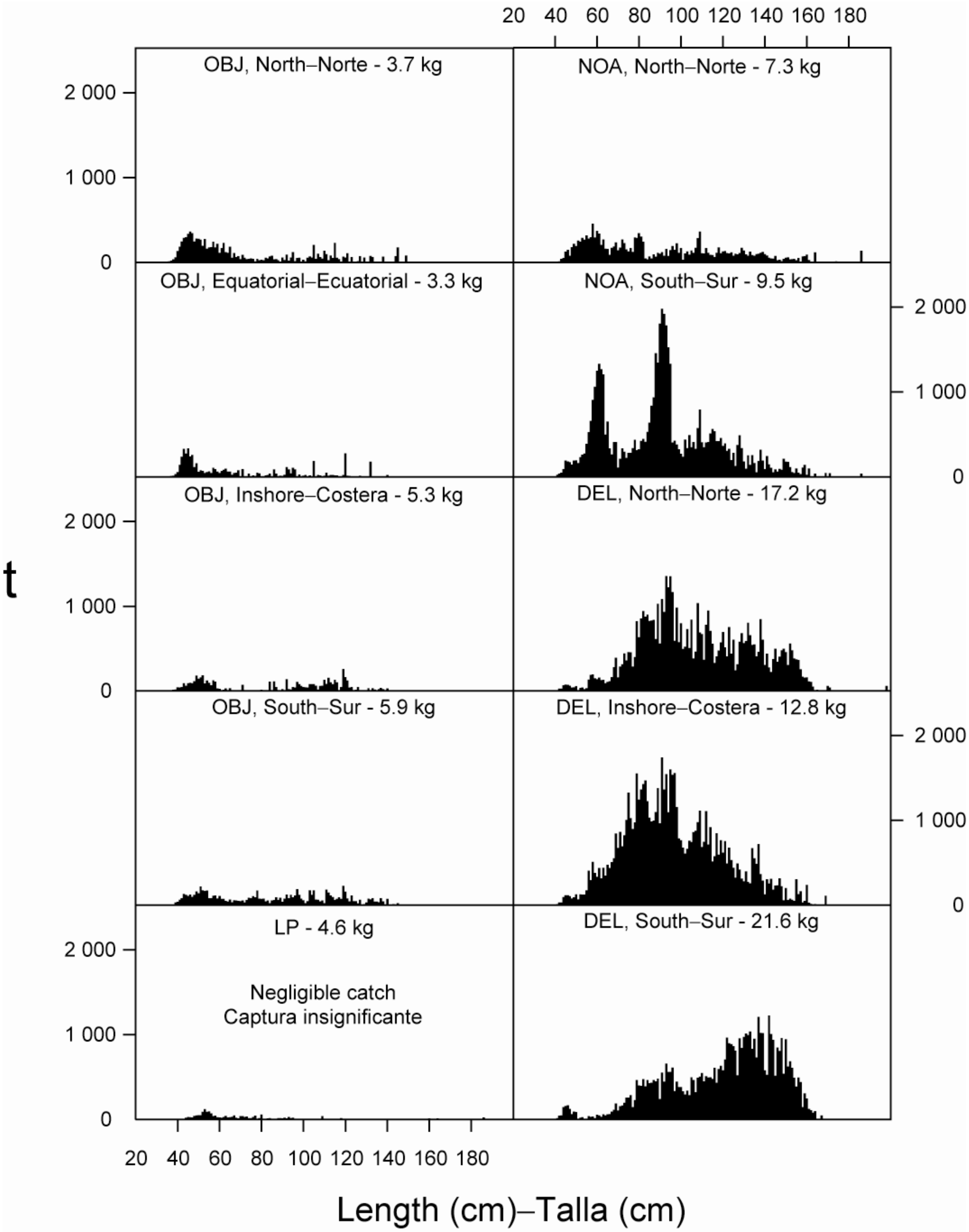


FIGURE A-6a. Estimated size compositions of the yellowfin caught in each fishery of the EPO during 2004. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en cada pesquería del OPO en 2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

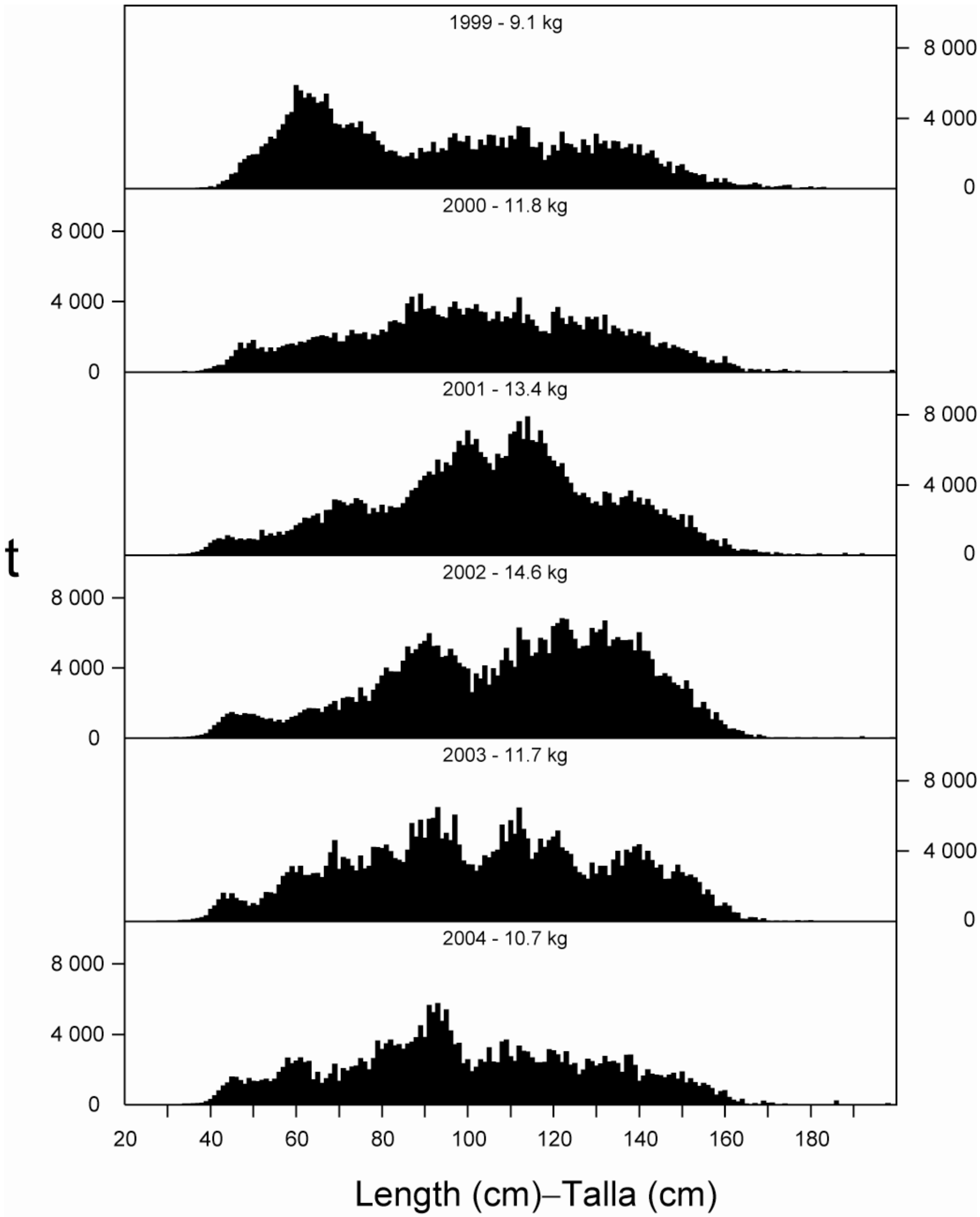


FIGURE A-6b. Estimated size compositions of the yellowfin caught in the EPO during 1999-2004. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 1999-2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

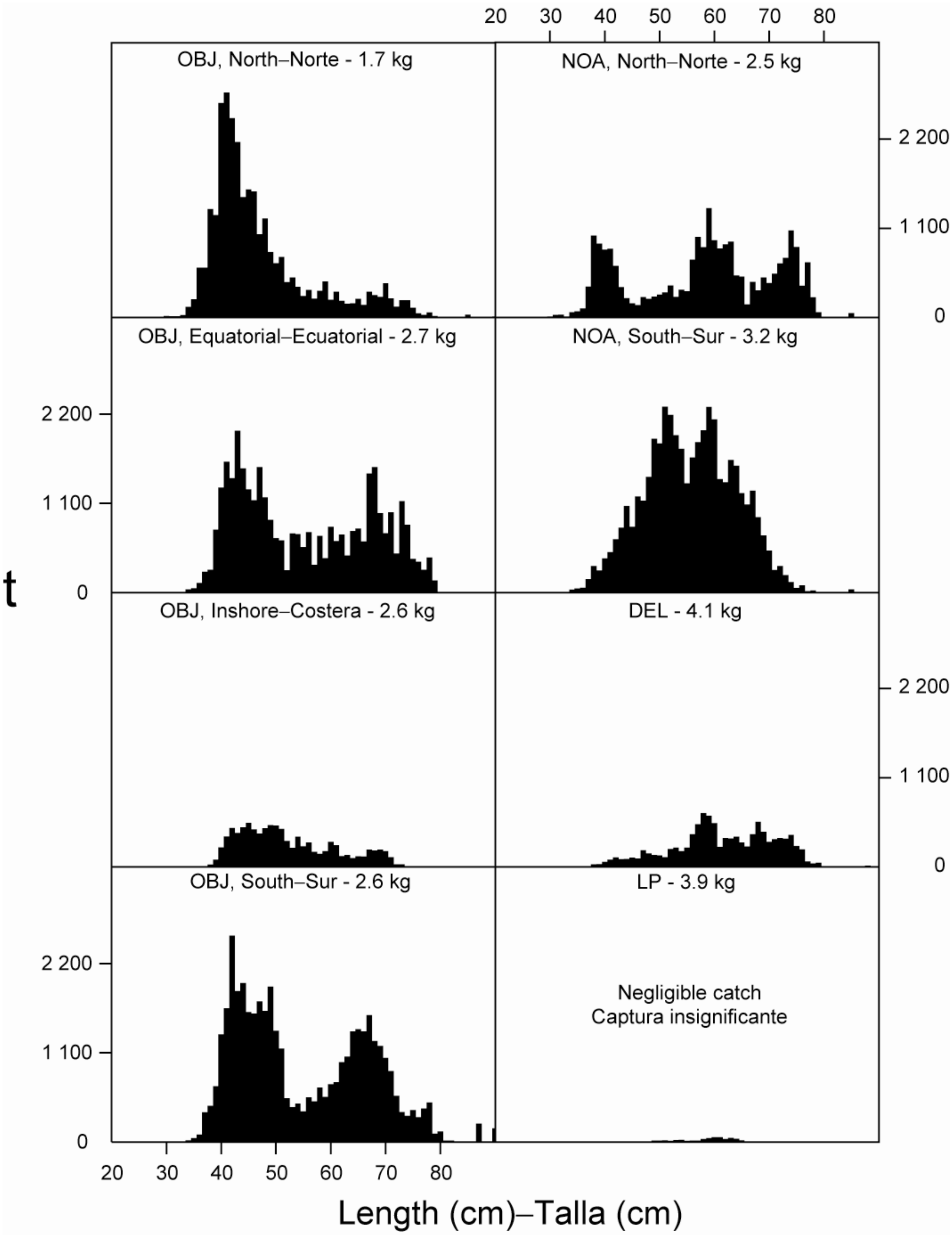


FIGURE A-7a. Estimated size compositions of the skipjack caught in each fishery of the EPO during 2004. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7a. Composición por tallas estimada del barrilete capturado en cada pesquería del OPO en 2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

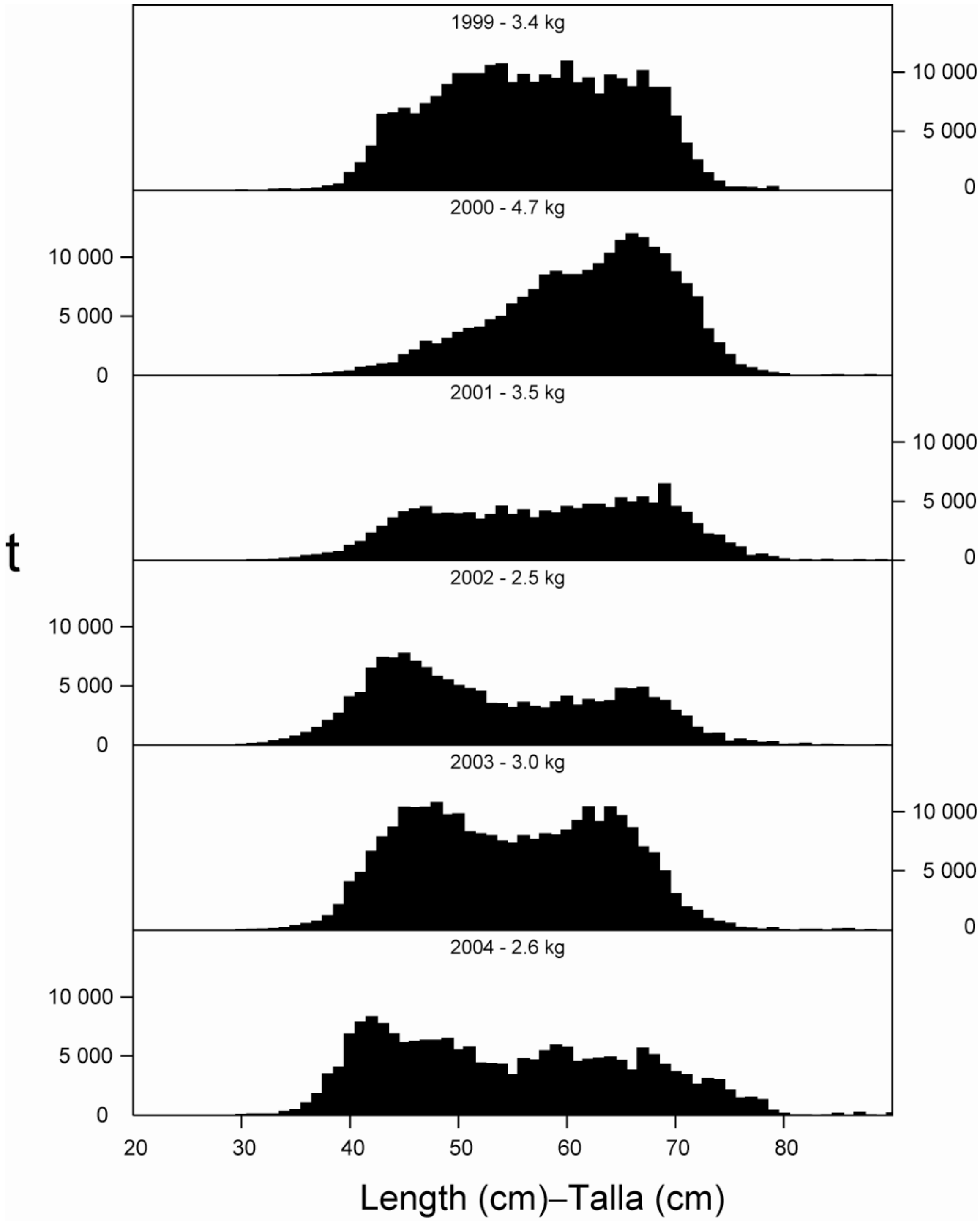


FIGURE A-7b. Estimated size compositions of the skipjack caught in the EPO during 1999-2004. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-7b. Composición por tallas estimada del barrilete capturado en el OPO durante 1999-2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

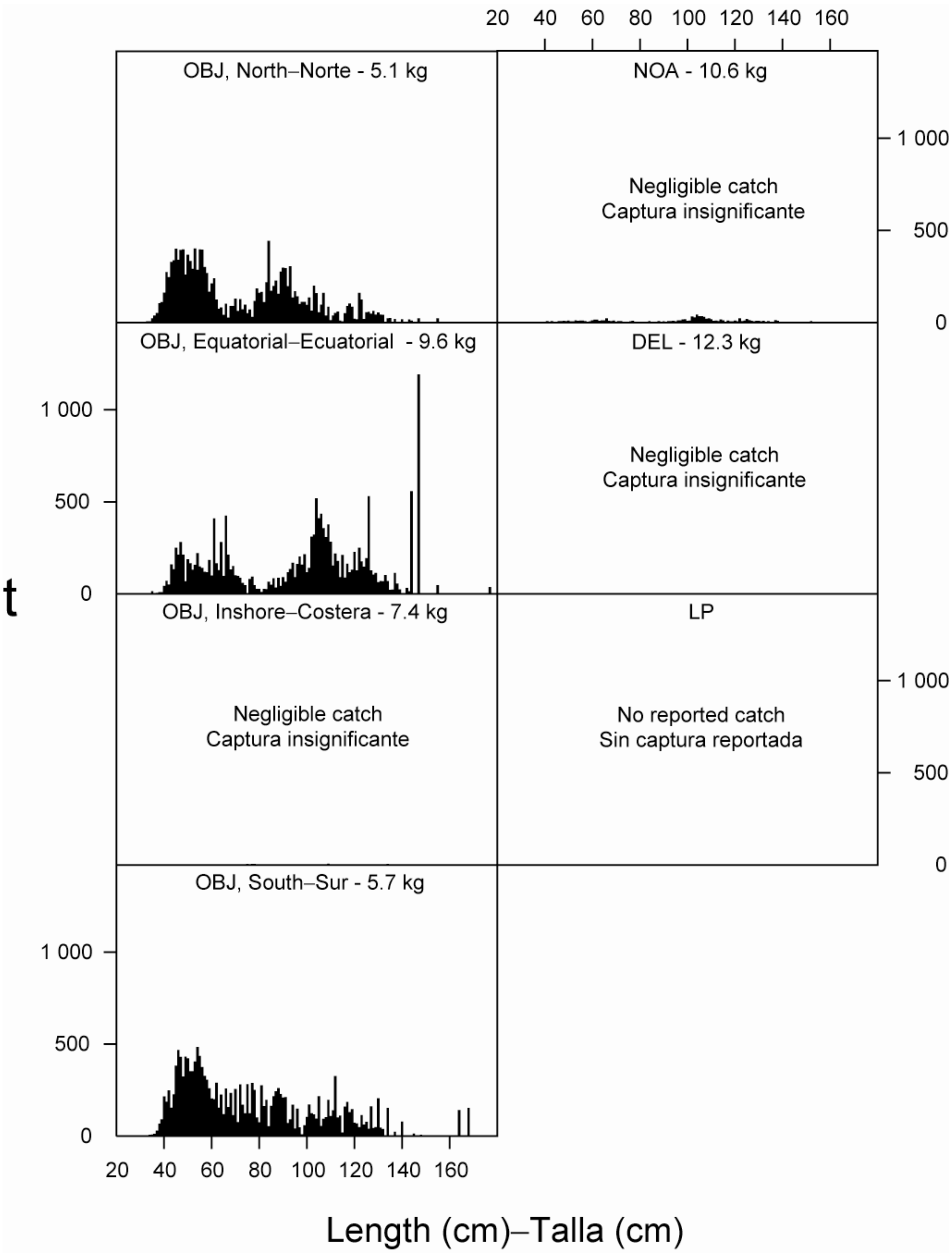


FIGURE A-8a. Estimated size compositions of the bigeye caught in each fishery of the EPO during 2004. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-8a. Composición por tallas estimada del patudo capturado en cada pesquería del OPO en 2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

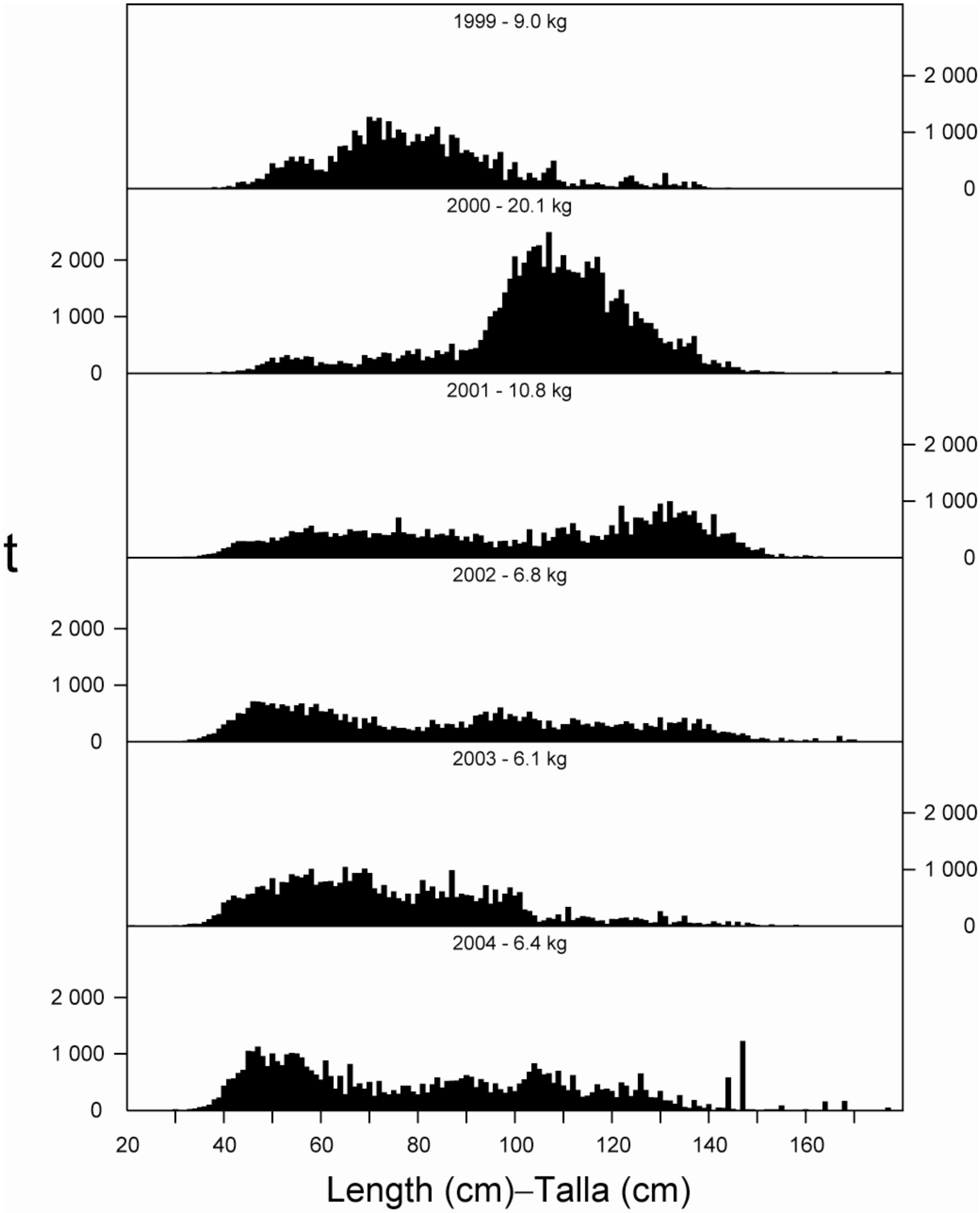


FIGURE A-8b. Estimated size compositions of the bigeye caught in the EPO during 1999-2004. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-8b. Composición por tallas estimada para el patudo capturado en el OPO durante 1999-2004. En cada recuadro se detalla el peso promedio de los peces en las muestras.

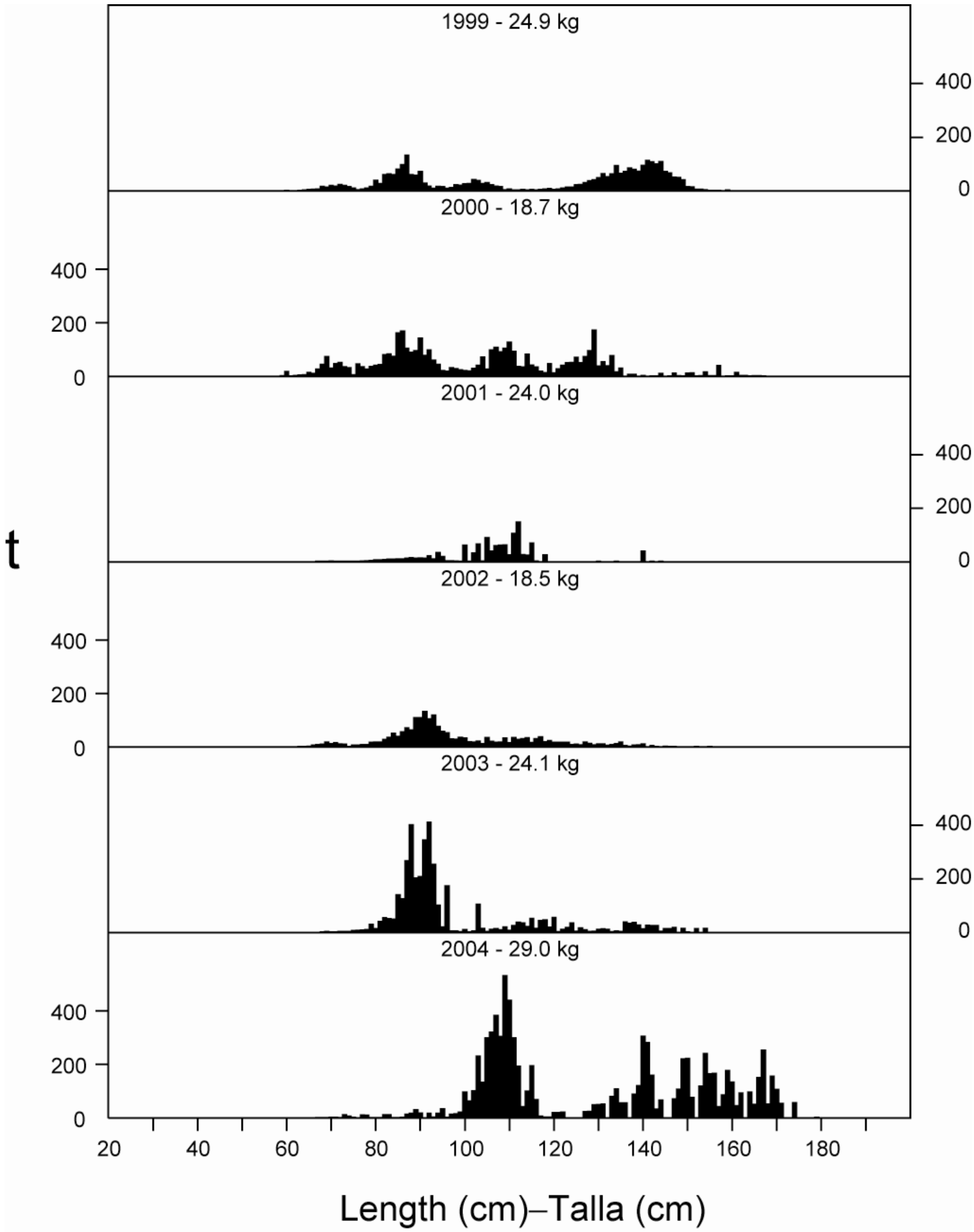


FIGURE A-9. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 1999-2004. The values at the tops of the panels are the average weights.
FIGURA A-9. Captura estimada de aleta azul del Pacífico por buques cerqueros y deportivos en el OPO durante 1999-2004. El valor en cada recuadro representa el peso promedio.

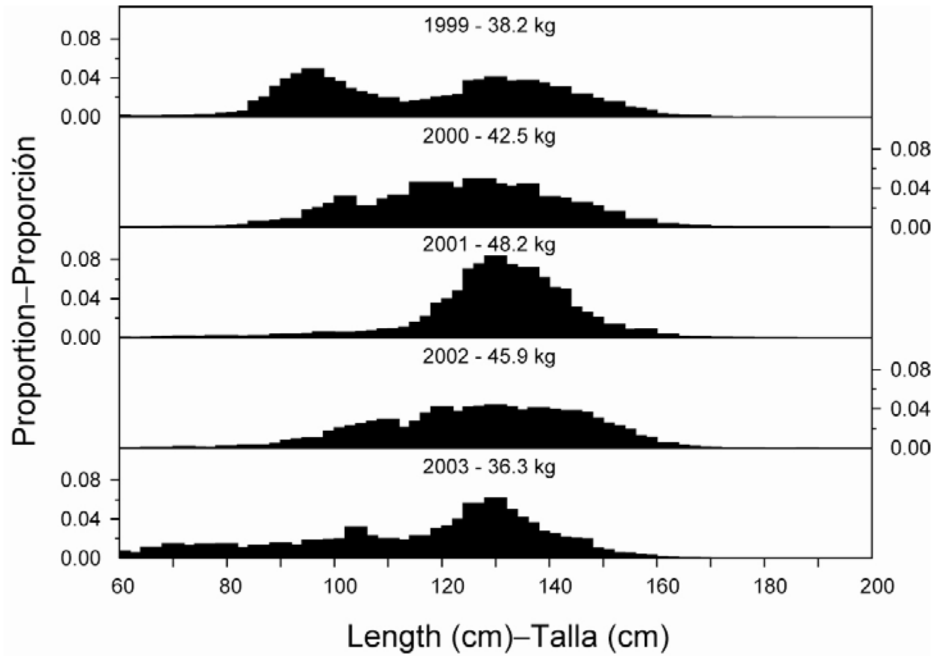


FIGURE A-10. Estimated size compositions of the catch of yellowfin tuna by the Japanese longline fishery in the EPO, 1999-2003.
FIGURA A-10. Composición por tallas estimada de la captura de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 1999-2003.

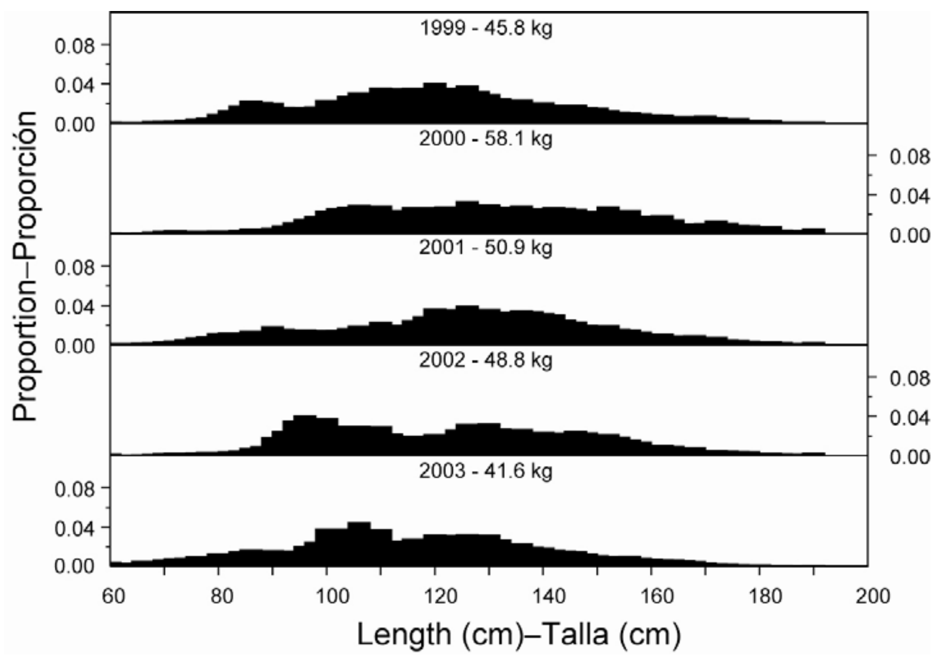


FIGURE A-11. Estimated size compositions of the catch of bigeye tuna by the Japanese longline fishery in the EPO, 1999-2003.
FIGURA A-11. Composición por tallas estimada de la captura de atún patudo por la pesquería palangrera japonesa en el OPO, 1999-2003.

TABLE A-1. Annual catches of yellowfin, skipjack, and bigeye, by all types of gear combined, in the Pacific Ocean, 1975-2004. The EPO totals include discards from the purse-seine fishery.
TABLA A-1. Capturas anuales de aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico, 1975-2004. Los totales del OPO incluyen descartes de la pesquería de cerco.

	YFT			SKJ			BET			Total		
	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total
1975	199,866	132,232	332,098	134,733	288,980	423,713	48,344	60,386	108,730	382,943	481,598	864,541
1976	234,371	145,415	379,786	136,926	357,899	494,825	71,585	73,386	144,971	442,883	576,700	1,019,583
1977	199,382	176,798	376,180	94,111	404,101	498,212	85,251	73,483	158,734	378,744	654,382	1,033,126
1978	173,996	174,505	348,501	179,675	450,473	630,148	89,198	58,120	147,318	442,869	683,098	1,125,967
1979	187,137	194,150	381,287	141,504	411,304	552,808	67,533	65,862	133,395	396,174	671,316	1,067,490
1980	158,848	210,075	368,923	138,109	458,419	596,528	86,403	62,592	148,995	383,360	731,086	1,114,446
1981	178,517	225,309	403,826	126,003	438,178	564,181	68,340	53,069	121,409	372,860	716,556	1,089,416
1982	127,536	219,440	346,976	104,669	491,105	595,774	60,346	58,734	119,080	292,551	769,279	1,061,830
1983	100,011	253,870	353,881	62,149	683,821	745,970	64,754	59,585	124,339	226,914	997,276	1,224,190
1984	149,478	248,656	398,134	63,612	755,538	819,150	55,273	63,644	118,917	268,364	1,067,838	1,336,202
1985	226,034	256,131	482,165	52,002	599,785	651,787	72,404	68,519	140,923	350,440	924,435	1,274,875
1986	286,150	244,546	530,696	67,748	756,846	824,594	105,119	63,339	168,458	459,017	1,064,731	1,523,748
1987	286,359	301,922	588,281	66,465	685,890	752,355	101,313	80,738	182,051	454,137	1,068,550	1,522,687
1988	296,634	259,468	556,102	92,126	841,675	933,801	74,304	68,035	142,339	463,064	1,169,178	1,632,242
1989	299,737	313,402	613,139	98,931	818,241	917,172	72,994	75,268	148,262	471,662	1,206,911	1,678,573
1990	302,283	350,930	653,213	77,120	891,244	968,364	104,806	91,719	196,525	484,209	1,333,893	1,818,102
1991	266,089	391,316	657,405	65,895	1,121,092	1,186,987	109,116	77,577	186,693	441,099	1,589,985	2,031,084
1992	253,711	403,466	657,177	87,354	1,011,401	1,098,755	92,000	92,708	184,708	433,065	1,507,575	1,940,640
1993	256,674	389,554	646,228	100,521	907,534	1,008,055	82,834	80,687	163,521	440,030	1,377,775	1,817,805
1994	248,314	402,831	651,145	84,526	1,004,300	1,088,826	109,346	90,485	199,831	442,187	1,497,616	1,939,803
1995	244,601	374,430	619,031	150,667	1,050,337	1,201,004	108,208	81,847	190,055	503,476	1,506,614	2,010,090
1996	266,463	316,667	583,130	132,931	1,026,792	1,159,723	114,704	80,565	195,269	514,099	1,424,024	1,938,123
1997	278,264	449,039	727,303	188,497	972,985	1,161,482	122,346	102,057	224,403	589,107	1,524,081	2,113,188
1998	280,140	465,642	745,782	165,467	1,301,054	1,466,521	93,946	104,746	198,692	539,553	1,871,442	2,410,995
1999	304,600	430,775	735,375	291,954	1,154,102	1,446,056	93,299	113,852	207,131	689,853	1,698,729	2,388,582
2000	288,965	431,346	720,311	231,806	1,245,003	1,476,809	147,535	106,955	254,418	668,306	1,783,304	2,451,610
2001	423,360	428,238	851,598	157,665	1,134,772	1,292,437	131,143	102,939	234,053	712,168	1,665,949	2,378,117
2002	440,156	403,390	843,546	165,802	1,277,431	1,443,233	131,139	114,685	245,712	737,098	1,795,506	2,532,604
2003	409,760	456,947	866,707	296,287	1,252,738	1,549,025	114,860	95,991	210,647	820,907	1,805,676	2,626,583
2004	276,597	*	276,597	213,855	*	213,855	108,290	*	108,290	598,743	*	598,743

TABLE A-2a. Estimated retained catches, by gear type, and estimated discards (purse-seine only), of scombrids, in metric tons, in the EPO, 1975-2004. 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. Data for 2003-2004 are preliminary.

TABLA A-2a. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes (red de cerco únicamente), de escómbridos, en toneladas métricas, en el OPO, 1975-2004. 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. Los datos de 2003-2004 son preliminares.

	Yellowfin—Aleta amarilla (YFT)						**Skipjack—Barrilete (SKJ)**						**Bigeye—Patudo (BET)**					
	PS		**LP**	**LL**	**OTR**	**Total**	**PS**		**LP**	**LL**	**OTR**	**Total**	**PS**		**LP**	**LL**	**OTR**	**Total**
	Ret.	**Dis.**					**Ret.**	**Dis.**					**Ret.**	**Dis.**				
1975	183,029		5,630	10,640	568	199,866	120,358		13,848	94	433	134,733	6,574		36	41,733	0	48,344
1976	215,106		3,280	15,632	353	234,371	124,958		11,256	130	583	136,926	17,214		75	54,290	7	71,585
1977	184,922		1,841	12,355	263	199,382	84,606		7,521	112	1,872	94,111	11,162		2	74,086	0	85,251
1978	158,800		3,887	10,188	1,120	173,996	172,293		6,048	61	1,273	179,675	18,539		0	70,659	0	89,198
1979	170,648		4,790	11,473	225	187,137	133,695		6,345	33	1,430	141,504	12,097		0	55,435	1	67,533
1980	143,042		1,480	13,477	849	158,848	130,912		5,226	26	1,945	138,109	21,939		0	64,335	130	86,403
1981	168,235		1,477	7,999	805	178,517	119,165		5,906	20	911	126,003	14,922		0	53,416	2	68,340
1982	114,754		1,538	10,961	283	127,536	100,498		3,760	28	383	104,669	6,939		42	53,365	0	60,346
1983	83,928		4,007	10,894	1,182	100,011	56,851		4,387	28	883	62,149	4,575		39	60,043	97	64,754
1984	135,785		2,991	10,345	357	149,478	59,859		2,884	32	838	63,612	8,860		2	46,394	17	55,273
1985	211,460		1,069	13,198	308	226,034	50,829		946	44	182	52,002	6,056		2	66,325	21	72,404
1986	260,512		2,537	22,807	293	286,150	65,635		1,921	57	135	67,748	2,685		0	102,425	9	105,119
1987	262,007		5,107	18,911	335	286,359	64,019		2,233	38	176	66,465	1,177		0	100,121	16	101,313
1988	277,293		3,723	14,659	958	296,634	87,113		4,325	26	663	92,126	1,535		5	72,758	6	74,304
1989	277,995		4,145	17,032	564	299,737	94,935		2,941	28	1,027	98,931	2,031		0	70,963	0	72,994
1990	263,251		2,675	34,634	1,724	302,283	74,370		824	41	1,885	77,120	5,920		0	98,871	15	104,806
1991	231,257		2,856	30,729	1,247	266,089	62,229		1,717	33	1,916	65,895	4,870		31	104,194	21	109,116
1992	228,121		3,789	18,526	3,276	253,711	84,283		1,956	24	1,091	87,354	7,179		0	84,800	21	92,000
1993	219,494	4,722	4,950	23,808	3,700	256,674	83,829	10,588	3,772	62	2,271	100,521	9,657	645	0	72,473	59	82,834
1994	208,409	4,757	3,625	29,545	1,978	248,314	70,127	10,360	3,240	69	730	84,526	34,900	2,280	0	71,359	808	109,346
1995	215,434	5,275	1,268	20,054	2,570	244,601	127,045	16,378	5,253	75	1,917	150,667	45,319	3,251	0	58,256	1,381	108,208
1996	238,606	6,314	3,761	16,426	1,356	266,463	103,976	24,837	2,555	51	1,512	132,931	61,312	5,689	0	46,957	746	114,704
1997	244,878	5,516	4,418	21,448	2,004	278,264	153,456	31,558	3,260	102	121	188,497	64,270	5,482	0	52,571	23	122,346
1998	253,959	4,718	5,084	14,196	2,183	280,140	140,631	22,856	1,684	88	208	165,467	44,128	2,853	0	46,347	617	93,946
1999	281,920	6,638	1,783	10,642	3,617	304,600	261,564	26,851	2,044	109	1,385	291,954	51,158	5,176	0	36,405	541	93,279
2000	254,988	6,796	2,386	22,766	2,029	288,965	205,240	26,256	236	68	5	231,806	94,083	5,600	0	47,511	269	147,463
2001	382,402	7,486	3,785	28,482	1,205	423,360	143,948	11,964	570	1,182	1	157,665	61,259	1,111	0	68,726	47	131,143
2002	412,285	3,707	954	22,437	773	440,156	153,633	11,461	496	212	0	165,802	57,412	807	0	72.890	30	131.139
2003	380,523	4,497	478	22,192	2,071	409,760	275,089	20,106	416	441	235	296,287	54,103	1,640	0	59.096	21	114.860
2004	268,356	2,853	1,905	2,041	1,442	276,597	196,911	16,420	481	26	17	213,855	66,944	1,612	0	39,887	6	108,449

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

	Pacific bluefin—Aleta azul del Pacífico (PBF)						Albacore—Albacore (ALB)						Black skipjack—Barrilete negro (BSJ)					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1975	9,498		83	49	1	9,631	0		3,332	1,369	19,706	24,407	437		74			511
1976	10,620		22	59	3	10,704	271		3,456	2,506	16,975	23,208	1,497		29			1,526
1977	5,446		10	57	34	5,547	15		1,960	10,578	11,471	24,024	1,445		12		1	1,458
1978	5,387		4	37	10	5,439	157		1,577	11,939	17,436	31,109	2,167		3			2,170
1979	6,102		5	40	20	6,167	148		179	5,583	5,043	10,953	1,336		30			1,366
1980	2,909		0	13	30	2,952	194		407	5,319	5,649	11,569	3,653		28			3,680
1981	1,086		0	14	9	1,109	99		608	7,275	12,301	20,282	1,907		3			1,911
1982	3,145		0	15	11	3,171	355		198	8,407	3,562	12,522	1,338		0			1,338
1983	836		0	10	35	881	7		449	7,433	7,840	15,730	1,222		0		13	1,236
1984	839		0	10	68	917	3,910		1,441	6,712	9,794	21,857	663		0		3	666
1985	3,996		0	3	113	4,111	42		877	7,268	6,654	14,840	289		0		7	296
1986	5,040		0	5	66	5,111	47		86	6,450	4,701	11,284	577		0		18	595
1987	980		0	15	55	1,050	1		320	9,994	2,661	12,976	562		0		2	564
1988	1,380		0	19	51	1,450	17		271	9,934	5,549	15,771	956		0		311	1,267
1989	1,102		5	6	124	1,238	1		21	6,784	2,695	9,501	803		0			803
1990	1,430		61	14	93	1,599	39		170	6,536	4,105	10,850	787		0		4	791
1991	419		0	5	94	519	0		834	7,894	2,754	11,482	421		0		25	446
1992	1,928		0	20	118	2,066	0		255	17,081	5,740	23,076	104		0		3	107
1993	580	0	0	19	331	930	0	0	1	11,194	4,410	15,605	104	4,116	0		31	4,250
1994	969	0	0	12	121	1,102	0	0	85	10,390	10,075	20,550	188	853	0		40	1,080
1995	630	0	0	25	264	919	0	0	465	6,184	7,386	14,035	202	1,448	0			1,650
1996	8,223	0	0	19	79	8,322	11	0	72	7,631	8,398	16,112	704	2,304	0		12	3,020
1997	2,608	3	2	14	260	2,887	1	0	59	9,678	7,532	17,270	101	2,512	0		11	2,624
1998	1,772	0	0	94	507	2,373	42	0	81	12,635	12,966	25,724	490	1,876	39			2,405
1999	2,553	54	5	151	553	3,316	47	0	227	11,632	14,494	26,400	171	3,424	0			3,595
2000	3,718	0	61	51	374	4,204	71	0	86	9,663	13,387	23,207	294	1,877	0			2,170
2001	891	3	0	148	390	1,432	3	0	18	19,410	13,679	33,111	2,258	1,162	0			3,420
2002	1,708	6	1	8	358	2,081	31	0	0	14,837	14,406	29,274	1,459	1,764	8			3,231
2003	3,233	0	0	49	741	4,023	34	0	0	21,186	22,900	44,121	433	1,332	6			1,771
2004	8,548	19	0	11	53	8,631	106	0	0	11,509	7,676	19,291	848	351	0			1,200

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

	Bonito (BZX)						Unidentified tunas—Atunes no identificados (TUN)						Scombrids—Escómbridos TOTAL					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1975	16,828		11		145	16,984	0		0		7,670	7,670	336,725		23,015	53,886	28,523	442,147
1976	4,325		44		286	4,655	97		0		4,981	5,078	374,088		18,161	72,616	23,189	488,054
1977	10,983		292		2,875	14,150	22		0		5,782	5,804	298,601		11,638	97,188	22,299	429,726
1978	4,801		35		2,419	7,255	190		0		6,677	6,867	362,333		11,555	92,885	28,935	495,708
1979	1,801		3		2,658	4,462	559		0		3,016	3,575	326,386		11,354	72,565	12,393	422,697
1980	6,089		36		2,727	8,852	441		0		836	1,277	309,179		7,176	83,170	12,166	411,691
1981	5,690		27		4,609	10,326	214		3		1,109	1,326	311,319		8,025	68,723	19,746	407,814
1982	2,122		0		6,776	8,898	51		0		382	433	229,203		5,537	72,775	11,397	318,912
1983	3,827		2		7,291	11,120	81		0		4,711	4,792	151,326		8,884	78,410	22,053	260,672
1984	3,514		0		7,291	10,805	6		0		2,524	2,530	213,437		7,318	63,493	20,892	305,139
1985	3,599		5		7,869	11,473	18		0		678	696	276,291		2,898	86,837	15,831	381,857
1986	232		258		1,889	2,379	177		4		986	1,166	334,905		4,805	131,744	8,098	479,552
1987	3,205		121		1,772	5,098	481		0		2,043	2,524	332,432		7,781	129,078	7,059	476,350
1988	8,811		739		947	10,497	258		0		2,939	3,197	377,363		9,062	97,397	11,424	495,246
1989	11,278		818		465	12,561	469		0		627	1,095	388,613		7,930	94,814	5,502	496,859
1990	13,641		215		371	14,227	393		0		692	1,085	359,830		3,946	140,096	8,889	512,761
1991	1,207		82		242	1,531	4		0	1	192	197	300,407		5,520	142,856	6,491	455,274
1992	977		0		318	1,295	133		0	2	1,071	1,207	322,725		6,000	120,453	11,638	460,816
1993	599	12	1		436	1,048	13	2,288	0	2	4,082	6,385	314,275	22,370	8,724	107,559	15,320	468,248
1994	8,331	147	362		185	9,025	10	1,337	0	1	464	1,812	322,934	19,734	7,312	111,375	14,401	475,756
1995	7,929	55	81		54	8,119	12	1,394	0	1	1,004	2,411	396,571	27,800	7,067	84,596	14,576	530,610
1996	647	1	7		16	671	37	1,756	0	2	1,038	2,832	413,515	40,900	6,395	71,087	13,158	545,055
1997	1,097	4	8		34	1,143	74	4,580	0	1	1,437	6,092	466,484	49,655	7,748	83,813	11,422	619,122
1998	1,330	4	7		588	1,929	15	2,294	0	2	18,158	20,469	442,367	34,601	6,896	73,363	35,227	592,454
1999	1,719	0	0	24	369	2,112	29	3,470	0	2,107	4,279	9,885	599,161	45,613	4,059	61,090	25,237	735,162
2000	636	0	0	75	56	767	190	2,175	0	1,986	1,468	5,819	559,220	42,703	2,769	82,193	17,588	704,473
2001	17	0	0	34	19	70	206	2,495	0	2,322	1	5,024	590,985	24,220	4,373	120,305	15,341	755,224
2002	0	0	0	42	1	43	576	2,785	0	2,791	0	6,152	627,105	20,530	1,459	113,217	15,568	777,880
2003	0	0	0	*	25	25	81	2,086	0	24	0	2,191	713,496	29,661	900	102,988	25,993	873,038
2004	15	47	0	*	*	62	267	2,783	0	3,054	*	6,105	541,996	24,085	2,387	56,528	9,194	634,190

TABLE A-2b. Estimated retained catches, by gear type, and estimated purse-seine discards, of billfishes, in metric tons, in the EPO, 1975-2004. Data for 2003-2004 are preliminary. PS dis = purse-seine discards.

TABLA A-2b. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes (red de cerco únicamente), de peces picudos, en toneladas métricas, en el OPO, 2000. Los datos de 2003-2004 son preliminares. PS dis = descartes de la pesca de cerco.

	Swordfish—Pez espada (SWO)				Blue marlin—Marlín azul (BUM)				Black marlin—Marlín negro (BLM)				Striped marlin—Marlín rayado (MLS)			
	PS dis.	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**
1975		2,321	864	3,185		2,200		2,200		388		388		5390		5,390
1976		3,489	363	3,852		3,240		3,240		253		253		6432		6,432
1977		4,298	788	5,086		3,016		3,016		621		621		3145		3,145
1978		4,103	2,205	6,308		3,570		3,570		417		417		2495		2,495
1979		2,658	614	3,272		4,528		4,528		332		332		4137		4,137
1980		3,746	1,107	4,853		4,016		4,016		335		335		4827		4,827
1981		3,070	1,134	4,204		4,476		4,476		247		247		4876		4,876
1982		2,604	1,551	4,155		4,745		4,745		213		213		4711		4,711
1983		3,221	2,338	5,559		4,451		4,451		240		240		4280		4,280
1984		2,705	3,336	6,041		5,197		5,197		248		248		2662		2,662
1985		1,867	3,768	5,635		3,588		3,588		180		180		1510		1,510
1986		2,887	3,294	6,181		5,255		5,255		297		297		2617		2,617
1987		4,140	3,740	7,880		7,227		7,227		358		358		5520		5,520
1988		4,322	5,642	9,964		5,649		5,649		288		288		3682		3,682
1989		4,514	6,072	10,586		5,392		5,392		193		193		3416		3,416
1990		5,807	5,066	10,873		5,540		5,540		223		223		3260		3,260
1991	17	10,564	4,385	14,966	69	6,462	257	6,788	58	246		304	76	2805	188	3,069
1992	4	9,793	4,294	14,091	52	6,426	201	6,679	95	228		323	69	2907	147	3,123
1993	6	6,167	4,434	10,607	56	6,279	292	6,627	64	217		281	35	3332	243	3,610
1994	3	4,963	3,849	8,815	75	8,609	418	9,102	118	256		374	34	3126	270	3,430
1995	6	4,466	3,003	7,475	83	6,944	344	7,371	82	158		240	21	2943	306	3,270
1996	2	6,756	2,801	9,559	84	3,396	200	3,680	90	99		189	22	2981	237	3,240
1997	6	9,508	2,854	12,368	134	5,468	340	5,942	124	153		277	26	4201	272	4,499
1998	2	9,326	3,713	13,041	138	4,477	580	5,195	113	168		281	18	3277	281	3,576
1999	3	7,374	2,161	9,538	190	3,010	680	3,880	138	94		232	31	2287	334	2,652
2000	3	9,474	2,790	12,267	135	3,028	606	3,769	103	105		208	17	1747	190	1,954
2001	4	15,756	2,615	18,375	149	3,554	643	4,346	114	123		237	18	1693	274	1,985
2002	1	16,293	2,600	18,894	185	2,791	350	3,326	115	77		192	60	1953	133	2,146
2003	6	14,898	394	15,298	150	2,835	876	3,861	123	69		192	29	1759	133	1,921
2004	3	1,916	45	1,964	328	416	73	817	123	4		127	20	214	33	267

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

	Shortbill spearfish—Marlín trompa corta (SSP)				Sailfish—Pez vela (SFA)				Unidentified billfishes—Picudos no identificados (BIL)				Billfishes—Peces picudos TOTAL			
	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total
1975						554		554						10,853	864	11,717
1976						494		494						13,908	363	14,271
1977						753		753						11,833	788	12,621
1978						878		878						11,463	2,205	13,668
1979						251		251						11,906	614	12,520
1980						244		244						13,168	1,107	14,275
1981						379		379						13,048	1,134	14,182
1982						1,084		1,084						13,357	1,551	14,908
1983						502		502						12,694	2,338	15,032
1984						345		345						11,157	3,336	14,493
1985						395		395						7,540	3,768	11,308
1986		5		5		526		526						11,587	3,294	14,881
1987		15		15		435		435		362		362		18,057	3,740	21,797
1988		13		13		465		465		367		367		14,786	5,642	20,428
1989		0		0		121		121		47		47		13,683	6,072	19,755
1990		0		0		6	0	6		123		123		14,959	5,066	20,025
1991	0	1		1	40	10	707	757		111		111	260	20,199	5,537	25,996
1992	1	1		2	41	741	610	1,392		1,082		1,082	262	21,178	5,252	26,692
1993	0	1		1	36	1,145	1,121	2,302	24	1,610		1,634	221	18,751	6,090	25,062
1994	0	144		144	29	878	804	1,711	13	961		974	272	18,937	5,341	24,550
1995	1	155		156	31	237	1,114	1,382	8	223		231	232	15,126	4,767	20,125
1996	1	126		127	24	197	541	762	10	278	1	289	233	13,833	3,780	17,846
1997	1	141		142	28	799	418	1,245	4	1,324	0	1,328	323	21,594	3,884	25,801
1998	0	200		200	49	394	988	1,431	9	566	52	627	329	18,408	5,614	24,351
1999	1	278		279	42	103	1,113	1,258	9	1,134	0	1,143	414	14,280	4,288	18,982
2000	1	285		286	58	93	1,239	1,390	3	856	136	995	320	15,588	4,961	20,869
2001	0	304		304	37	196	1,289	1,522	6	1,197	204	1,407	328	22,823	5,025	28,176
2002	0	269		269	42	160	132	334	3	1,596	14	1,613	406	23,139	3,229	26,774
2003	1	292		293	102	77	1,012	1,191	4	1,160	0	1,164	415	21,090	2,415	23,920
2004	0	*		*	67	48	87	202	4	162	0	166	545	2,760	238	3,543

TABLE A-2c. Estimated retained catches, by gear type, and estimated purse-seine discards, of other species, in metric tons, in the EPO, 1975-2004. Data for 2003-2004 are preliminary.
TABLA A-2c. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes (red de cerco únicamente), de otras especies, en toneladas métricas, en el OPO, 2000. Los datos de 2003-2004 son preliminares.

	Unidentified Carangidae—Carángidos no identificados (CGX)						Dorado (*Coryphaena* spp.) (DOX)						Unidentified elasmobranchs—Elasmobranquios no identificados (SKX)						Unidentified marine fishes—Peces marinos no identificados (MZZ)					
	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.				
1975	99		0			99	54		15		382	451	23		4		137	164	78		3			81
1976	483		0			483	124		9		963	1,096	307		10		141	458	291		3			294
1977	1,099		0			1,099	167		0		827	994	233		0		35	268	429		0			429
1978	238		1			239	87		0		738	825	145		0		390	535	148		0			148
1979	81		0			81	124		0		927	1,051	7		0	17	1,290	1,314	478		0			478
1980	224		2			226	124		0		1,001	1,125	16		0	7	859	882	301		0			301
1981	111		17			128	410		0		628	1,038	49		0	120	1,211	1,380	201		3			204
1982	122		0			122	274		0		980	1,254	22		30	215	863	1,130	284		0			284
1983	1,240		0			1,240	88		0		3,374	3,462	34		0	85	694	813	267		1			268
1984	413		0			413	103		0		202	305	47		0	6	1,039	1,092	415		0		3	418
1985	317		4			321	93		0		108	201	27		0	13	481	521	78		0			78
1986	188		19			207	632		0		1,828	2,460	29		0	1	1,979	2,009	91		0			91
1987	566		5			571	271		0		4,272	4,543	96		0	87	1,019	1,202	210		0	489		699
1988	825		1			826	69		0		1,560	1,629	1		0	23	1,041	1,065	141		0	359		500
1989	60		2			62	210		0		1,680	1,890	29		0	66	1,025	1,120	237		0	134		371
1990	234		0		1	235	63		0		1,491	1,554	0		0	1	1,096	1,097	240		0	260	14	514
1991	116		0		0	116	57		0	7	613	677	1		6	74	1,346	1,427	463		1	430		894
1992	116		0		0	116	69		0	37	708	814	0		0	311	1,190	1,501	445		0	177		622
1993	17	73	0		3	93	36	909	0	17	724	1,686	24	438	0	219	918	1,599	223	481	2	130		836
1994	7	48	0		16	71	279	1,634	0	46	3,459	5,418	113	258	0	892	1,315	2,578	10	384	0	131		525
1995	11	58	0		9	78	110	1,592	0	39	2,127	3,868	20	182	0	554	1,077	1,833	0	606	0	203		809
1996	55	230	0		57	342	119	1,902	0	43	183	2,247	3	256	0	520	2,151	2,930	5	397	0	445		848
1997	2	179	0		39	220	36	1,899	0	564	9,411	11,910	22	250	0	531	2,360	3,163	14	531	0	808		1,353
1998	57	214	0		4	275	15	1,293	0	39	11,656	13,003	6	489	0	686	4,483	5,664	65	1,150	0	1,313		2,528
1999	35	260	1			296	75	1,758	0	2,333	5,111	9,277	0	372	0	4,289	2,145	6,806	86	1,033	0	953		2,072
2000	57	160	0			217	109	2,152	0	3,550	1,041	6,852	3	327	0	5,809	405	6,544	1	379	0	1,348		1,728
2001	0	199	0			199	148	2,664	0	4,722	11,357	18,891	0	246	0	8,847	117	9,210	0	328	0	1,518		1,846
2002	0	161	0			161	45	2,298	0	3,915	4,208	10,466	0	285	0	4,901	102	5,288	0	283	0	1,745		2,028
2003	0	134	0			134	23	1,420	0	526	4,133	6,102	0	409	0	1,045	14	1,468	0	301	0	4,011		4,312
2004	0	213	0			213	80	2,274	0	39	13	2,406	0	248	0	3,326	0	3,574	0	425	0	*		425

TABLE A-3a. Estimates of the retained catches of scombrid species, by flag, gear type, and species, in metric tons, in the EPO, 2000. 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.

TABLA A-3a. Estimaciones de las capturas retenidas de escómbridos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2000. 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.

2000		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
CAN	LT					3,900				3,900
CHL	FX	77		20		3		55		155
COL	PS	16,509	6,327	719	0	0	0	0	0	23,555
CRI	FX	1,084		27			0			1,111
ECU	FX	503		220						723
	PS	34,360	105,174	37,836	0	0	269	0	6	177,645
ESP	PS	5,147	16,288	18,931	0	0	0	0	0	40,366
GTM	LL	10						75	1,985	2,070
JPN	LL	15,243	23	28,746	2	1,180				45,194
KOR	LL	5,134	6	13,280	2	336				18,758
MEX	LL	170		47	42	4				263
	LP	2,376	183	0	61	29	0	0	0	2,649
	PS	97,703	16,928	1	3,025	70	2	449	184	118,362
PAN	LL	359		14		5				378
	PS	3,619	12,647	6,294	0	0	10	0	0	22,570
PER	FX								1,468	1,468
PYF	LL	1,052	39	653		2,638				4,382
TWN	LL	742	0	1,916	1	5,151				7,810
USA	GO	1		2	30			1		34
	LL	10	0	162	4	28			1	205
	LT					7,686				7,686
	PS	3,053	10,117	3,827	693	1	0	187	0	17,878
	RO	364	5		344	1,798				2,511
VEN	PS	68,672	5,144	252	0	0	12	0	0	74,080
VUT	LL	5		2,754		321				3,080
	PS	12,618	11,618	7,723	0	0	0	0	0	31,959
OTR[1]	LL[2]	41		11						52
	LP[3]	10	53			57				120
	PS[4]	13,308	20,997	18,501	0	0	0	0	0	52,806

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 Nicaragua and El Salvador—Incluye Nicaragua y El Salvador.
3. Includes Ecuador and United States—Incluye Ecuador y Estados Unidos.
4. Includes Belize, Bolivia, Guatemala, Honduras, Nicaragua and unknown—Incluye Belice, Bolivia, Guatemala, Honduras, Nicaragua y desconocido.

TABLE A-3b. Estimates of the retained catches of scombrid species, by flag, gear type, and species, in metric tons, in the EPO, 2001. 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.

TABLA A-3b. Estimaciones de las capturas retenidas de escómbridos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2001. 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.

2001		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	1,833	1,080	1,987	131	4,854				9,885
CAN	LT					4,600				4,600
CHL	FX	66		5		5		19		95
CHN	LL	942		2,639		1,581				5,162
COL	PS	24,662	2,250	287	0	0	79	0	0	27,278
CRI	FX	1,133		28			0			1,161
ECU	FX			14					1	15
	PS	55,268	67,617	25,485	0	0	2,101	0	203	150,674
ESP	PS	10,878	21,531	7,881	0	0	0	0	0	40,290
GTM	LL	8						34	2,321	2,363
JPN	LL	14,804	28	38,048	2	1,889				54,771
KOR	LL	5,230	29	12,576	10	355				18,200
MEX	LL	40		1						41
	LP	3,785	570	0	0	18	0	0	0	4,373
	PS	126,096	9,778	14	863	0	0	17	0	136,768
PAN	LL	732	26	80		28				866
	PS	11,772	6,175	2,525	0	0	0	0	0	20,472
PYF	LL	846	14	684		3,542				5,086
TWN	LL	3,928	3	9,285	0	6,811				20,027
USA	GO	5	1		34			0	0	40
	LL	29	1	147	5	56			1	239
	LT					7,439				7,439
	PS	5,230	3,699	3,399	28	3	60	0	0	12,419
	RO				356	1,635				1,991
VEN	PS	106,777	3,274	3	0	0	0	0	0	110,054
VUT	LL	13		3,277		294				3,584
	PS	10,246	7,267	5,692	0	0	0	0	0	23,205
OTR[1]	LL[2]	77		3						80
	PS[3]	31,472	22,355	15,974	0	0	18	0	3	69,823

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 Nicaragua and El Salvador—Incluye Nicaragua y El Salvador.

3. Includes Belize, Bolivia, China, El Salvador, Guatemala, Honduras, Nicaragua and unknown—Incluye Belice, Bolivia, China, El Salvador, Guatemala, Honduras, Nicaragua, y desconocido.

TABLE A-3c. Estimates of the retained catches of scombrid species, by flag, gear type, and species, in metric tons, in the EPO, 2002 .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.
TABLA A-3c. Estimaciones de las capturas retenidas de escómbridos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2002. 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.

2002		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
CAN	LT					4,753				4,753
CHL	FX	15		7		40		0		62
CHN	LL	1,457		7,614		1,327				10,398
COL	PS	31,150	2,357	25	0	0	0	0	284	33,816
CRI	FX	756		18			0			774
ECU	FX			5						5
	PS	37,314	75,701	27,542	0	0	877	0	84	141,518
ESP	PS	5,465	21,646	5,919	0	0	0	0	0	33,030
JPN	LL	8,518	64	34,141	2	2,622				45,347
KOR	LL	3,626	44	10,358	1	341				14,370
MEX	LL	27			5					32
	LP	954	496	0	1	0	8	0	0	1,459
	PS	151,213	7,206	0	1,708	28	358	0	0	160,513
PAN	LL	761	49	2		4				816
	PS	19,514	7,955	2,739	0	0	5	0	0	30,213
PYF	LL	278	27	388		2,545				3,238
TWN	LL	7,360	27	17,253	0	7,096				31,736
USA	GO	1			7			1	0	9
	LL	5	1	132		0			1	139
	LT					7,256				7,256
	PS	6,639	3,723	3,918	0	3	214	0	194	14,691
	RO				351	2,357				2,708
VEN	PS	119,473	4,252	708	0	0	0	0	0	124,433
VUT	LL	290		2,995		902				4,187
	PS	5,197	6,876	2,448	0	0	0	0	0	14,521
OTR[1]	LL[2]	115		7				42	2,790	2,954
	PS[3]	36,319	23,918	14,114	0	0	5	0	14	74,370

[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 El Salvador, Guatemala, Honduras, and Nicaragua—Incluye Nicaragua y El Salvador.
[3.] Includes Belize, Bolivia, El Salvador, Guatemala, Honduras, Nicaragua, Peru, and unknown—Incluye Belice, Bolivia, El Salvador, Guatemala, Honduras, Nicaragua, Perú, y desconocido .

TABLE A-3d. Preliminary estimates of the retained catches of scombrid species, 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 estimate and are preliminary.
TABLA A-3d. Estimaciones preliminares de las capturas retenidas de escómbridos, 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
CAN	LT					6,295				6,295
CHL	FX	73		14		1		24		112
CHN	LL	2,739		10,066		1,743				14,548
COL	PS	22,693	4,767	312	0	0	0	0	0	27,772
CRI	FX	1,401		0						1,401
ECU	FX		93							93
	LL	148	293							441
	PS	35,991	142,216	21,977	0	0	61	0	38	200,283
ESP	LL			58						58
	PS	4,726	25,152	6,395	0	0	0	0	0	36,273
JPN	LL	9,800	52	25,194	3	2,303				37,352
KOR	LL	4,911	25	10,272		343				15,551
MEX	LL	381			46					427
	LP	478	416	0	0	0	6	0	0	900
	PS	164,284	13,063	2	3,211	29	193	0	0	180,782
PAN	LL								24	24
	PS	27,530	14,480	5,392	0	0	3	0	10	47,415
TWN	LL	3,477	71	12,016		12,663				28,227
USA	GO		2	6	4			1		13
	LL			232		2				234
	LT					14,392				14,392
	PS	993	6,430	3,326	22	3	163	0	25	10,962
	RO	597	140	1	737	2,212				3,687
VEN	PS	86,778	13,887	1,098	0	0	0	0	0	101,763
VUT	LL	699		1,258		4,133				6,090
VUT	PS	3,591	17,143	6,970	0	0	13	0	0	27,717
OTR[1]	LL[2]	37								37
	PS[3]	33,936	37,952	8,630	0	2	0	0	8	80,528

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 Honduras and Nicaragua—Incluye Honduras y Nicaragua.
3. Includes Belize, Bolivia, El Salvador, Guatemala, Honduras, Peru, and unknown—Incluye Belice, Bolivia, El Salvador, Guatemala, Honduras, Perú, y desconocido.

TABLE A-3e. Preliminary estimates of the retained catches of scombrid species, 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 estimate and are preliminary.
TABLA A-3e. Estimaciones preliminares de las capturas retenidas de escómbridos, 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		296				632
CAN	LT					7,676				7,676
CHN	LL			2,602						2,602
CRI	FX	390		2			0			392
ECU	PS	40,542	87,643	30,852	0	0	62	7	17	159,123
ESP	LL			5						5
	PS	3,913	14,901	6,577	0	0	0	0	0	25,391
JPN	LL			18,458						18,458
KOR	LL			10,729						10,729
MEX	LL	27			11					38
	LP	1,905	481	0	0	0	0	0	0	2,386
	PS	87,334	26,380	98	8,548	106	418	8	57	122,949
PAN	LL								3,054	3,054
	PS	30,904	18,392	13,202	0	0	25	0	2	62,525
TWN	LL	1,824		7,384		9,988				19,196
USA			158							158
	PS	1,977	4,745	4,027	0	0	296	0	178	11,223
	RO	1,052	17	4	53					1,126
VEN	PS	56,128	13,827	986	0	0	47	0	1	70,989
VUT	LL			431		1,225				1,656
	PS	1,760	7,205	5,137	0	0	0	0	0	14,102
OTR[1]	PS[2]	45,797	23,818	6,066	0	0	1	0	13	75,695

[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, El Salvador, Guatemala, Honduras, Nicaragua, Peru, and unknown—Incluye Bolivia, El Salvador, Guatemala, Honduras, Nicaragua, Perú, y desconocido.

TABLE A-4a. Preliminary estimates of the retained catches and landings, in metric tons, of tunas caught by purse-seine and pole-and-line vessels in the EPO in 2003, by species and vessel flag (upper panel) and location where processed (lower panel). 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.
TABLA A-4a. Estimaciones preliminares de las capturas retenidas y descargas de atún capturado por buques cerqueros y cañeros en el OPO en 2003, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. 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.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches – Capturas retenidas									
COL	22,693	4,767	312	0	0	0	0	0	27,772	3.9
ECU	35,991	142,216	21,977	0	0	61	0	38	200,283	28.0
ESP	4,726	25,152	6,395	0	0	0	0	0	36,273	5.1
MEX	164,762	13,479	2	3,211	29	199	0	0	181,682	25.4
PAN	27,530	14,480	5,392	0	0	3	0	10	47,415	6.6
USA	993	6,430	3,326	22	3	163	0	25	10,962	1.5
VEN	86,778	13,887	1,098	0	0	0	0	0	101,763	14.2
VUT	3,591	17,143	6,970	0	0	13	0	0	27,717	3.9
OTR[1]	33,936	37,952	8,630	0	2	0	0	8	80,528	11.3
Total	**381,000**	**275,506**	**54,102**	**3,233**	**34**	**439**	**0**	**81**	**714,395**	
	Landings–Descargas									
COL	58,319	10,131	2,119	0	0	2	0	0	70,571	10.2
CRI	34,717	3,139	802	0	0	0	0	0	38,657	5.6
ECU	72,653	199,795	39,790	0	2	66	0	56	312,362	45.3
ESP	26,991	14,137	4,130	0	0	0	0	10	45,267	6.6
MEX	152,952	13,174	2	3,017	28	208	0	5	169,386	24.6
USA	666	1,956	111	830	2	163	0	25	3,753	0.5
VEN	21,811	5,591	97	0	0	0	0	0	27,499	4.0
OTR[2]	10,199	9,588	1,406	122	0	0	0	0	21,315	3.1
Total	**378,307**	**257,511**	**48,456**	**3,969**	**32**	**439**	**0**	**96**	**688,810**	

[1] Includes Belize, Bolivia, El Salvador, Guatemala, Honduras, Peru, and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye Belice, Bolivia, El Salvador, Guatemala, Honduras, Perú, y no identificados. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatamala, Italy, Panama, Peru, Singapore, Thailand, and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador, Guatamala, Italia, Panamá, Perú, Singapur, Tailandia, y no identificados. 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 caught by purse-seine, pole-and-line, and recreational vessels in the EPO in 2004, by species and vessel flag (upper panel) and location where processed (lower panel). 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.
TABLA A-4b. Estimaciones preliminares de las capturas retenidas y descargas de atún capturado con buques cerqueros, cañeros y deportivos en el OPO en 2004, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. 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.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches – Capturas retenidas									
ECU	40,542	87,643	30,852	0	0	62	7	17	159,123	29.2
ESP	3,913	14,901	6,577	0	0	0	0	0	25,391	4.7
MEX	89,239	26,861	98	8,548	106	418	8	57	125,335	23.0
PAN	30,904	18,392	13,202	0	0	25	0	2	62,525	11.5
USA	1,977	4,745	4,027	0	0	296	0	178	11,223	2.1
VEN	56,128	13,827	986	0	0	47	0	1	70,989	13.0
VUT	1,760	7,205	5,137	0	0	0	0	0	14,102	2.6
OTR[1]	45,797	23,818	6,066	0	0	1	0	13	75,695	13.9
Total	**270,260**	**197,392**	**66,945**	**8,548**	**106**	**849**	**15**	**268**	**544,383**	
	Landings–Descargas									
COL	47,356	10,600	2,019	0	0	0	0	0	59,975	10.6
CRI	15,710	3,819	1,798	0	0	41	0	3	21,371	3.8
ECU	75,833	139,535	59,045	0	0	86	7	20	274,527	48.7
MEX	95,360	33,061	1,471	8,548	107	417	7	57	139,028	24.7
VEN	22,127	2,601	0	0	0	45	0	0	24,773	4.4
OTR[2]	28,699	12,215	2,209	53	0	259	0	187	43,622	7.7
Total	**285,086**	**201,831**	**66,542**	**8,601**	**107**	**848**	**14**	**267**	**563,296**	

[1] Includes, Bolivia, Colombia, El Salvador, Guatemala, Honduras, Nicaragua, and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye, Bolivia, Colombia, El Salvador, Guatemala, Honduras, Nicaragua, y no identificados. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatemala, Panama, Peru, Spain, United States,and unidentified. This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador, España, Guatemala, Panamá, Perú, Estados Unidos, y no identificados. 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. Source**:** Report of the Third Meeting of the Pacific Bluefin Tuna Working Group. FPN: pound net (trap); GND: drift gillnet; for other gear codes, see code tables.
TABLA A-5. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas métricas. Fuente: Informe de la Tercera Reunión del Grupo de Trabajo sobre el Atún Aleta Azul del Pacífico. FPN: almadraba; GND: red de transmalle de deriva; otros códigos de arte, ver tablas de códigos.

PBF	Western Pacific flags—Banderas del Pacífico occidental												Eastern Pacific flags—Banderas del Pacífico oriental									Total
	JPN							KOR[1]		TWN		Sub-total	USA[2]							MEX	Sub-total	
	PS	LL	LT	LP	FPN	GND	OTR	PS	TX	LL	PS		PL	PS	LL	LT	GND	OTR	RO	PS		
1975	4308	1558	1908	1401	2408	676	69					12328		9583					38	2145	11766	24094
1976	1964	520	1833	1082	3207	1085	15					9705		10646					23	1968	12637	22342
1977	3960	712	3070	2256	2419	884	28					13330		5473					21	2186	7680	21010
1978	8878	1049	6328	1154	2827	2030	68					22334		5396					5	545	5946	28280
1979	12266	1223	5158	1250	5021	1541	75					26534		6118					12	213	6343	32877
1980	10414	1170	2323	1392	2701	1479	63					19542		2938					8	582	3528	23069
1981	23219	796	2456	754	2130	2130	15			179		31679	0	868	0	10	4	1	6	218	1107	32786
1982	17584	880	1479	1777	1644	1577	3	31		176		25151	0	2566	0	0	1	1	7	502	3077	28228
1983	13272	707	2606	356	962	807	30	13		157		18911	6	754	0	0	3	0	21	218	1002	19913
1984	4217	360	2722	587	2475	532	25	4		471		11395	4	674	0	0	5	1	31	166	881	12276
1985	3820	496	2904	1817	2678	728	37	1		210		12691	3	3320	0	0	6	1	55	676	4061	16752
1986	7138	249	2714	1086	2885	316	13	344		70		14815	1	4851	0	0	15	0	7	189	5063	19878
1987	7962	346	1352	1565	2085	258	3	89		365		14026	0	861	0	0	2	0	21	119	1003	15028
1988	3243	241	1714	907	864	371	3	32		108	197	7680	5	923	0	0	4	0	4	447	1383	9063
1989	5423	440	1593	754	823	173	4	71		205	259	9745	8	1046	0	0	3	0	70	57	1184	10929
1990	2678	396	1756	536	768	256	19	132		189	149	6879	62	1380	0	0	9	94	40	50	1635	8514
1991	8410	285	3015	286	1734	236	26	265		342		14599	0	410	2	0	3	5	57	9	486	15085
1992	6313	573	1331	166	1227	888	2	288		464	73	11325	1	1928	38	0	8	81	93	0	2149	13474
1993	5678	857	895	231	978	159	3	40		471	1	9313	4	580	42	0	32	25	114	0	797	10110
1994	6917	1138	2883	314	1149	126	3	50		559		13139	1	906	30	0	28	101	24	65	1155	14294
1995	15975	769	3417	396	1835	110	12	821		335		23670	0	689	29	0	19	0	166	11	914	24584
1996	6675	978	2331	437	1106	67	8	102		956		12661	0	4639	25	2	43	0	30	3700	8439	21099
1997	11122	1383	1476	243	756	109	9	1054		1814		17965	1	2240	26	1	57	0	90	367	2782	20747
1998	4375	1260	1640	269	821	91	8	188		1910		10562	3	1771	54	172	40	1	213	1	2255	12817
1999	13439	1155	1548	256	1082	59	355	256		3089		21239	2	184	54	20	19	2	397	2369	3047	24286
2000	14020	1005	1944	398	1229	51	314	794	0	2780		22536	12	692	19	1	30	0	220	3025	3999	26536
2001	6728	1004	1551	666	1371	100	37	995	10	1839		14301	1	149	6	7	34	0	226	863	1286	15587
2002	8007	615	982	517	887	212	83	674	1	1523		13501	2	50	2	2	7	0	348	1714	2125	13333

[1] Catch statistics for Korea were derived from Japanese import statistics, 1982-1999 (minimum estimates.—Las estadísticas de captura de Corea fueron derivadas de estadísticas de importación japonesas, 1982-1999 (estimaciones mínimas).
[2] Catch statistics for United States were categorized into commercial fishing and sport fishing during 1975-1980.—Las estadísticas de captura de Estados Unidos fueron categorizadas en pesca comercial y pesca deportiva durante 1975-1980.

TABLE A-6a. Annual retained catches of North Pacific albacore by region, in metric tons. The data for the western and central Pacific Ocean were obtained from the Secretariat of the Pacific Community.

TABLA A-6a. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas. Los datos del Océano Pacífico occidental y central provienen de la Secretaría de la Comunidad del Pacífico.

ALB (N)	Eastern Pacific Ocean Océano Pacífico oriental						Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LP	LT	PS	OTR	Subtotal	LL	LP	LT	OTR	Subtotal	
1975	218	3,332	18,861	0	640	23,052	14,139	52,152	182	554	67,027	90,079
1976	227	3,456	15,905	272	717	20,577	17,764	85,331	278	2,487	105,860	126,437
1977	969	1,960	9,968	15	543	13,456	16,554	31,934	54	1,712	50,254	63,710
1978	795	1,577	16,613	155	821	19,961	12,762	59,877	23	7,223	79,885	99,846
1979	1,421	179	4,955	148	74	6,778	13,321	44,662	2,347	4,108	64,438	71,216
1980	1,261	407	5,421	194	168	7,451	14,445	46,742	2,347	4,531	68,065	75,516
1981	2,552	608	12,039	99	227	15,524	17,727	27,426	798	11,287	57,238	72,762
1982	2,328	198	3,303	355	257	6,440	17,007	29,614	3,410	13,632	63,663	70,103
1983	1,611	449	7,751	7	87	9,905	14,746	21,098	1,833	7,586	45,263	55,168
1984	2,645	1,441	8,343	3,910	1,427	17,766	13,226	26,010	1,011	17,236	57,483	75,249
1985	1,345	877	5,308	42	1,178	8,749	13,592	20,679	1,163	13,667	49,101	57,850
1986	764	86	4,282	47	199	5,378	12,671	16,096	456	10,710	39,933	45,311
1987	1,110	320	2,300	1	176	3,907	13,822	19,110	570	11,396	44,898	48,805
1988	878	271	4,202	17	79	5,447	14,026	6,216	165	18,836	39,243	44,690
1989	964	21	1,852	1	164	3,003	12,786	8,629	148	19,726	41,289	44,292
1990	1,140	170	2,440	39	53	3,842	14,953	8,532	465	26,098	50,048	53,890
1991	1,517	834	1,783	0	23	4,157	15,889	7,103	201	10,697	33,890	38,047
1992	1,496	255	4,515	0	2	6,268	18,200	13,888	420	16,499	49,007	55,275
1993	1,656	1	4,331	0	25	6,014	28,972	12,797	2,417	4,054	48,240	54,254
1994	2,343	85	9,533	0	144	12,105	28,086	26,389	3,601	3,094	61,170	73,275
1995	1,703	465	7,267	0	154	9,589	30,286	20,981	2,636	2,400	56,303	65,892
1996	2,879	72	8,195	11	171	11,328	36,256	20,296	12,839	1,661	71,052	82,380
1997	3,812	59	6,053	1	1,078	11,004	44,778	32,311	11,036	3,190	91,315	102,319
1998	3,556	81	11,748	42	1,288	16,716	44,946	23,005	7,136	3,078	78,165	94,881
1999	4,475	227	10,791	47	3,770	19,309	41,751	50,406	2,172	8,250	102,579	121,888
2000	2,536	86	10,862	71	1,853	15,408	39,342	21,520	3,737	3,387	67,986	83,394
2001	7,762	18	11,537	3	1,729	21,050	40,342	29,707	4,770	1,851	76,670	97,720
2002	2,892	0	11,903	31	2,387	17,213	40,411	29,587	1,909	1,803	73,710	90,923
2003	4,252	0	20,511	34	2,227	27,024	*	*	*	*	*	27,024
2004	2,631	0	7,676	106	*	10,414	*	*	*	*	*	10,414

TABLE A-6b. Annual retained catches of South Pacific albacore by region, in metric tons. The data for the western and central Pacific Ocean were obtained from the Secretariat of the Pacific Community.
TABLA A-6b. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas. Los datos del Océano Pacífico occidental y central provienen de la Secretaría de la Comunidad del Pacífico.

ALB (S)	Eastern Pacific Ocean Océano Pacífico oriental			Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LT	Subtotal	LL	LP	LT	OTR	Subtotal	
1975	4,130	*	4,130	24,899	100	646	0	25,645	29,775
1976	2,009	*	2,009	22,221	100	25	0	22,346	24,355
1977	4,343	*	4,343	26,375	100	621	0	27,096	31,439
1978	12,282	*	12,282	26,825	100	1,686	0	28,611	40,893
1979	8,397	*	8,397	25,546	100	814	0	26,460	34,857
1980	4,910	*	4,910	28,689	101	1,468	0	30,258	35,168
1981	4,908	*	4,908	29,162	0	2,085	5	31,252	36,160
1982	5,458	*	5,458	24,095	1	2,434	6	26,536	31,994
1983	7,590	*	7,590	20,663	0	744	39	21,446	29,036
1984	5,010	*	5,010	17,776	2	2,773	1,589	22,140	27,150
1985	6,073	*	6,073	24,502	0	3,253	1,937	29,692	35,765
1986	5,769	74	5,843	29,069	0	1,929	1,946	32,944	38,787
1987	6,378	188	6,566	18,970	9	1,946	930	21,855	28,421
1988	9,813	1,282	11,096	23,124	0	3,014	5,283	31,421	42,517
1989	5,659	593	6,252	16,589	0	7,777	21,968	46,334	52,586
1990	5,871	1,336	7,207	17,368	245	5,639	7,538	30,790	37,997
1991	6,753	795	7,548	18,489	14	7,010	1,489	27,002	34,550
1992	6,039	1,205	7,244	14,593	11	5,373	65	20,042	27,286
1993	16,223	35	16,258	19,937	74	4,261	70	24,342	40,600
1994	9,793	415	10,207	25,172	67	6,749	89	32,077	42,284
1995	7,646	2	7,648	21,053	139	7,706	104	29,002	36,650
1996	3,940	94	4,033	18,263	30	7,137	156	25,586	29,619
1997	5,145	460	5,605	24,180	21	4,070	133	28,404	34,009
1998	9,395	10	9,405	28,714	36	6,081	85	34,916	44,321
1999	5,844	75	5,919	29,681	138	3,063	74	32,956	38,875
2000	7,947	724	8,671	32,792	102	4,793	139	37,826	46,497
2001	10,381	501	10,883	39,207	37	4,859	199	44,302	55,185
2002	11,513	106	11,619	36,417	7	4,227	150	40,801	52,420
2003	12,812	176	12,989	*	*	*	*	*	12,989
2004	9,913	*	9,913	*	*	*	*	*	9,913

TABLE A-7. Catches per cubic meter of well volume for the EPO purse-seine fleet, by species and vessel capacity group, in the EPO and in all ocean fishing areas. All = YFT, SKJ, BET, PBF, ALB, BZX, BKJ, OTR (see code tables).
TABLA A-7. Capturas por metro cúbico de volumen de bodega de la flota cerquera del OPO, por especie y clase de arqueo, en el OPO y en todas las áreas oceánicas de pesca. EPO = OPO; All = YFT, SKJ, BET, PBF, ALB, BZX, BKJ, OTR (ver tablas de códigos).

	Species	Well volume—Volumen de bodega (m^3)																Total	
	—	<401		401-800		801-1100		1101-1300		1301-1500		1501-1800		1801-2100		>2100			
	Especie	EPO	All	EPO	All	EPO	All	EPO	All	EPO	All	EPO	All	EPO	All	EPO	All	EPO	All
1999	YFT	3.1	3.1	1.3	1.3	1.0	1.1	1.8	1.9	1.2	1.2	2.1	2.1	0.5	0.6	0.5	0.5	1.5	1.5
	SKJ	1.8	1.8	1.9	1.9	1.7	1.7	0.8	0.8	1.3	1.3	1.0	1.1	1.6	1.7	2.2	2.5	1.3	1.4
	BET	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.4	0.4	0.8	0.8	0.2	0.2
	All	5.3	5.3	3.5	3.5	3.0	3.0	2.7	2.8	2.7	2.7	3.3	3.3	2.4	2.7	3.5	3.8	3.1	3.2
2000	YFT	1.8	1.8	0.8	0.8	0.9	0.9	2.1	2.1	1.3	1.3	1.7	1.7	0.5	0.6	0.4	0.4	1.4	1.4
	SKJ	2.5	2.5	1.4	1.4	1.6	1.6	0.5	0.5	0.9	1.0	0.7	0.7	1.0	1.3	1.1	1.2	1.0	1.1
	BET	0.1	0.1	0.3	0.3	0.5	0.5	0.1	0.1	0.3	0.3	0.2	0.2	0.7	0.8	1.3	1.3	0.3	0.4
	All	4.5	4.5	2.5	2.6	3.0	3.0	2.7	2.7	2.6	2.7	2.6	2.7	2.1	2.6	2.8	3.0	2.7	2.9
2001	YFT	2.3	2.3	1.2	1.2	1.2	1.2	2.4	2.4	1.8	1.8	2.3	2.3	0.5	0.5	0.4	0.4	1.6	1.7
	SKJ	1.2	1.2	0.9	0.9	0.7	0.7	0.2	0.2	0.5	0.5	0.3	0.3	0.9	0.9	0.7	0.7	0.6	0.6
	BET	0.0	0.0	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.4	0.4	0.2	0.2	0.2	0.2
	All	3.7	3.7	2.3	2.3	2.1	2.1	2.7	2.7	2.7	2.7	2.7	2.8	1.7	1.7	1.3	1.3	2.4	2.4
2002	YFT	1.6	1.6	1.4	1.4	0.8	0.8	2.3	2.3	2.2	2.2	1.5	1.5	0.2	0.2	0.2	0.2	1.5	1.5
	SKJ	1.3	1.3	1.0	1.0	0.7	0.7	0.2	0.2	0.5	0.5	0.2	0.2	0.7	0.7	0.5	0.5	0.5	0.6
	BET	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.3	0.3	0.1	0.1	0.1	0.1
	All	3.2	3.2	2.5	2.5	1.7	1.7	2.7	2.7	3.0	3.0	1.7	1.8	1.2	1.2	0.7	0.8	2.2	2.2
2003	YFT	1.7	1.7	1.5	1.5	1.0	1.0	2.4	2.4	1.7	1.7	1.9	1.9	0.3	0.3	0.5	0.5	1.6	1.6
	SKJ	2.9	2.9	2.0	2.0	1.4	1.4	0.5	0.5	0.7	0.7	0.4	0.4	1.0	1.1	0.8	1.0	1.0	1.0
	BET	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.2	0.3	0.1	0.2
	All	4.9	4.9	3.7	3.7	2.7	2.7	3.0	3.0	2.5	2.5	2.4	2.4	1.6	1.6	1.6	1.8	2.7	2.8
2004	YFT	1.0	1.0	0.8	0.8	0.7	0.7	1.4	1.4	1.3	1.3	0.8	0.8	0.3	0.3	0.3	0.4	1.0	1.0
	SKJ	1.6	1.6	1.1	1.1	0.9	0.9	0.4	0.4	0.5	0.5	0.3	0.3	0.4	0.4	0.3	0.5	0.6	0.6
	BET	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.1	0.1
	All	2.9	2.9	2.1	2.1	2.0	2.0	1.9	1.9	1.9	1.9	1.2	1.2	0.8	0.9	0.8	1.1	1.7	1.7

TABLE A-8. Estimated numbers of sets, by set type and vessel size class, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2004 are preliminary. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary.

TABLA A-8. Números estimados de lances, por tipo de lance y clase de arqueo de los buques, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de 2004 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		
	Class—Clase		Total	YFT	SKJ	BET
	1-5	6				
DEL	**Sets on fish associated with dolphins Lances sobre peces asociados con delfines**					
1987	57	13,286	13,343	187,608	517	32
1988	49	11,160	11,209	153,936	5,392	37
1989	33	12,827	12,860	191,660	1,729	26
1990	31	10,997	11,028	173,893	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	111,219	582	51
1994	5	7,804	7,809	125,486	1,096	1
1995	0	7,185	7,185	133,180	2,561	1
1996	14	7,472	7,486	138,595	1,753	57
1997	43	8,977	9,020	152,308	8,154	0
1998	0	10,645	10,645	154,734	4,982	5
1999	0	8,648	8,648	143,297	1,693	5
2000	0	9,235	9,235	146,592	398	15
2001	0	9,823	9,823	231,844	1,674	6
2002	0	12,446	12,446	301,570	3,164	1
2003	0	13,839	13,839	258,367	13,082	1
2004	0	11,783	11,783	176,172	10,901	3
OBJ	**Sets on fish associated with floating objects Lances sobre peces asociados con objetos flotantes**					
1987	1,322	1,813	3,135	27,447	34,722	767
1988	823	2,281	3,104	25,210	38,616	809
1989	974	2,339	3,313	28,383	44,684	1,527
1990	719	2,558	3,277	35,526	35,572	3,994
1991	819	2,165	2,984	25,501	39,049	2,747
1992	868	1,763	2,631	15,010	49,144	2,048
1993	493	2,063	2,556	19,304	53,079	6,125
1994	668	2,770	3,438	20,842	51,121	33,960
1995	707	3,521	4,228	21,097	80,049	41,964
1996	1,230	4,007	5,237	27,820	69,737	58,367
1997	1,699	5,653	7,352	30,051	116,792	62,703
1998	1,198	5,481	6,679	26,328	110,326	41,911
1999	630	4,620	5,250	43,052	181,650	49,326
2000	494	3,916	4,410	43,155	121,203	91,815
2001	697	5,744	6,441	69,292	123,142	60,480
2002	778	5,781	6,559	37,783	116,875	55,891
2003	750	5,497	6,247	31,831	182,921	52,314
2004	557	5,083	5,640	27,721	116,524	65,478

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

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Class—Clase		Total	YFT	SKJ	BET
	1-5	6				
NOA	Sets on unassociated schools / Lances sobre cardúmenes no asociados					
1987	1,823	3,981	5,804	46,951	28,779	377
1988	4,147	7,536	11,683	98,147	43,105	689
1989	2,955	5,878	8,833	57,952	48,521	477
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	47,463	33,876	5,130
1993	5,739	6,267	12,006	88,971	30,169	3,481
1994	5,440	5,064	10,504	62,081	17,910	938
1995	6,120	4,782	10,902	61,158	44,436	3,354
1996	5,807	5,118	10,925	72,191	32,486	2,888
1997	5,334	4,693	10,027	62,519	28,509	1,567
1998	5,700	4,631	10,331	72,897	25,323	2,213
1999	5,632	6,143	11,775	95,571	78,222	1,827
2000	6,119	5,482	11,601	65,240	83,639	2,254
2001	4,481	3,030	7,511	81,267	19,131	774
2002	5,008	3,409	8,417	72,931	33,594	1,519
2003	7,825	5,781	13,606	90,325	79,086	1,788
2004	5,050	5,083	10,133	64,463	69,486	1,463
ALL	Sets on all types of schools / Lances sobre todos tipos de cardumen					
1987	3,202	19,080	22,282	262,007	64,019	1,177
1988	5,019	20,977	25,996	277,293	87,113	1,535
1989	3,962	21,044	25,006	277,995	94,935	2,031
1990	4,433	18,952	23,385	263,251	74,370	5,920
1991	4,390	15,438	19,828	231,257	62,229	4,870
1992	4,904	16,240	21,144	228,121	84,283	7,179
1993	6,266	15,283	21,549	219,494	83,829	9,657
1994	6,113	15,638	21,751	208,409	70,127	34,900
1995	6,827	15,488	22,315	215,434	127,045	45,319
1996	7,051	16,597	23,648	238,606	103,976	61,312
1997	7,076	19,323	26,399	244,878	153,456	64,270
1998	6,898	20,757	27,655	253,959	140,631	44,128
1999	6,262	19,411	25,673	281,920	261,564	51,158
2000	6,613	18,633	25,246	254,988	205,240	94,083
2001	5,178	18,597	23,775	382,402	143,948	61,259
2002	5,786	21,636	27,422	412,285	153,633	57,412
2003	8,575	25,117	33,692	380,523	275,089	54,103
2004	5,607	21,949	27,556	268,356	196,911	66,944

TABLE A-9. Types of floating objects on which sets were made. The 2004 data are preliminary.
TABLA A-9. Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2004 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
1992	1,087	61.7	556	0.32	120	0.07	1,763
1993	1,138	55.2	825	0.40	100	0.05	2,063
1994	773	27.9	1,899	0.69	98	0.04	2,770
1995	729	20.7	2,704	0.77	88	0.02	3,521
1996	537	13.4	3,447	0.86	23	0.01	4,007
1997	832	14.7	4,768	0.84	52	0.01	5,652
1998	752	13.7	4,627	0.84	102	0.02	5,481
1999	833	18.0	3,758	0.81	29	0.01	4,620
2000	488	12.5	3,381	0.86	47	0.01	3,916
2001	567	9.9	5,076	0.88	100	0.02	5,743
2002	756	13.1	4,953	0.86	66	0.01	5,775
2003	713	13.0	4,744	0.86	40	0.01	5,497
2004	601	11.8	4442	0.87	40	0.01	5,083

TABLE A-10. Reported total fishing effort for all species (E; 1000 hooks), and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only, by flag, by the longline fishing fleets operating in the EPO.
TABLA A-10. Esfuerzo de pesca total reportado (E; 1000 anzuelos) para todas las especies, y captura (C; toneladas métricas) de aleta amarilla, barrilete, patudo, aleta azul del Pacífico, y albacora solamente, por bandera, de las flotas palangreras que faenan en el OPO.

LL	CHN		JPN		KOR		MEX		PAN		PYF		TWN		USA		VUT	
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
1975			86,134	51,566	2,191	786							3,580	1,534				
1976			117,301	68,895	3,931	2,043							2,364	1,679				
1977			132,875	83,725	10,958	5,628							11,973	7,835				
1978			140,006	79,320	8,571	7,012							8,743	6,553				
1979			137,769	67,932	5,021	2,305							3,138	2,327				
1980			138,141	75,639	11,788	5,907							3,000	1,624				
1981			131,275	59,226	19,731	6,539							5,952	2,958				
1982			116,200	61,370	18,612	7,488							8,117	3,918				
1983			127,176	69,563	14,675	6,479	1	49					4,850	2,319				
1984			119,635	57,261	11,767	4,491							3,730	1,741				
1985			106,758	74,348	19,785	10,508	0	2					3,126	1,980				
1986			160,553	111,672	30,765	17,432	3	68					4,874	2,572				
1987			188,393	104,053	36,436	19,405	5	273					12,267	5,348				
1988			182,694	82,383	43,056	10,172	4	234					9,567	4,607				
1989			170,373	84,961	43,365	4,879	0	9					16,360	4,964				
1990			178,419	117,923	47,166	17,415							12,543	4,757				
1991			200,365	112,337	65,024	24,644							17,969	5,862	43	12		
1992			191,284	93,011	45,634	13,104					500	89	33,025	14,141	325	106		
1993			159,955	87,977	46,375	12,843	3	2			2,605	79	18,064	6,574	417	81		
1994			163,976	92,606	44,788	13,250	8	41			3,410	574	12,588	4,879	302	25		
1995			129,598	69,435	54,979	12,778	13	7			3,452	559	2,910	1,637	823	180		
1996			103,653	52,298	40,290	14,121	3	0			4,219	931	5,830	3,553	507	182		
1997			96,383	59,325	30,493	16,663					5,490	1,941	8,720	5,640	462	215		
1998			106,569	50,167	51,817	15,089	9				6,415	2,858	10,586	4,834	1,020	406		
1999			80,958	32,886	54,269	13,294	17	64			9,190	4,446	23,247	7,774	1,680	450		
2000			79,277	45,194	33,585	18,759	76	263	40	378	10,230	4,382	18,152	7,809	1,076	132	34	3,080
2001	13,056	5,162	102,204	54,772	72,261	18,201	74	42	60	866	11,200	5,086	53,224	20,027	1,440	209	26	3,583
2002	36,756	10,398	103,572	45,346	96,273	14,370	35	32	90	816	10,700	3,238	77,051	31,736	236	26	45	4,187
2003	43,289	14,548	105116	37,352	*	15,551	30	427	*	*	*	*	74,322	28,227	*	30	18	6,090
2004	*	2,602	*	18,458	*	*	17	38	*	*	*	*	*	19,196	*	*	21	1,656

[1]Less than 100% of the total catch and effort (KOR 1975-1986 only)—Menos del 100% de la captura y esfuerzo totales (KOR 1975-1986 solamente)

TABLE A-11. Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet, 1975-2004. The data for 2004 are preliminary.
TABLA A-11. Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO, 1975-2004. Los datos de 2004 son preliminares.

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
1975	253	174,016	111	8,055	364	182,072
1976	254	187,512	137	8,471	391	195,983
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	189,865	10	1,259	215	191,124
2002	218	200,075	6	925	224	201,000
2003	214	202,706	3	338	217	203,044
2004	215	206,028	3	338	218	206,366

TABLE A-12a. Estimates of the numbers and well volumes, in cubic meters, of purse-seine and pole-and-line vessels that fished in the EPO in 2003 by flag, gear, and size class. 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-12a. Estimaciones del número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros que pescaron en el OPO en 2003, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag Bandera	Gear Arte	Size class—Clase de arqueo 1	2	3	4	5	6	Total	Well Volume Volumen de bodega
		Number—Número							m^3
BLZ	PS	-	-	1	-	-	1	2	695
BOL	PS	-	-	2	1	-	7	10	7,910
COL	PS	-	-	1	1	2	5	9	7,259
ECU	PS	-	5	11	12	9	37	74	48,415
ESP	PS	-	-	-	-	-	5	5	12,177
GTM	PS	-	-	-	-	-	3	3	5,700
HND	PS	-	-	-	-	-	2	2	1,798
MEX	PS	-	-	3	6	11	38	58	50,633
	LP	-	1	2	-	-	-	3	338
PAN	PS	-	-	-	1	-	13	14	17,909
PER	PS	-	-	-	-	-	2	2	2,018
SLV	PS	-	-	-	-	-	3	3	5,377
USA	PS	-	-	2	-	-	6	8	8,665
VEN	PS	-	-	-	-	-	25	25	32,699
VUT	PS	-	-	-	-	-	6	6	7,449
UNK	PS	-	-	-	-	-	1	1	1,864
Grand total—Total general	PS	-	5	19	21	21	148	214	
	LP	-	1	2	-	-	-	3	
	PS + LP	-	6	21	21	21	148	217	
		Well volume—Volumen de bodega (m^3)							
Grand total—Total general	PS	-	551	3,552	5,825	9,328	183,450	202,706	
	LP	-	101	237	-	-	-	338	
	PS + LP	-	652	3,789	5,825	9,328	183,450	203,044	

- : none—ninguno

TABLE A-12b. Estimates of the numbers and well volumes, in cubic meters, of purse-seine (PS) and pole-and-line vessels that fished in the EPO in 2004 by flag, gear, and size class. 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-12b. Estimaciones del número y volumen de bodega, en metros cúbicos, de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2004, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag / Bandera	Gear / Arte	Size class—Clase de arqueo 1	2	3	4	5	6	Total	Well Volume / Volumen de bodega
		Number—Número							m^3
BOL	PS	-	-	2	1	-	5	8	6,412
COL	PS	-	-	-	1	1	6	8	8,318
ECU	PS	-	4	8	13	10	39	74	49,128
ESP	PS	-	-	-	-	-	4	4	8,859
GTM	PS	-	-	-	-	-	2	2	3,415
HND	PS	-	-	-	-	-	3	3	2,810
MEX	PS	-	-	2	7	11	39	59	52,443
	LP	-	1	2	-	-	-	3	338
NIC	PS	-	-	-	-	-	3	3	3,926
PAN	PS	-	-	-	2	1	19	22	27,411
SLV	PS	-	-	-	-	-	3	3	5,377
USA	PS	-	-	1	-	-	6	7	8,178
VEN	PS	-	-	-	-	-	23	23	29,961
VUT	PS	-	-	-	-	-	4	4	5,082
UNK	PS	-	-	2	-	-	-	2	360
Grand total—Total general	PS	-	4	13	24	22	152	215	
	LP	-	1	2	-	-	-	3	
	PS + LP	-	5	15	24	22	152	218	
		Well volume—Volumen de bodega (m^3)							
Grand total—Total general	PS	-	383	2,294	6,712	9,727	186,912	206,028	
	LP	-	101	237	-	-	-	338	
	PS + LP	-	484	2,531	6,712	9,727	186,912	206,366	

- : none—ninguno

TABLE A-13. Minimum, maximum, and average values, in thousands of metric tons, for monthly capacities of purse seiners and pole-and-line vessels at sea in the EPO during l994-2003, and the 2004 values.
TABLA A-13. Valores mínimos, máximos, y medios, en miles de toneladas métricas, de la capacidad mensual de buques cerqueros y cañeros en el mar en el OPO durante 1994-2003, y los valores de 2004.

Month Mes	1994-2003			2004
	Min	Max	Ave-Prom	
1	67.0	121.6	92.1	121.4
2	67.9	138.7	99.4	144.1
3	66.0	123.8	95.6	149.8
4	64.2	139.1	99.8	143.0
5	65.3	130.0	96.3	135.4
6	66.8	115.9	97.2	144.7
7	69.3	128.2	100.2	153.5
8	65.1	140.2	100.5	116.9
9	64.2	137.7	100.9	111.9
10	60.1	145.6	100.8	145.2
11	60.0	145.0	96.9	129.6
12	33.1	116.4	72.2	56.3
Ave-Prom	62.4	131.9	96.0	129.3

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 analysis method is 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, which is consistent with the management of the stock. Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and west. Purse-seine catches of yellowfin tuna are lower close to the 150ºW EPO boundary (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 longline catch per unit of effort (CPUE) trends differing 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 could not 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. The assessment for 2005 differs from the 2004 assessment in the following ways. Catch and length-frequency data for the purse-seine and pole-and-line (surface) fisheries have been updated to include new data for 2004 and revised data for 2000-2003. Effort data for the surface fisheries have been updated to include new data for 2004 and revised data for 1975-2003. Catch data for the Japanese longline fisheries have been updated for 1999-2002, and new data for 2003 have been added. Catch data for the longline fisheries of Chinese Taipei have been updated to include new data for 2002. Catch data for the longline fisheries of the People's Republic of China have been updated to include new data for 2003 and revised data for 2001 and 2002. Longline catch-at-length data for 2001-2002 have been updated, and new data for 2003 added. Longline effort data have been standardized via a generalized linear model standardization of CPUE rather than a neural network, using data for 1975-2003. The growth model likelihood has been adjusted to account for sampling at length rather than assuming random sampling. 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 highest 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 by catching schools associated with dolphins, and accordingly this method has the greatest impact on the yellowfin tuna population (Figure B-4), although it has almost the lowest impact per weight captured of all fishing methods. It appears that the yellowfin population has experienced two different productivity regimes (1975-1983 and 1984-2004), with greater recruitment during the second regime. The two recruitment regimes (Figure B-3) correspond to two regimes in biomass (Figure B-4), the high-recruitment regime corresponding to 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 capable of supporting the average maximum sustainable yields (AMSYs) during the low-recruitment regime, but close to that level during the high-recruitment regime (Figure B-5). The two different productivity regimes may support two different levels of AMSY and associated SBRs, and the AMSY reported here is an average for the 1975-2004 period. The current SBR is below the SBR level at AMSY (Figure B-5). However, there is substantial uncertainty in the most recent estimate of SBR, and there is a moderate probability that the current SBR is above the level that would support the AMSY. The effort levels are estimated to be above those capable of supporting the AMSY (based on the recent (2002-2003) distribution of effort among the different fisheries). Because of the flat yield curve, the recent effort levels are estimated to produce, under average conditions, catch that is only slightly less than AMSY. Future projections under the current effort levels and average recruitment indicate that the population will remain at approximately the same level over the next 5 years (Figure B-6). These simulations were carried out using the average recruitment for the 1975-2004 period. If they had been carried out using the average recruitment for the 1984-2004 period, the projected trend in SBR and catches would have been more positive. Both the purse-seine and longline catches are expected to remain close to 2004 levels (Figure B-6).

AMSY has been stable during the assessment period (Figure B-7). This suggests that the overall pattern of selectivity has not varied a great deal through time. However, the overall level of fishing effort has varied with respect to the AMSY multiplier.

The analysis indicates that strong cohorts entered the fishery in 1998-2000, and that these cohorts increased the population biomass during 1999-2000. However, they have now moved through the population, so the biomass decreased during 2001-2004.

The overall average weights of yellowfin tuna that are caught have consistently been much less than those that would maximise the AMSY, 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 AMSY calculations indicate that the yield levels could be increased if the fishing effort were diverted to the fisheries that catch larger yellowfin and, *vice versa*, 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.

The conservation measures imposed in 2004 under Resolution C-04-09 are predicted to result in slightly higher biomass and SBR than would otherwise have been the case. However, it is likely that the stock is below the AMSY level.

A sensitivity analysis was carried out to estimate the effect of a stock-recruitment relationship. The results suggest that the model with a stock-recruitment relationship fits the data slightly better than the base case, but this result could also be explained by the regime shift, since spawning biomass is low during the period of low recruitment and high during the high recruitment. The results from the analysis with a stock-recruitment relationship are more pessimistic, suggesting that the effort level is greater than that which would produce the AMSY (Table B-1); however, the yield at this effort level is still only 6% less than AMSY. The biomass is estimated to have been less than the biomass that would produce the AMSY for most of the modeling period, except for most of the 2000-2002 period.

The assessment results are very similar to those from the previous assessments. The major differences occur, as expected, in the most recent years. The current assessment, and those for 2002, 2003 and 2004, indicate that the biomass increased in 2000, whereas the earlier assessments indicated a decline. In addition, SBR and the SBR corresponding to the AMSY have increased compared to the 2004 assessment because of changes in estimates of growth and recent age-specific fishing mortality.

Summary

1. The results are similar to those of the previous five assessments, except that SBR at AMSY is higher than in these assessments.
2. The biomass is estimated to have declined very slightly in 2004.
3. There is uncertainty about recent and future recruitment and biomass levels.
4. The estimate of current SBR is less than that required to produce AMSY but its confidence intervals encompass the AMSY.
5. The recent fishing mortality rates are 20% above those required to produce AMSY.

6. Increasing the average weight of the yellowfin caught could substantially increase AMSY.
7. There have been two different productivity regimes, and the levels of AMSY and the biomass required to produce AMSY may differ between the regimes.
8. The results are more pessimistic if a stock-recruitment relationship is assumed.

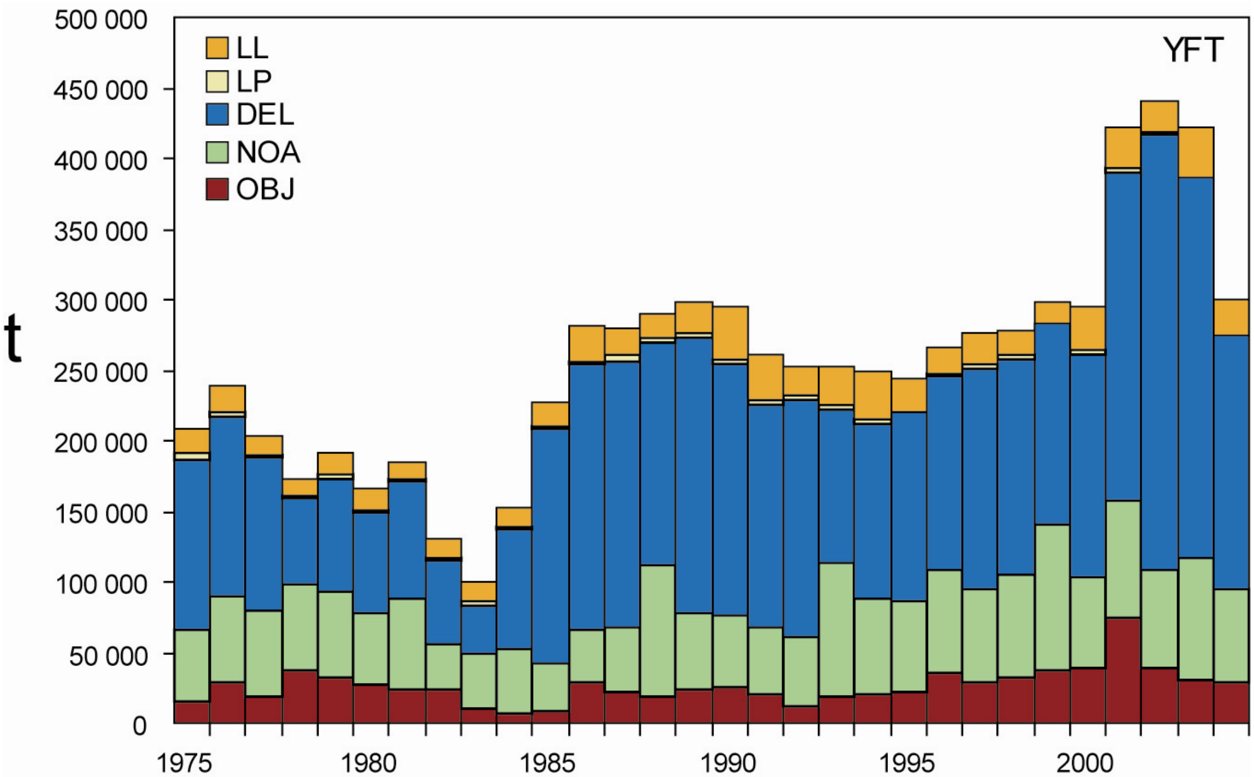


FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line fishery and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2004, used in the stock assessment. Purse-seine catches for 1975-1992 are based on unloading data. Longline catches for 1975-2003 are those reported to the IATTC by governments, and those for 2004 are predicted by the model based on 2003 effort levels and estimates of the biomass vulnerable to longlining in 2004.

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, 1975-2004, usadas en la evaluación de la población. Las capturas cerqueras de 1975-1992 se basan en datos de descargas. Las capturas palangreras de 1975-2003 son las que reportaron los gobiernos a la CIAT, y las de 2004 son predichas por el modelo con base en el nivel de esfuerzo de 2003 y estimaciones de la biomasa vulnerable a los palangres en 2004.

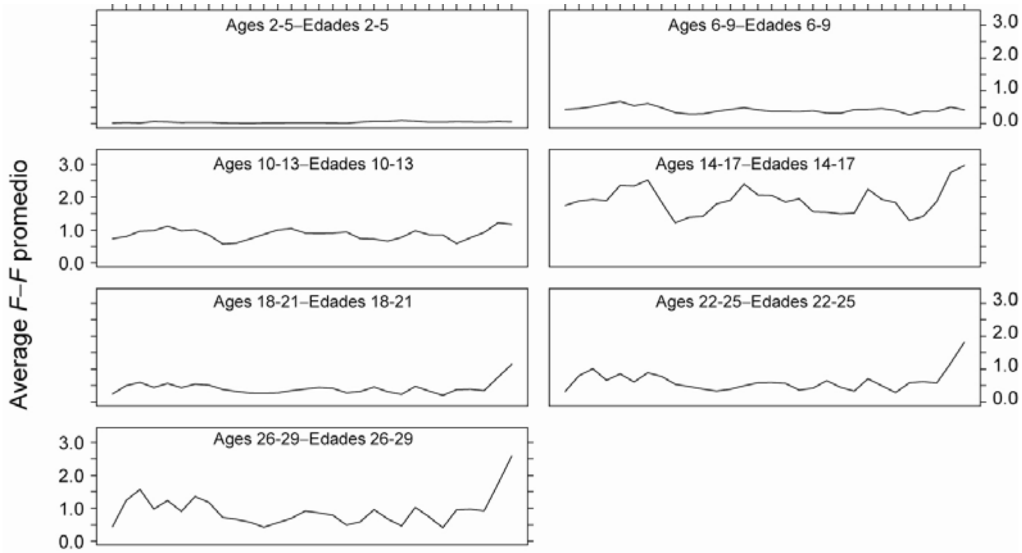


FIGURE B-2. Time series of average total annual fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish of the age range indicated in the title of each panel. For example, 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. Series de tiempo de la mortalidad por pesca trimestral total media de atún aleta amarilla reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores trimestrales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron a los peces de entre 2 y 5 trimestres de edad.

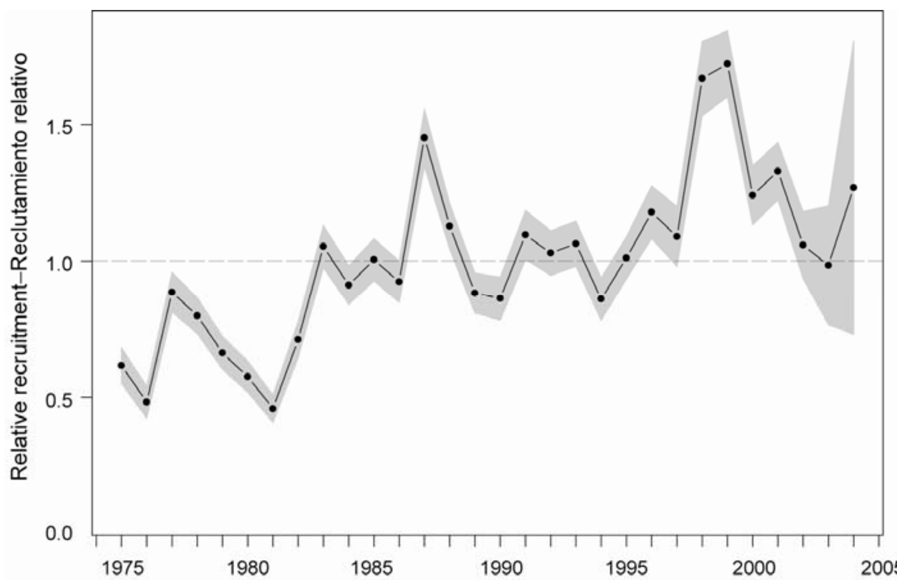


FIGURE B-3. Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals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

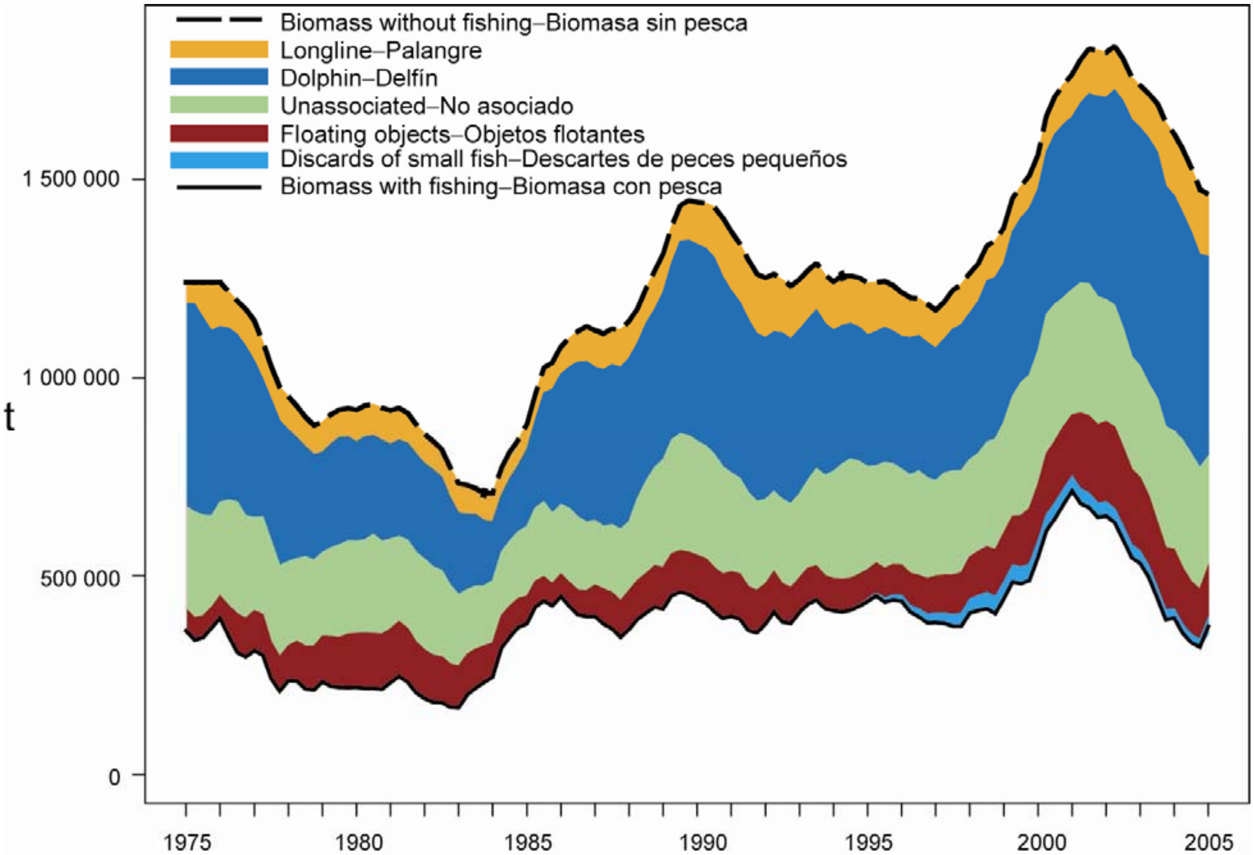


FIGURE B-4. Biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The different colored areas between the two lines represent the portion of the fishery impact attributed to each fishing method.

FIGURA B-4. Trayectoria de la biomasa de una población simulada de atún aleta amarilla no explotada durante 1975-2004 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas coloreadas entre las dos líneas represantan la porción del impacto de la pesca atribuida a cada método de pesca.

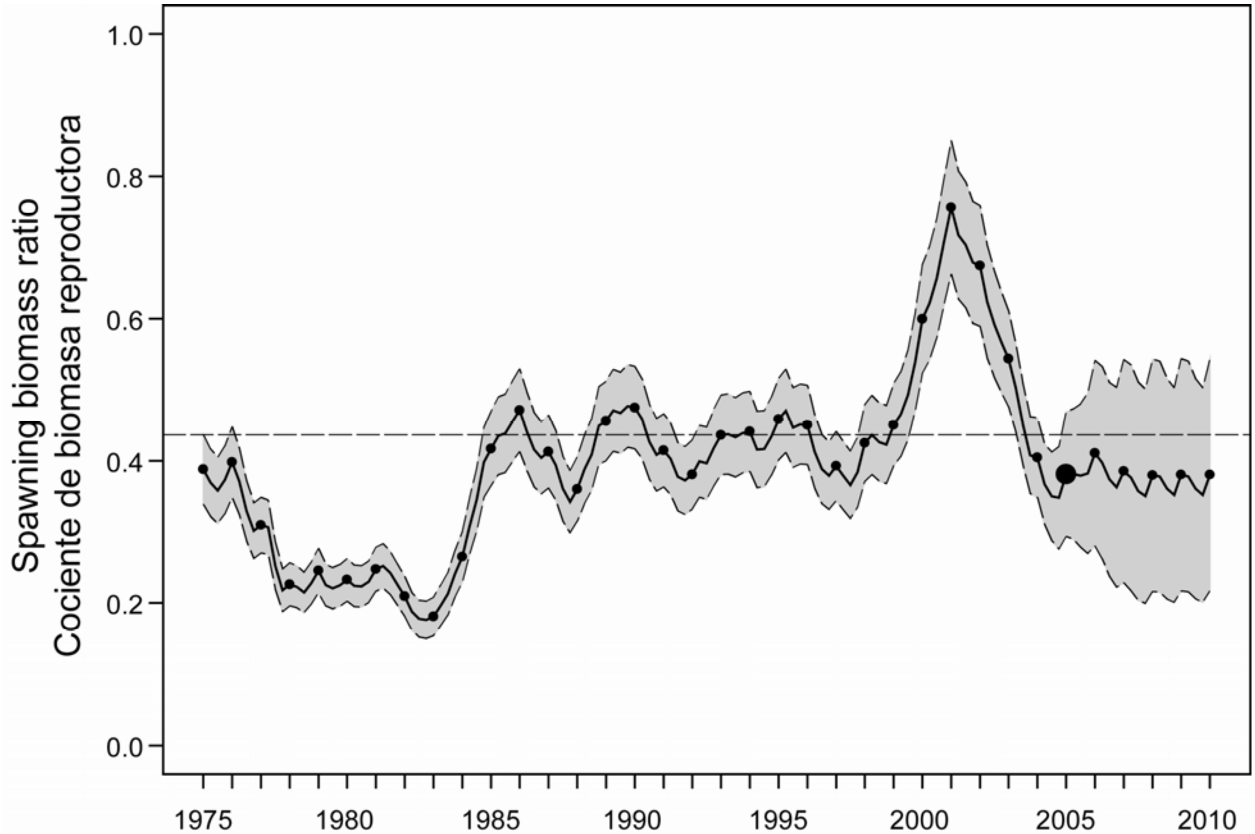


FIGURE B-5. Spawning biomass ratios (SBRs) for 1975-2004 and SBRs projected during 2005-2010 for yellowfin tuna in the EPO by the likelihood profile approximation method. The dashed horizontal line (at 0.44) identifies SBR_{AMSY}. The shaded area represents the 95% confidence limits of the estimates. The estimates after 2005 (the large dot) indicate the SBR predicted to occur if effort continues at the average of that observed in 2004, catchability (with effort deviates) continues at the average for 2002 and 2003, and average environmental conditions occur during the next 10 years.

FIGURA B-5. Cocientes de biomasa reproductora (SBR) para 1975-2004 y SBR proyectados durante 2005-2010 para el atún aleta amarilla en el OPO por el método de aproximación de perfil de verosimilitud. La línea de trazos horizontal (en 0.44) identifica SBR_{RPMS}. El área sombreada representa los límites de confianza de 95% de las estimaciones. Las estimaciones a partir de 2005 (el punto grande) señalan el SBR predicho si el esfuerzo continúa en el nivel promedio de 2004, la capturabilidad (con desvíos de esfuerzo) continúa en el promedio de 2002 y 2003, y ocurren condiciones ambientales medias en los 10 próximos años.

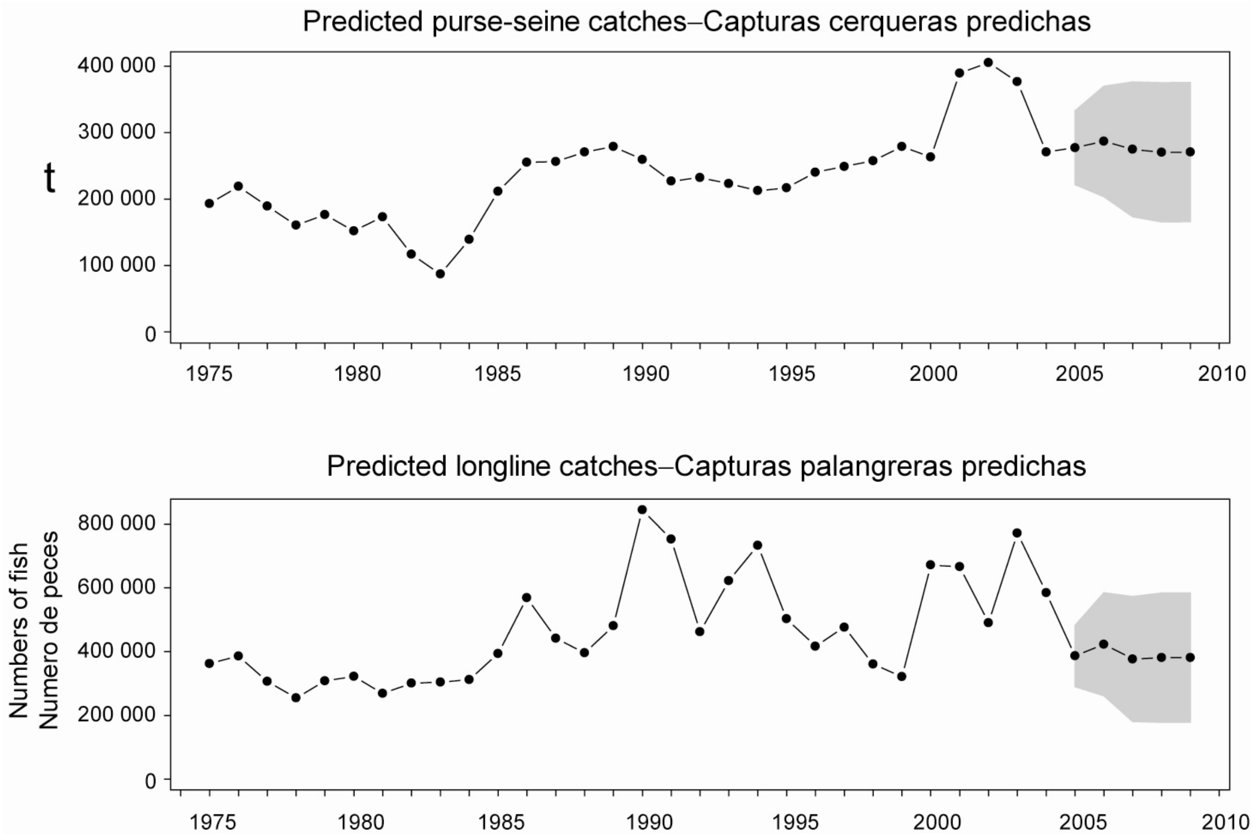


FIGURE B-6. Catches of yellowfin tuna during 1975-2004 and simulated catches of yellowfin tuna during 2005-2009 taken by the purse-seine and pole-and-line fleets (upper panel) and the longline fleet (lower panel), using the likelihood profile method. The shaded area represents the 95% confidence limits of the estimates.

FIGURA B-6. Capturas de atún aleta amarilla durante 1975-2004 y capturas simuladas de aleta amarilla durante 2005-2009 por las flotas de cerco y de caña (recuadro superior) y la flota palangrera (recuadro inferior), usando el método de aproximación de perfil de verosimilitud. El área sombreada representa los intervalos de confianza de 95% estimades de las estimaciones.

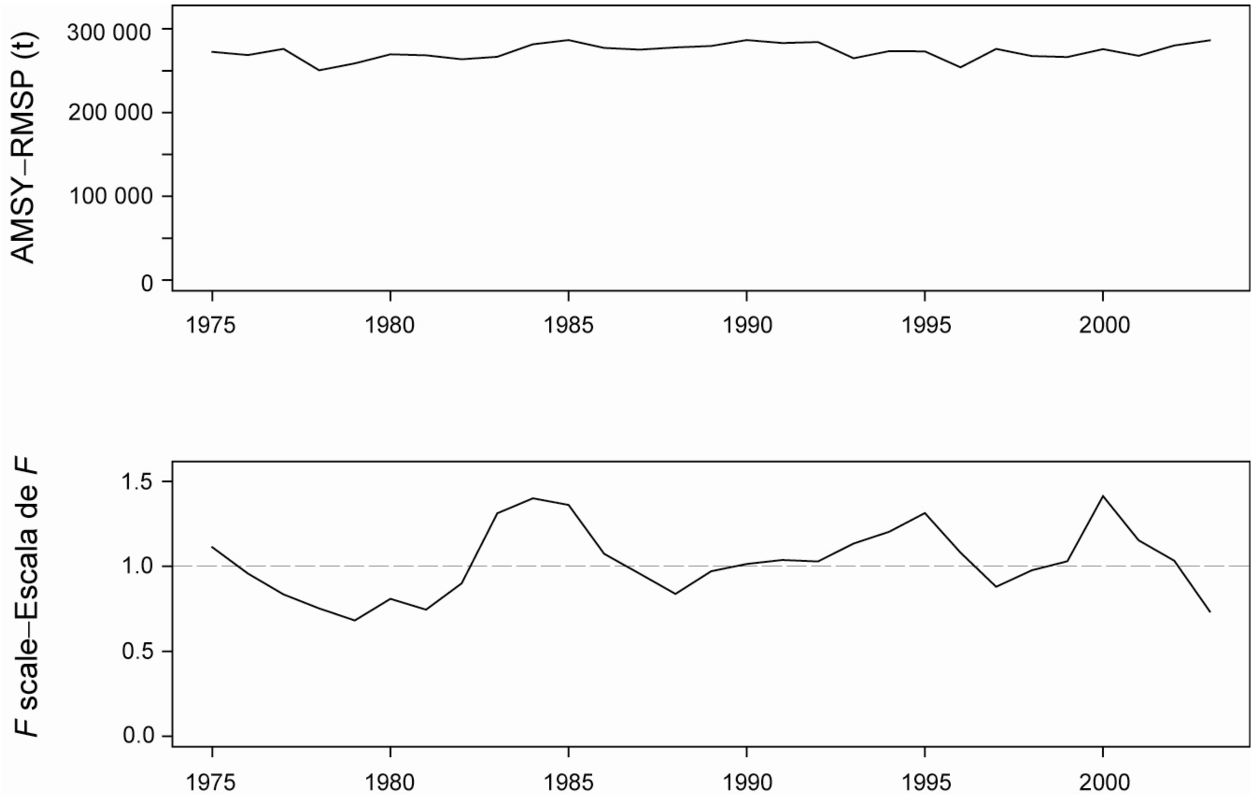


FIGURE B-7. AMSY (upper panel), 1975-2004, and the change (increase or reduction) in the effort required to produce the AMSY (lower panel), estimated separately for each year using the average age-specific fishing mortality for that year.
FIGURA B-7. RMSP (recuadro superior), 1975-2004, y cambio (aumento o reducción) del esfuerzo necesario para producir el RMSP (recuadro inferior), estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

TABLE B-1. Estimates of the AMSY and its associated quantities for the base case assessment and the sensitivity analysis including a stock-recruitment relationship with a steepness (*h*) of 0.7.5. All analyses are based on average fishing mortality for 2002 and 2003. B_{2005}, B_{AMSY}, and B_0 are the biomass of yellowfin 1.5+ years old at the start of 2005, at AMSY, and without fishing, respectively, and S_{2005}, S_{AMSY}, and S_0 are the female spawning biomass at the start of 2005, at AMSY, and without fishing, respectively. C_{2004} is the estimated total catch in 2004.

TABLA B-1. Estimaciones del RMSP y sus 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 2002 y 2003. B_{2005}, B_{RMSP}, y B_0 son la biomasa de aleta amarilla de edad 1.5+ años al principio de 2005, en RMSP, y sin pesca, respectivamente, y S_{2005}, S_{RMSP}, y S_0 son la biomasa reproductora de hembras al principio de 2005, en RMSP, y sin pesca, respectivamente. C_{2004} es la captura total estimada en 2004.

		Base case Caso base	***h* = 0.75**
AMSY–RMSP	(t)	284,707	306,775
B_{AMSY} –B_{RMSP}	(t)	419,598	531,276
S_{AMSY}—S_{RMSP}	(t)	8,144	10,141
B_{AMSY}/B_0—B_{RMSP}/B_0		0.34	0.36
S_{AMSY}/S_0 –S_{RMSP}/S_0		0.44	0.45
C_{2004}/AMSY—C_{2004}/RMSP		1.04	0.97
B_{2005}/B_{AMSY} –B_{2005}/B_{RMSP}		0.89	0.72
S_{2005}/S_{AMSY} –S_{2005}/S_{RMSP}		0.87	0.71
F multiplier—Multiplicador de *F*		0.83	0.67

C. SKIPJACK TUNA

An age-structured catch-at-length analysis (A-SCALA) is used to assess skipjack tuna in the eastern Pacific Ocean (EPO). The analysis method is described in IATTC Bulletin, Vol. 22, No. 5, and readers are referred to that report for technical details. This method was used for the most recent assessment of skipjack tuna conducted in 2004, which included data up to and including 2003.

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

The recruitment of skipjack tuna to the fisheries in the EPO is highly variable (Figure C-2). Fishing mortality (Figure C-3) is estimated to be about the same or less than the rate of natural mortality. These estimates of fishing mortality are supported by estimates from tagging data. Biomass fluctuates in response to variations in both recruitment and exploitation (Figure C-4). Estimates of absolute biomass are moderately sensitive to weights given to the information about abundance in the catch and effort data for the floating-object fisheries and the monotonic selectivity assumption, but the trends in biomass are not.

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

There is considerable variation in spawning biomass ratio (ratio of the spawning biomass to that for the unfished stock; SBR) for skipjack tuna in the EPO (Figure C-5). In 2003 the SBR was at a high level (about 0.61). Estimates based on average maximum sustainable yield (AMSY) and yield-per-recruit indicate that maximum yields are achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the fishery. However, this is uncertain because of uncertainties in the estimates of natural mortality and growth. Estimates of SBR are not sensitive to weights given to the information about abundance in the catch and effort data for the floating-object fisheries and the monotonic selectivity assumption.

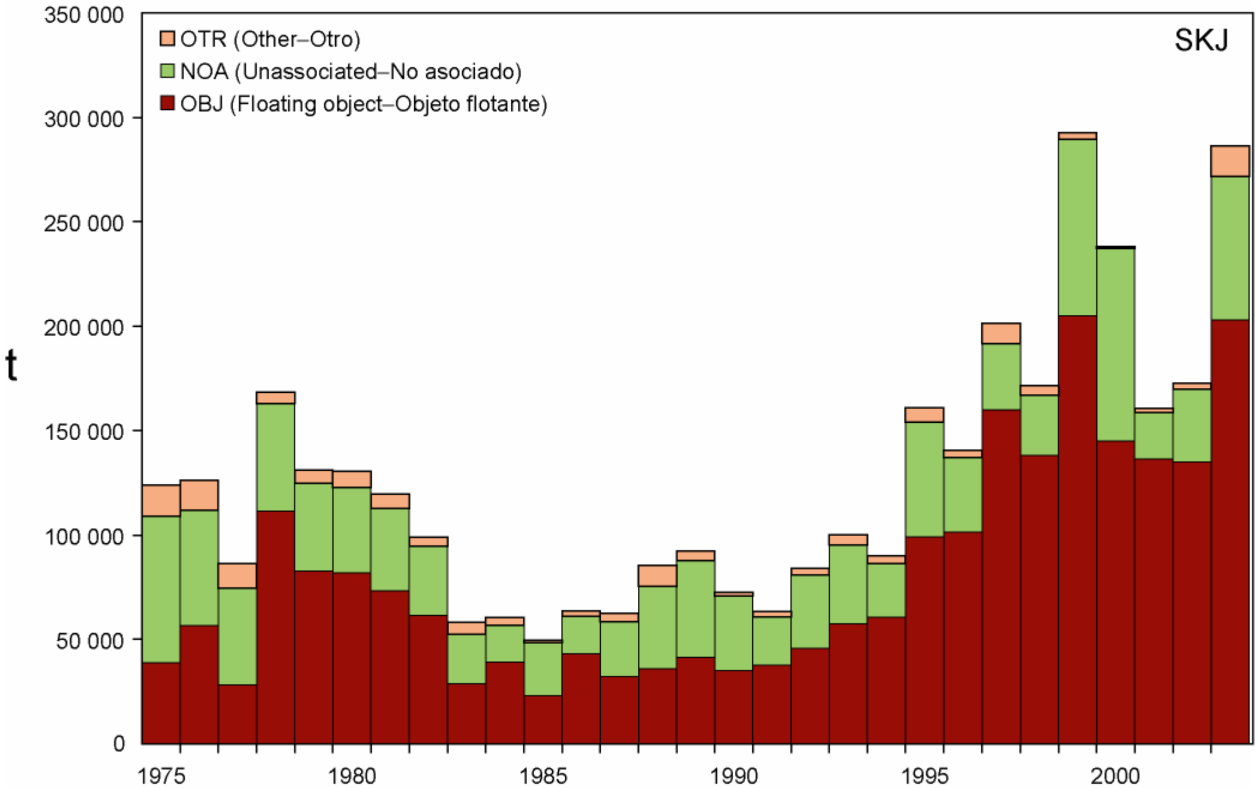


FIGURE C-1. Total catches (retained catches plus discards) for the purse-seine fisheries on floating objects and unassociated schools, and for other fisheries combined, of skipjack tuna in the eastern Pacific Ocean, 1975-2004, used in the stock assessment. Purse-seine catches are based on unloading data.

FIGURA C-1. Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco sobre objetos flotantes y cardúmenes no asociados, y de las demás pesquerías combinadas, de atún barrilete en el Océano Pacífico oriental, 1975-2004, usadas en la evaluación de la población. Las capturas cerqueras se basan en datos de descargas.

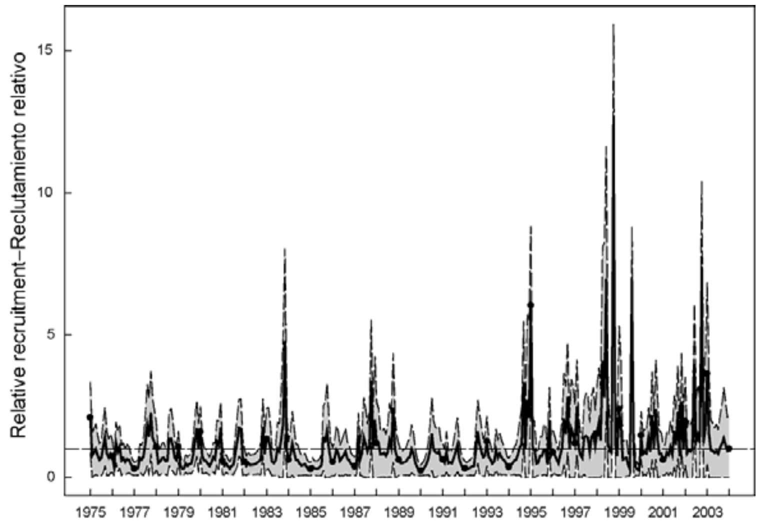


FIGURE C-2. Estimated recruitment of skipjack tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The solid line illustrates the maximum-likelihood estimates of recruitment, and the shaded area the 95% confidence intervals. The labels on the time axis are drawn at the start of each year, but, since the assessment model represents time on a monthly basis, there are 12 estimates of recruitment for each year.

FIGURA C-2. Reclutamiento estimado de atún barrilete a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea sólida ilustra las estimaciones de reclutamiento de probabilidad máxima, y el área sombreada los intervalos de confianza de 95%. Se dibujan las leyendas en el eje de tiempo al principio de cada año, pero, ya que el modelo de evaluación representa el tiempo por meses, hay 12 estimaciones de reclutamiento para cada año.

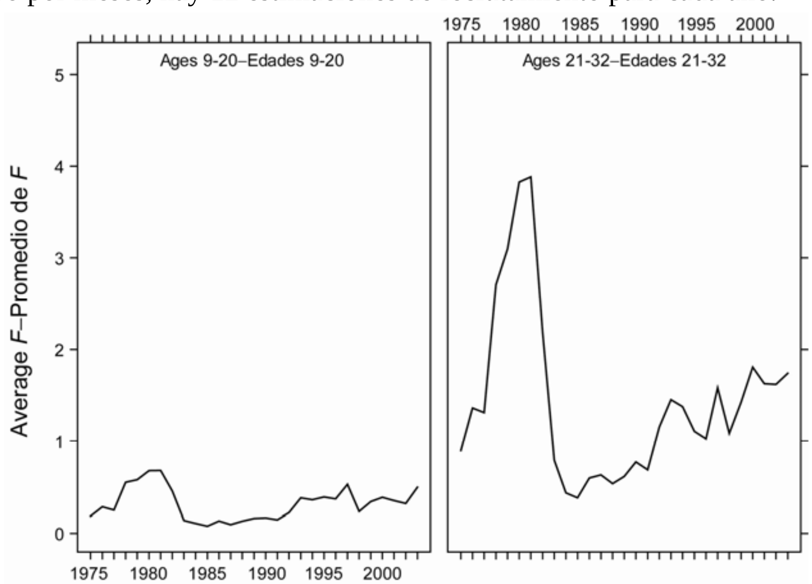


FIGURE C-3. Time series of average total monthly fishing mortality of skipjack tuna recruited to the fisheries of the EPO. Each panel illustrates an average of 12 monthly fishing mortality vectors that affected fish of the age range indicated in the title of each panel. For example, the trend illustrated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

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

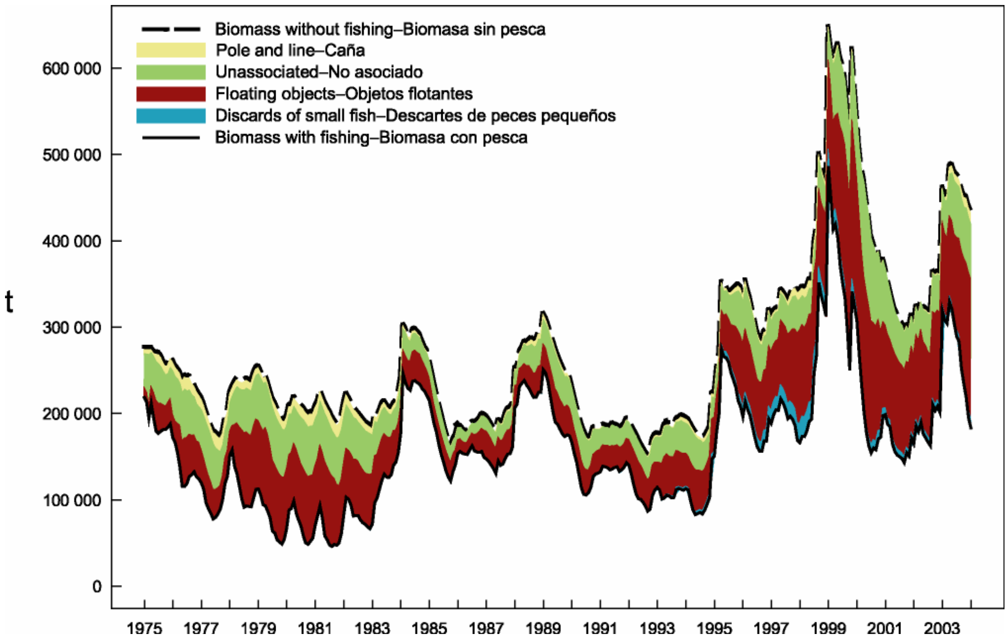


FIGURE C-4. Biomass trajectory of a simulated population of skipjack tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishing method.
FIGURA C-4. Trayectoria de la biomasa de una población simulada de atún barrilete no explotada durante 1975-2004 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas sombreadas entre las dos líneas representan la porción del impacto de la pesca atribuida a cada método de pesca.

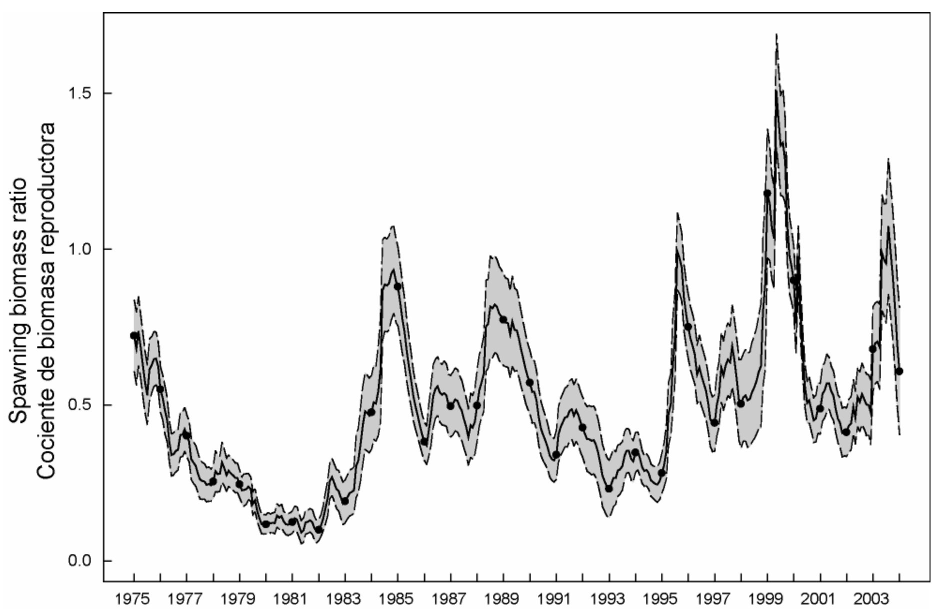


FIGURE C-5. Estimated time series of spawning biomass ratios (SBRs) for skipjack tuna in the EPO, from the monotonic selectivity assessment. The shaded area represents the 95% confidence limits of the estimates.
FIGURA C-5. Series de tiempo estimadas de los cocientes de biomasa reproductora (SBR) de atún barrilete en el OPO, de la evaluación de selectividad monotónica. El área sombreada representa los intervalos de confianza de 95% de las estimaciones.

D. BIGEYE TUNA

There have been substantial changes in the bigeye tuna fishery in recent years (Figure D-1). Initially, the majority of the bigeye catch was made caught by longline vessels. With the expansion of the FAD fishery since 1993, the purse-seine fishery has taken an increasing component of the bigeye catch. The FAD fishery captures smaller bigeye, and has therefore reduced the yield per recruit and the average maximum sustainable yield (AMSY).

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

Bigeye are distributed across the Pacific Ocean, but the bulk of the catch is made in the east and west. Purse-seine catches of bigeye tuna are substantially lower close to the 150ºW EPO boundary (Figure A-3); longline catches are more continuous, but show lower levels between 160ºW and 180º (Figure A-4). Bigeye tuna do not show large movements (95% of tagged bigeye moved less than 1000 miles), and current information indicates little exchange between the eastern and western Pacific Ocean (Figure D-2). This is consistent with longline catch per unit of effort (CPUE) trends differing among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at a local level. The assessment reported here is conducted as if there were a single stock in the EPO, to be consistent with the management of the stock. 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.

Several inputs into this assessment differ from that for 2003. New results from recent age and growth studies have been incorporated. Catch and length-frequency data for the purse-seine and pole-and-line fisheries have been updated to include new data for 2004 and revised data for 2000-2003. Effort data for the purse-seine and pole-and-line fisheries have been updated to include new data for 2004 and revised data for 1975-2003. Monthly reporting of catch data for the longline fishery provided, at the time of the assessment, provisional 2004 catch data for Japan and the Republic of Korea and partial catch data for the other nations. Catch data for the Japanese longline fisheries have been updated for 1999-2002 and new data for 2003 added. Catch data for the longline fisheries of Chinese Taipei have been updated to include new data for 2002. Catch data for the longline fisheries of the People’s Republic of China have been updated to include new data for 2003 and revised data for 2001 and 2002. Longline catch-at-length data for 2001-2002 have been updated and new data for 2003 added. Longline effort data based on statistical habitat-based standardization of CPUE have been updated to include data for 2002, and raw catch and effort data were used to extend the time series to the second quarter of 2004.

A sensitivity analysis was performed that investigated including a stock-recruitment relationship in the assessment.

There have been important changes in the amounts of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. 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-3). The increase in average fishing mortality on the younger fish was caused by the expansion of the fisheries that catch bigeye in association with floating objects.

There are several important features in the estimated time series of bigeye recruitment (Figure D-4). First, estimates of recruitment before 1993 are very uncertain, as the floating-object 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. The recruitments were above average in 2001 and 2002. 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 large recruitments in 1995 to 1998 coincided with the expansion of the fisheries that catch bigeye in association with floating objects.

Fishing has reduced the total biomass of bigeye present in the EPO, and it is predicted that it will be near its lowest level by the end of 2005 (Figure D-5). There has been an accelerated decline in biomass since the peak in 2000. Analysis of the levels of fishing mortality associated with each fishery indicates that, since the expansion of the purse-seine fishing on floating objects in the early to mid-1990s, the purse-seine fishery has had a much greater impact on the stock than has the longline fishery.

The relationship between recruitment and the environmental index used in previous assessments was found to be not significant, and therefore was not used in the analysis.

At the beginning of 2005, the spawning biomass of bigeye tuna in the EPO (Figure D-6; large dot) was declining from a recent high level. 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 0.13, about 41% less than the level corresponding to the average maximum sustainable yield (SBR_{AMSY}), with lower and upper confidence limits (±2 standard deviations) of about 0.08 and 0.18. The estimate of the upper confidence bound is less than the estimate of SBR_{AMSY} (0.21). Previous assessments had predicted that the spawning biomass would decline below the SBR_{AMSY} level.

Estimates of the average SBR projected to occur during 2005-2010 indicate that the SBR is likely to remain below the level corresponding to the AMSY for many years unless fishing mortality is greatly reduced or recruitment is greater than average levels for a number of years (Figure D-7).

The average weight of fish in the catch of all fisheries combined declined substantially in 1993 and 1994, and has remained at that lower level since then. The recent age-specific pattern of fishing mortality is not satisfactory from a yield-per-recruit perspective.

In the base case assessment, recent catches are estimated to have been about 5% above the AMSY (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 AMSY is about 57% of the recent (2002-2003) level of effort. Decreasing the effort to 57% of its present level would increase the long-term average yield by about 11% and would increase the spawning potential of the stock by about 69%. The AMSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery that operates south of 15°N because it catches larger individuals. Before the expansion of the floating-object fishery that started in 1993, AMSY was greater than the current AMSY and the fishing mortality was less than that corresponding to AMSY (Figure D-8).

All analyses considered suggest that at the start of 2005 the spawning biomass was below the level corresponding to the AMSY (Table D-1). AMSY and the fishing mortality (F) multiplier are sensitive to how the assessment model is parameterized, the data that are included in the assessment, and the periods assumed to represent average fishing mortality, but under all scenarios considered, fishing mortality is well above the level corresponding to the AMSY.

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

The effects of Resolution C-04-09 are estimated to be insufficient to allow the stock to rebuild. If the effort is reduced to levels corresponding to AMSY, the stock will rebuild to SBR_{AMSY} within the 5-year projection period.

Summary:

1. Recent fishing mortality levels are 75% greater than those corresponding to the AMSY.

2. As a consequence, if fishing effort is not reduced, total biomass and spawning biomass will remain around the lowest levels observed during the period modelled (1975-2005).
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 the alternative model and data formulations considered in this and previous analyses.

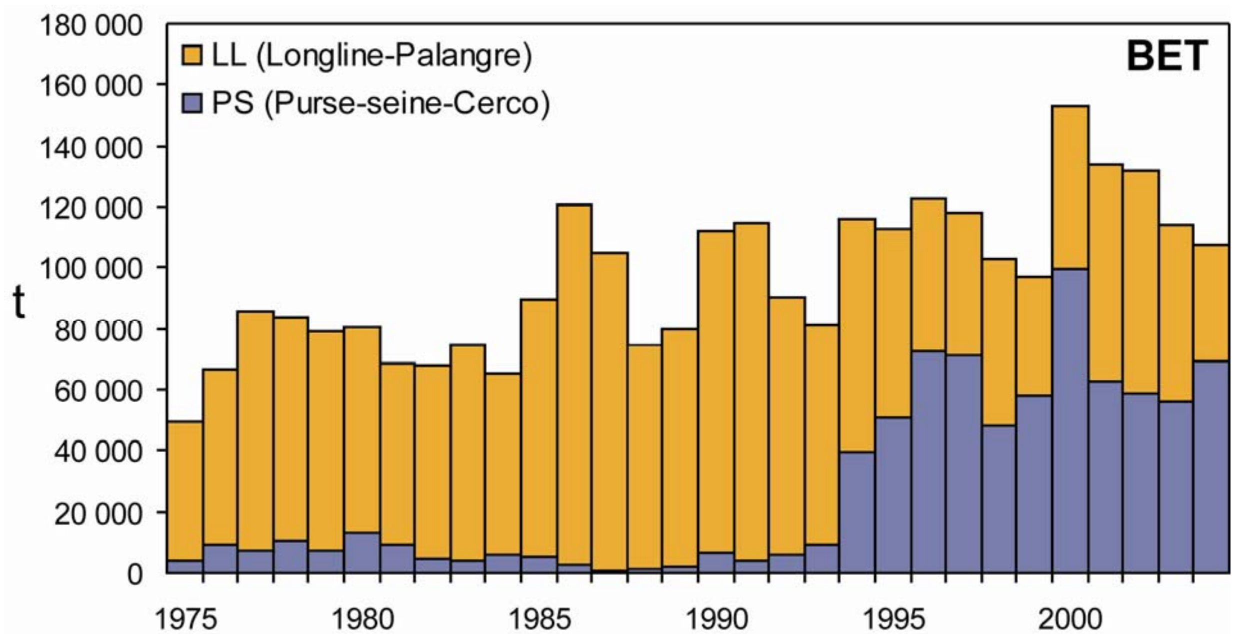


FIGURE D-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the longline fisheries, of bigeye tuna in the eastern Pacific Ocean, 1975-2004, used in the stock assessment. Purse-seine catches for 1975-1992 are based on unloading data, those for 1993-1999 on unloading data adjusted to account for mis-indentification, and those for 2000-2004 on species composition sampling.

FIGURA D-1. Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco y capturas retenidas de las pesquerías palangreras de atún patudo en el Océano Pacífico oriental, 1975-2004, usadas en la evaluación de la población. Las capturas cerqueras de 1975-1992 se basan en datos de descargas, las de 1993-1999 en datos de descargas adjustados para tomar en cuenta identificaciones incorrectas, y las de 2000-2004 en el muestreo de composición por especies. Las capturas palangreras de 1975-2002 son la reportadas a la CIAT por los gobiernos, y las de 2003 son predichas por el modelo con base en el nivel de esfuerzo de 2002 y estimaciones de la biomasa vulnerable a los palangres en 2003.

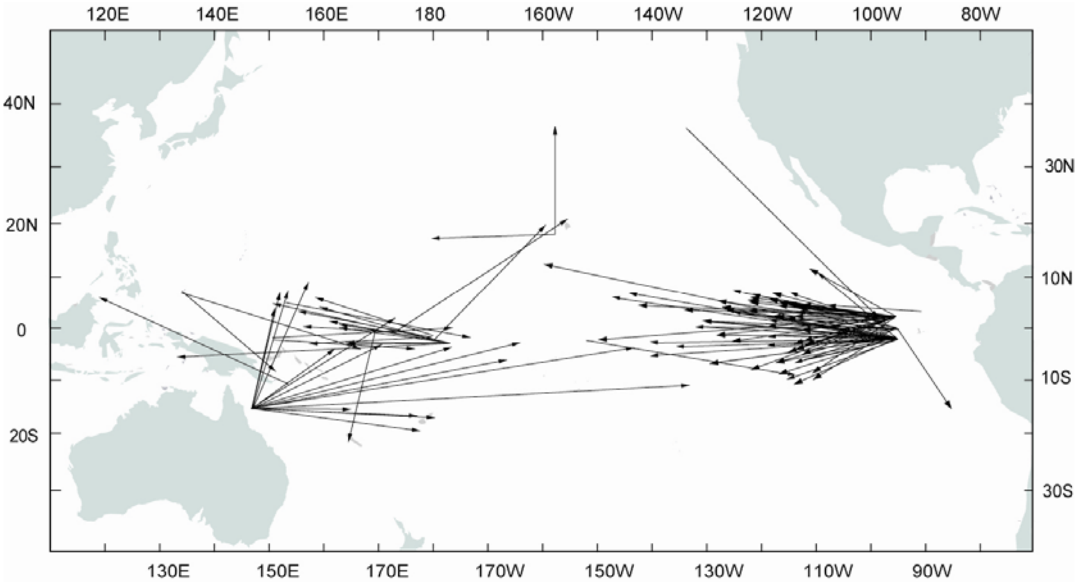


FIGURE D-2. Movements of more than 1000 nm of tagged bigeye tuna in the Pacific Ocean.
FIGURA D-2. Desplazamientos de más de 1000 mn de atunes patudo marcados en el Océano Pacífico.

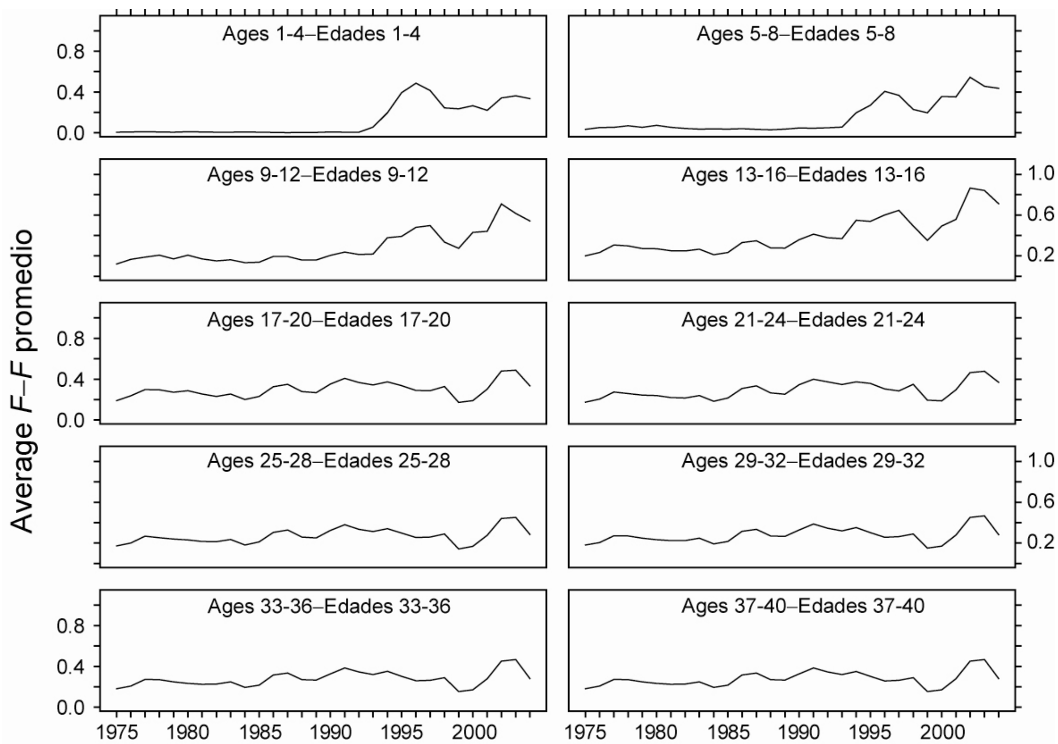


FIGURE D-3. Time series of average total annual fishing mortality on bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated in the upper-left panel is an average of the fishing mortalities that affected fish that were 1-4 quarters old.
FIGURA D-3. Series de tiempo de la mortalidad por pesca trimestral total media de atún patudo reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores trimestrales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron a peces de entre 1-4 trimestres de edad.

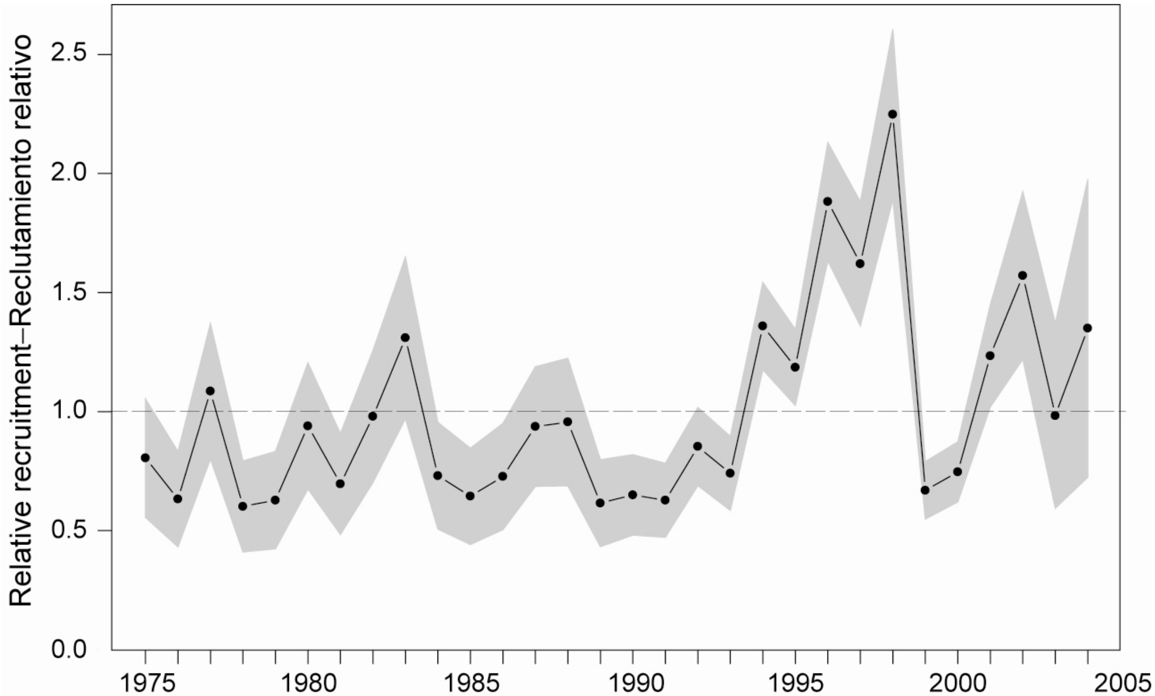


FIGURE D-4. Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded areas indicates the approximate 95% confidence intervals 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 gruesa ilustra las estimaciones de reclutamiento de verosimilitud máxima, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

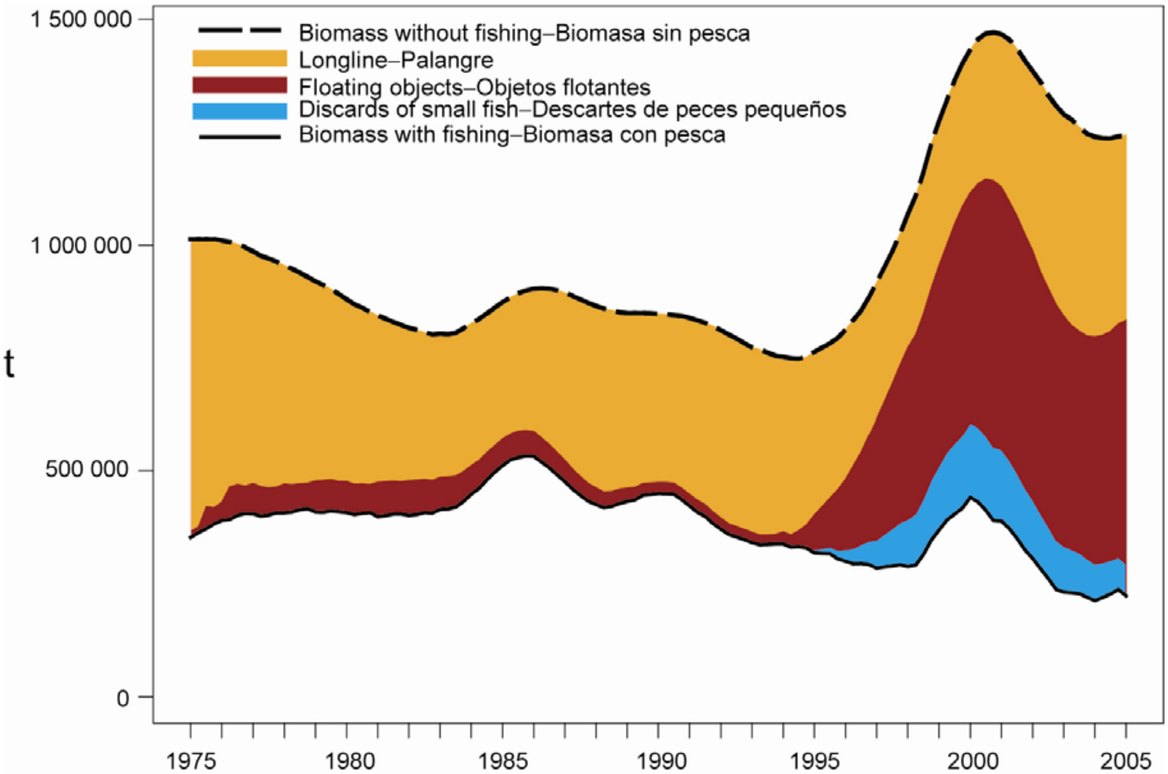


FIGURE D-5. Biomass trajectory of a simulated population of bigeye tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishery.

FIGURA D-5. Trayectoria de la biomasa de una población simulada de atún patudo no explotada durante 1975-2004 (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.

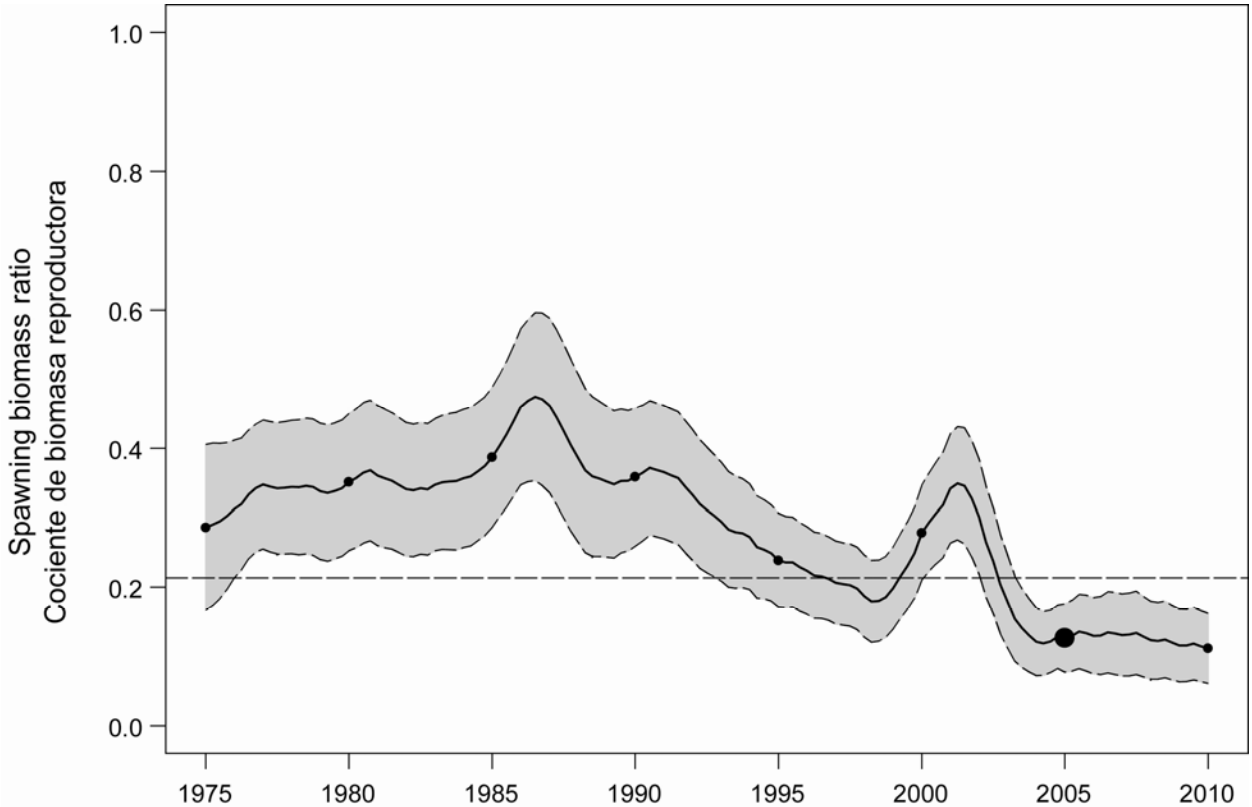


FIGURE D-6. Estimated time series of spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.21) identifies the SBR at AMSY. The solid line illustrates the maximum likelihood estimates, and the shaded areas are 95% confidence intervals around those estimates. The estimates after 2005 (the large dot) indicate the SBR predicted to occur if effort continues at the average of that observed in 2004, catchability (with effort deviates) continues at the average for 2002 and 2003 (except for the northern longline fishery, for which the data for 2001-2002 are used), and average environmental conditions occur during the next 5 years.

FIGURA D-6. Serie de tiempo estimada de los cocientes de biomasa reproductora (SBR) para el atún patudo en el OPO. La línea de trazos horizontal (en aproximadamente 0.21) identifica el SBR en RMSP. La línea sólida ilustra las estimaciones de verosimilitud máxima, y el área sombreada representa los intervalos de confianza de 95% alrededor de esas estimaciones. Las estimaciones a partir de 2005 (el punto grande) señalan el the SBR predicho si el esfuerzo continúa en el nivel observado en 2004, la capturabilidad (con desvíos de esfuerzo) continúa en el promedio de 2002 y 2003 (con excepción de la pesquería palangre del norte, para la cual se utiliza los datos de 2001-2002), y con condiciones ambientales promedio en los 5 próximos años.

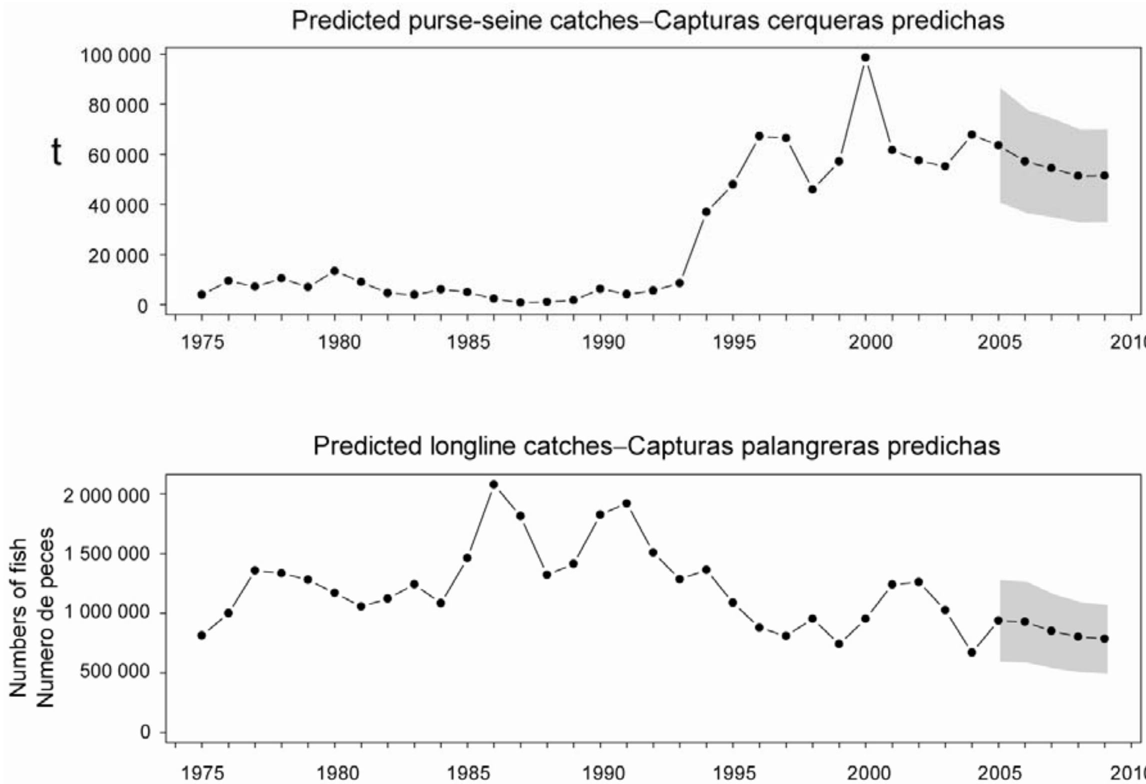


FIGURE D-7. Predicted catches of bigeye for the purse-seine and pole-and-line (upper panel) and longline (lower panel) fisheries, based on average effort for 2004 and average catchability for 2002 and 2003 (except for the northern longline fishery, for which the data for 2001-2002 are used). The shaded areas represent 95% confidence intervals for the predictions of future catches. Note that the vertical scales of the panels are different.

FIGURA D-7. Capturas predichas de atún patudo para las pesquerías de cerco y de caña (recuadro superior) y palangreras (recuadro inferior), basadas en el esfuerzo promedio de 2004 y la capturabilidad promedio de 2002 y 2003 (con excepción de la pesquería palangre del sur, para la cual se utiliza los datos de 2001-2002). Las zonas sombreadas representan intervalos de confianza de 95% para las predicciones de capturas futuras. Nótese que las escalas verticales de los recuadros son diferentes.

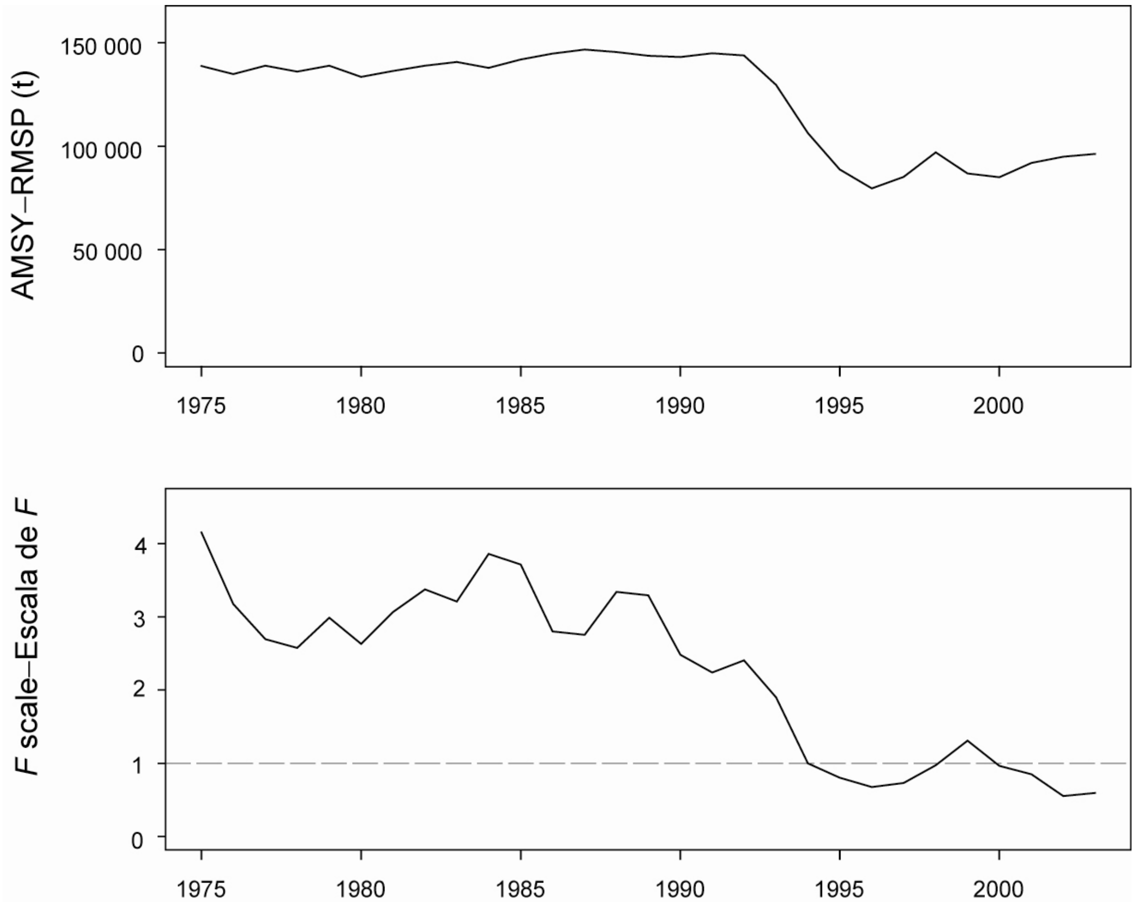


FIGURE D-8. AMSY (upper panel), 1975-2004, and the change (increase or reduction) in the effort required to produce the AMSY (lower panel), estimated separately for each year using the average age-specific fishing mortality for that year.
FIGURA D-8. RMSP (recuadro superior) y cambio (aumento o reducción) del esfuerzo necesario para producir el RMSP (recuadro inferior), estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

TABLE D-1. Estimates of the AMSY and its associated quantities for the base case assessment and the sensitivity analysis including a stock-recruitment relationship with a steepness (*h*) of 0.7.5. All analyses are based on average fishing mortality for 2002 and 2003. B_{2005}, B_{AMSY}, and B_0 are the biomass of bigeye 1+ years old at the start of 2005, at AMSY, and without fishing, respectively, and S_{2005}, S_{AMSY}, and S_0 are the female spawning biomass at the start of 2005, at AMSY, and without fishing, respectively. C_{2004} is the estimated total catch in 2004.

TABLA D-1. Estimaciones del RMSP y sus 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 2002 y 2003. B_{2005}, B_{RMSP}, y B_0 son la biomasa de patudo de edad 1+ años al principio de 2005, en RMSP, y sin pesca, respectivamente, y S_{2005}, S_{RMSP}, y S_0 son la biomasa reproductora de hembras al principio de 2005, en RMSP, y sin pesca, respectivamente. C_{2004} es la captura total estimada en 2004.

	Base case	**Steepness = 0.75**
	Caso base	**Inclinación = 0.75**
AMSY—RMSP	95572	91270
B_{AMSY}—B_{RMSP}	292504	462975
S_{AMSY}—S_{RMSP}	482	879
B_{AMSY}/B_0—B_{RMSP}/B_0	0.29	0.36
S_{AMSY}/S_0—S_{RMSP}/S_0	0.21	0.30
C_{2004}/AMSY—C_{2004}/RMSP	1.05	1.13
B_{2005}/B_{AMSY}—B_{2005}/B_{RMSP}	0.76	0.54
S_{2005}/S_{AMSY}—S_{2005}/S_{RMSP}	0.59	0.41
F multiplier—Multiplicador de *F*	0.57	0.41

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 western Pacific Ocean (WPO), but not the eastern Pacific Ocean (EPO), so it is likely that there is a single stock of bluefin in the Pacific Ocean.

Most of the catches of bluefin in the EPO are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 35°N. In recent years a considerable portion of the purse-seine catch of bluefin has been transported to holding pens, where the fish are held for fattening and later sale as sashimi-grade fish. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

Bluefin are exploited by various gears in the WPO from 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 also caught near the southeastern coast of Japan by longlining.

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

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

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

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

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

The total catches of bluefin have fluctuated considerably during the last 50 years (Figure 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.

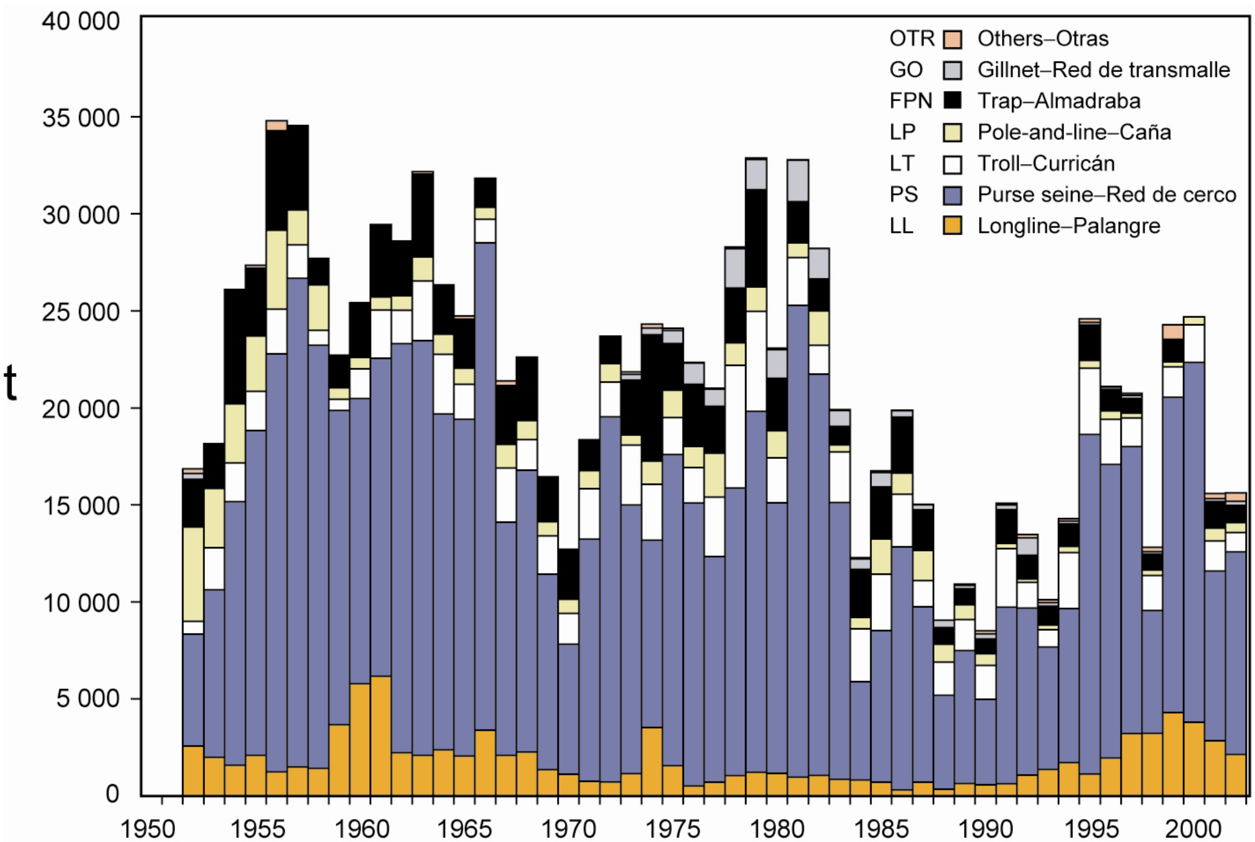


FIGURE E-1. Retained catches of Pacific bluefin, 1952-2002.
FIGURA E-1. Capturas retenidas de aleta azul del Pacífico, 1952-2002.

F. ALBACORE TUNA

Most scientists who have studied albacore in the Pacific Ocean have concluded that there are two stocks, one occurring in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longliners in most of the North and South Pacific, but not often between about 10°N and 5°S, by trollers in the eastern and central North Pacific and the central South Pacific, and by pole-and-line vessels in the western North Pacific. In the North Pacific about 62% of the fish are taken in surface fisheries that catch smaller, younger albacore, whereas only about 10% of the albacore caught in the South Pacific are taken by surface gears. Total annual catches of albacore from the North Pacific peaked in 1976 at about 125,000 t, and then declined. Catches recovered during the 1990s, and reached 121,500 t in 1999 (Figure F-1a). In the South Pacific, annual catches have ranged between about 25,000 and 55,000 t since 1980 (Figure F-1b).

The juveniles and adults are caught mostly in the Kuroshio Current, the North Pacific Transition Zone, and the California Current in the North Pacific and the Subtropical Convergence Zone in the South Pacific, but spawning occurs in tropical and subtropical waters, centering around 20ºN and 20ºS latitude. 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. The great majority are caught in waters between 15º and 19.5º C. Details of the migration remain unclear, but juvenile fish (2- to 5-year-olds) are believed to move into the eastern Pacific in the spring and early summer, returning to the western and central Pacific, perhaps annually, in the late fall and winter, and tending to remain there as they mature. It has been hypothesized that there are two subgroups of North Pacific albacore, separated at 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 the tropics, where they spawn. Recoveries of tagged fish released in areas east of 155°W were usually made at locations to the east and north of the release site, whereas those of fish released west of 155°W were usually made at locations to the west and north of the release site.

New age-structured stock assessments were presented for the South and North Pacific stocks of albacore in 2003 and 2004, respectively.

The South Pacific assessment, carried out with MULTIFAN-CL by the Secretariat for the Pacific Community, incorporated catch and effort, length-frequency, and tagging data. The stock was estimated to be well above the level that would produce the average maximum sustainable yield (AMSY), and that yield would continue to increase with further increases in effort, though the extent to which yield could increase sustainably 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.

Virtual population analyses of the North Pacific stock of albacore were carried out during the 19th North Pacific Albacore Workshop in 2004. The estimated 2004 biomass, 438,000 t (Figure F-2), was about 25% greater than that estimated for 1975, the first year of the period modeled. The estimated recruitments since 1990 have generally been greater than those of the 1980s, and the catches per unit effort for most of the surface fisheries have increased in recent years. However, longline catch rates have declined since the mid-1990s. The Workshop estimated low (0.43) and high (0.68) levels for fishing mortality (*F*) at full recruitment, and noted that if rates of *F* continue at assumed levels, it is unlikely that the spawning stock biomass (SSB) will rebuild to SSB_{AMSY} levels within a 5-year time period.

The 2005 meeting of the International Scientific Committee of the North Pacific gave the following advice:

> "Future SSB can be maintained at or above the minimum 'observed' SSB (43,000 t in 1977) with F's slightly higher than the current F range. However, the lowest 'observed' SSB estimates all occurred in late 1970's and may be the least reliable estimates of SSB. A more robust SSB threshold could be based on the lower 10th or 25th percentile of 'observed' SSB. If so done, current F should maintain SSB at or above the 10th percentile threshold but a modest reduction from current F may be needed to maintain SSB at or above the 25th percentile threshold."

The IATTC staff considers the higher level for current fishing mortality (0.68) to be more likely, based on the methods used to calculate the estimates. Furthermore, even the high estimate may be too low, given the retrospective bias shown by the model. According to North Pacific Albacore Workshop estimates, the higher fishing mortality of 0.68 implies an equilibrium spawning stock biomass at 17% of unfished levels. Projections assuming fishing mortality of 0.68, under low and high scenarios of future recruitment, suggest that the biomass may decline if current levels of fishing mortality persist.

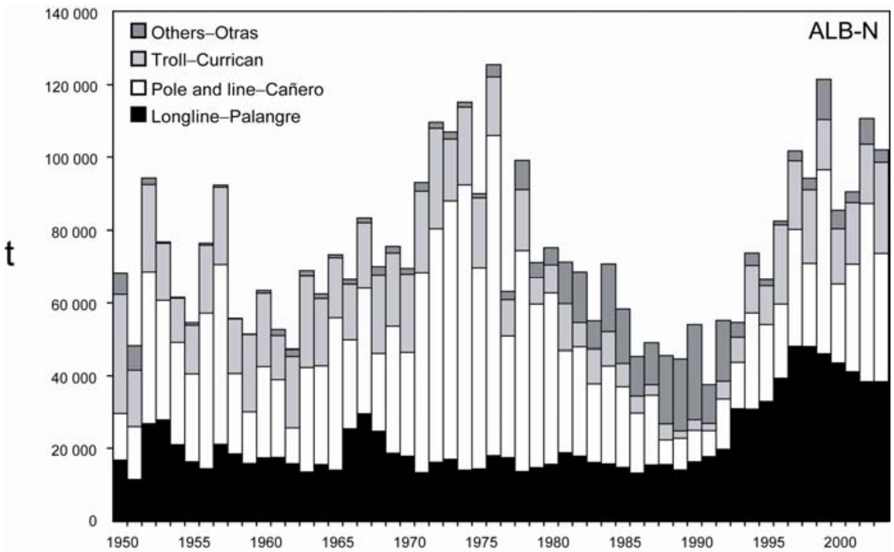


FIGURE F-1a. Retained catches of North Pacific albacore, 1950-2003.
FIGURA F-1a. Capturas retenidas de albacora del Pacífico norte, 1950-2003.

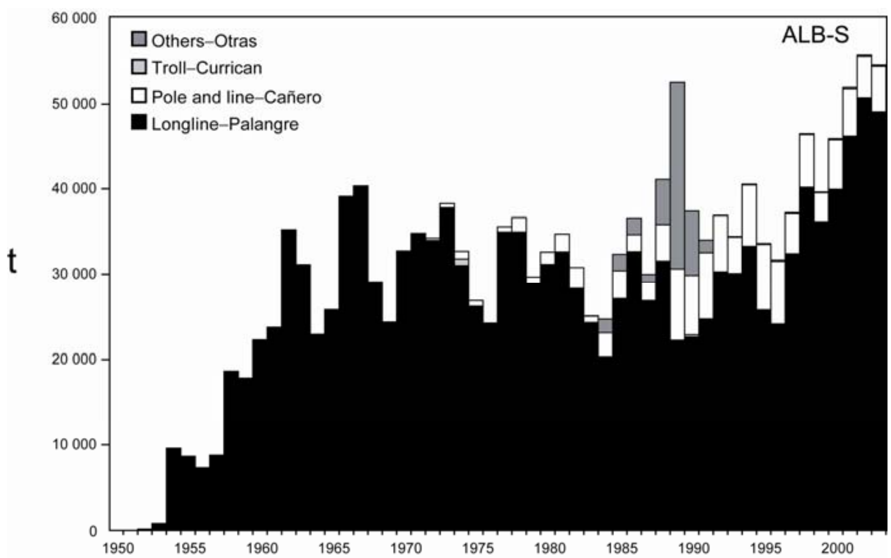


FIGURE F-1b. Retained catches of South Pacific albacore, 1950-2003.
FIGURA F-1b. Capturas retenidas de albacora del Pacífico sur, 1950-2003.

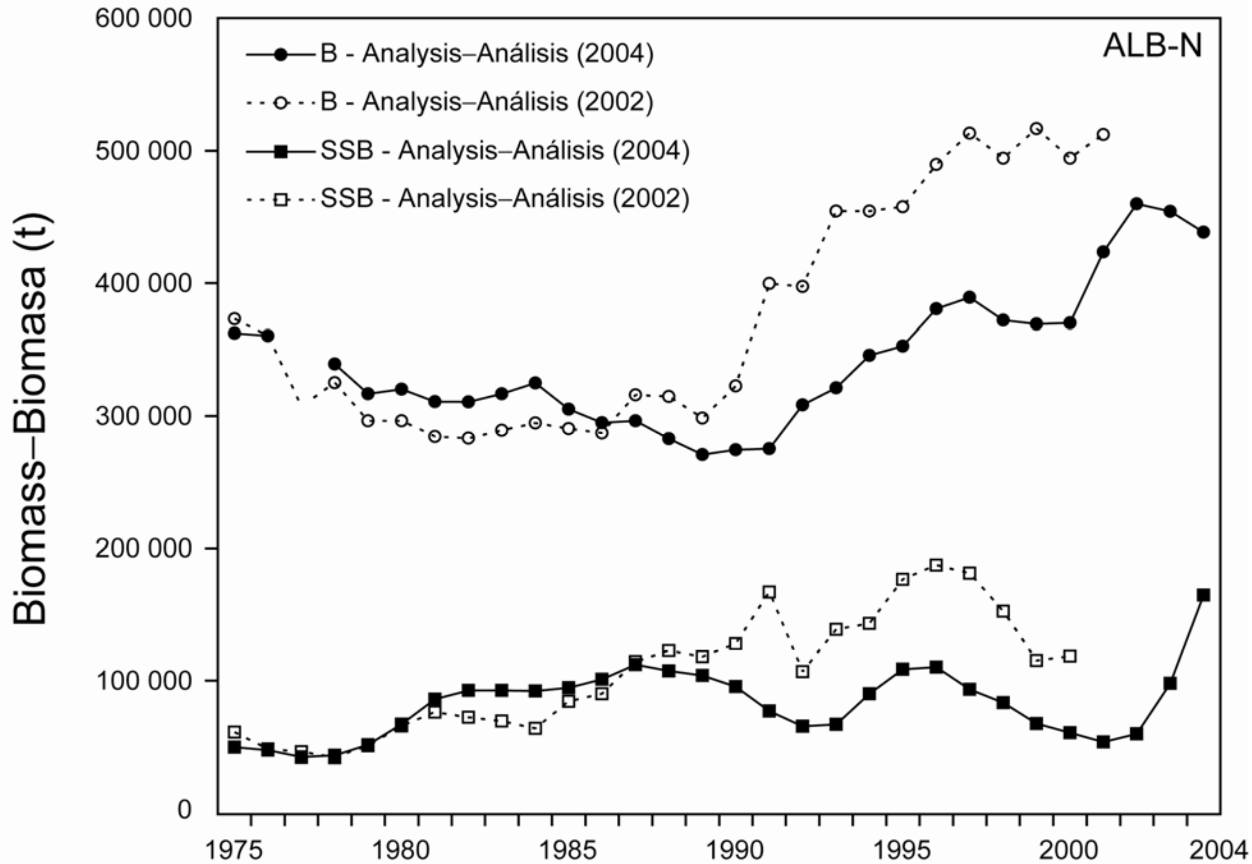


FIGURE F-2. Time series of total biomass (B) and spawning stock biomass (SSB) of North Pacific albacore tuna, in metric tons, from the North Pacific Albacore Workshop analyses in 2004 and 2002. Time series for B are based on January 1 estimates, and for SSB on estimates at the beginning of the spawning season ('mid-year').

FIGURA F-2. Serie de tiempo de la biomasa total (B) y biomasa de la población reproductora (SSB) del atún albacora del Pacífico Norte, en toneladas métricas, de los análisis de la Reunión Técnica sobre el Albacora del Pacífico Norte en 2004 y 2002. Las series de tiempo B se basan en estimaciones al 1 de enero, aquéllas de SSB en estimaciones al principio de la temporada de desove ('medio año').

G. SWORDFISH

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

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

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

It is considered, based on fisheries data, that there are two stocks of swordfish in the EPO, one with its center of distribution in the southeastern Pacific Ocean, and another with its center of distribution off California and Baja California. As well, there may be movement of a northwestern Pacific stock of swordfish into the EPO at various times. Results of genetic studies specifically undertaken to help resolve the question of stock structure are expected to be completed within the next few months.

Results of preliminary modeling with MULTIFAN-CL of a North Pacific swordfish stock in areas north of 10°N and west of 135°W indicate that in recent years the biomass level has been stable and well above 50% of the unexploited levels of stock biomass, implying that swordfish are not overexploited at current levels of fishing effort.

The standardized catch rates (CPUEs) of longline fisheries in the northern and southern regions 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 average maximum sustained yield, under reasonable assumptions of natural mortality rates, due to lack of contrast in the trends. This lack of contrast suggests that the fisheries that have been taking swordfish in these regions have not been of a magnitude sufficient to cause significant responses in the populations. Based on these considerations, and the historically stable catches, it appears that swordfish are not overfished in the northern and southern regions of the EPO.

However, there have been increases in operations of and catches (Figure G-1) from fisheries that are targeting swordfish, particularly those gillnet and longline fisheries previously noted, and the stocks should be monitored closely for changes in trends in catch and catch rates. The average annual catch during 1998-2002 for the northern region has been about 4,800 t, and for the southern region about 9,100 t. It should be noted that catches in the southern region have doubled during this period, reaching 13,300 t in 2002, which exceeded the previously-recorded high catch of 12,400 t reported in 1991. At some point it would be a normal expectation that high levels of catch maintained over a period of time will result in reductions in CPUE.

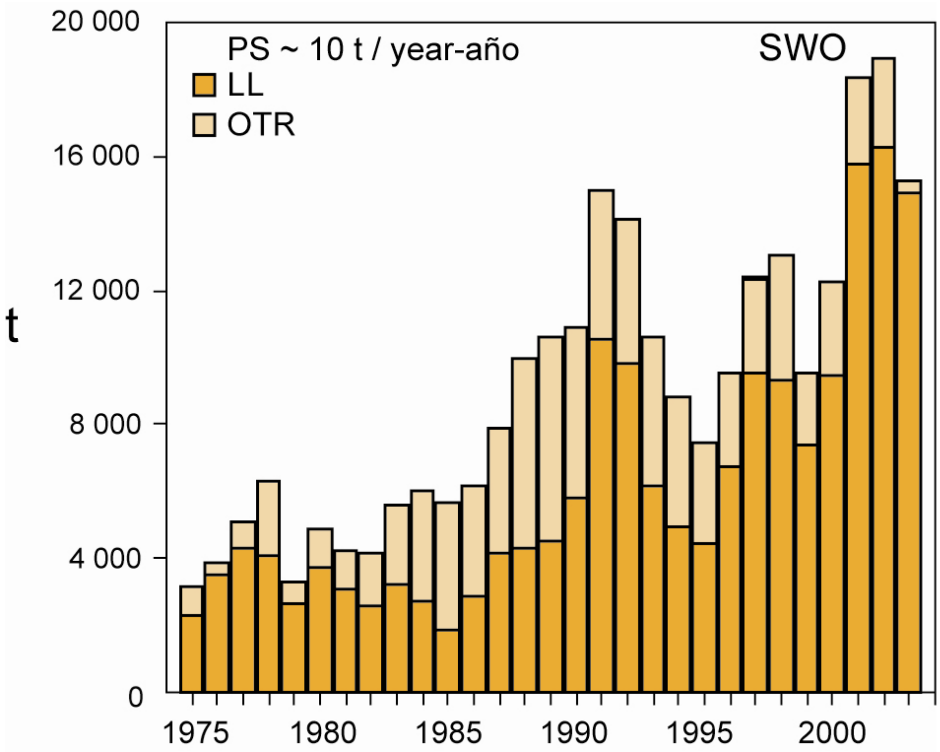


FIGURE G-1. Retained catches of swordfish in the eastern Pacific Ocean, 1975-2003, by gear type.
FIGURA G-1. Capturas retenidas de pez espada en del Océano Pacífico oriental, 1975-2003, por arte de pesca.

H. BLUE MARLIN

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

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

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

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

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

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

The fisheries in the EPO have historically captured about 10 to 18% of the total harvest of blue marlin from the Pacific Ocean, with captures in the most recent 5-year period averaging about 3,800 t, or 10% of the total harvest.

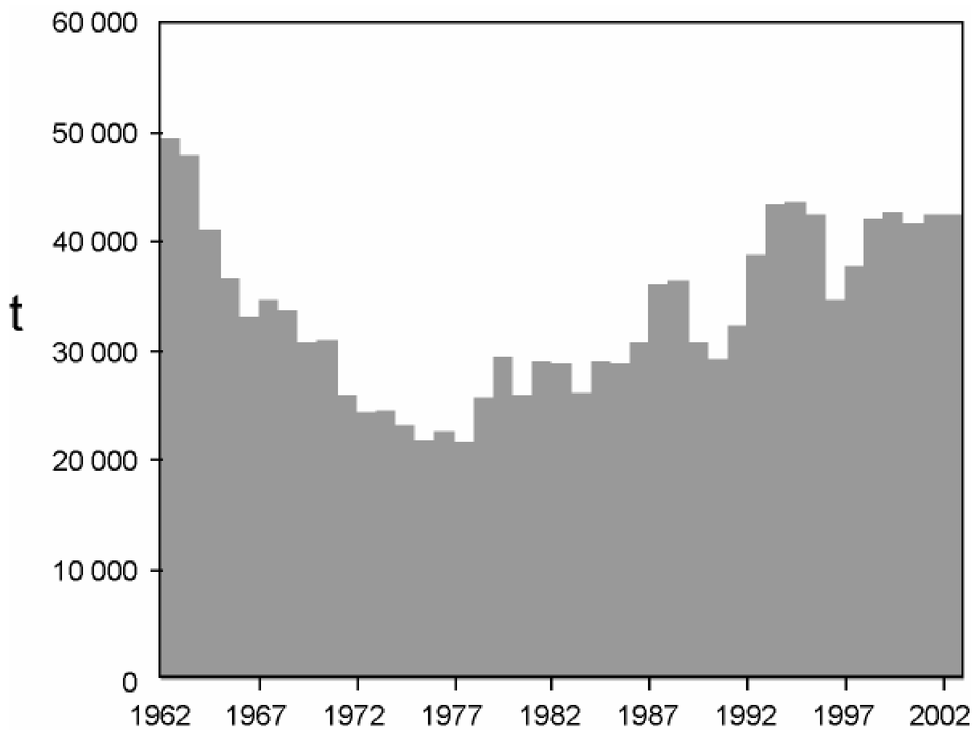


FIGURE H-1. Retained catches of blue marlin in the Pacific Ocean, 1962-2002.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, 1962-2002.

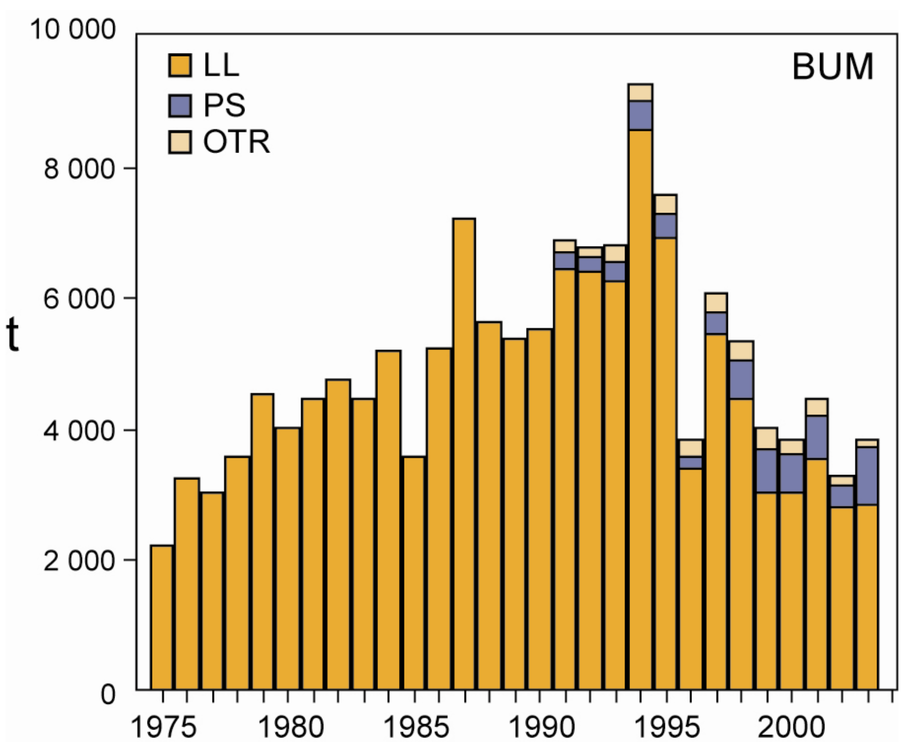


FIGURE H-2. Retained catches of blue marlin in the eastern Pacific Ocean, 1975-2003, by gear type.
FIGURA H-2. Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1975-2003, por arte de pesca.

I. STRIPED MARLIN

Striped marlin (*Tetrapturus audax*) occur throughout the Pacific Ocean between about 45°N and 45°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are caught by recreational, gillnet, and other fisheries. During recent years the greatest catches (Figure 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 central and western Pacific Ocean, so it is considered in this report that examinations of local depletions and independent assessments of the striped marlin of the EPO are meaningful. An analysis of trends in catch rates in subareas suggest that the fish in the EPO consist of one stock. Genetic studies have suggested that there are separate populations in the eastern and western South Pacific and that there may be a separate populations with centers of distribution in the regions proximate to Hawaii in the north-central Pacific and to Ecuador and to Mexico in the EPO. However, preliminary results of more recent analyses suggest that the fish in the Ecuador and Mexico region are from a single population.

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

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

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

Landings and standardized fishing effort for striped marlin decreased in the EPO from 1990-1991 through 1998, and this decline has continued, with annual catches during 2000 to 2003 between about 2,000 and 2,100 t, levels that are well below estimated AMSY harvest levels. This may result in a continued increase in the biomass of the stock in the EPO.

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

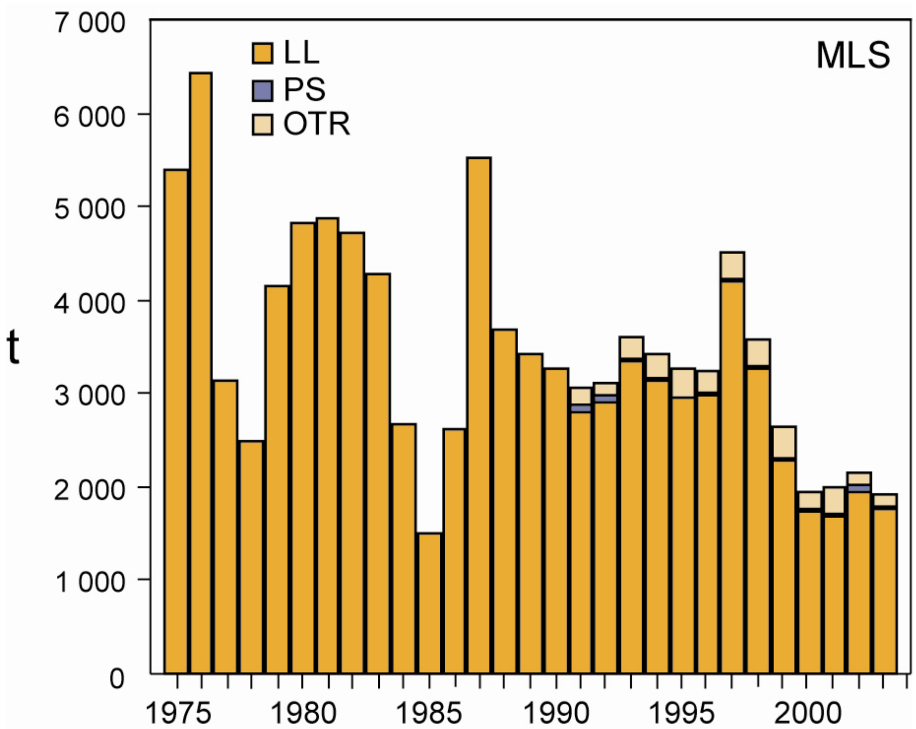


FIGURE I-1. Retained catches of striped marlin in the eastern Pacific Ocean, 1975-2003, by gear type.
FIGURA I-1. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1975-2003, por arte de pesca.

J. ECOSYSTEM CONSIDERATIONS

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

This review does not suggest objectives for the incorporation of ecosystem considerations into the management of tuna or billfish fisheries, nor any new management measures. Rather, its prime purpose is to offer the Commission the opportunity to ensure that ecosystem considerations are clearly part of its agenda.

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

In addition to reporting the catches of the principal species of tunas and billfishes, the staff has reported the bycatches of other species that are normally discarded. In this 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 t) 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 yet little information available on bycatches and discards for other fishing vessels.

5. THE IMPACT OF CATCHES

5.1. Single-species assessments

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

5.1.1. Tunas

5.1.1.a Yellowfin (*Thunnus albacares*)

Since 1984 the yellowfin stock has been close to or above the level that would provide the average maximum sustainable yield. To meet this objective, the spawning stock size must be kept above 44% of its unexploited size with the current mix of fishing methods. One estimate of the effect of this reduced stock size is that the predation by yellowfin on other parts of the ecosystem is reduced to about 30% of what it was in the absence of a fishery.

5.1.1.b Skipjack (*Katsuwonus pelamis*)

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. In 2003, the biomass was estimated to be about 60% of what it would have been in the absence of a fishery and under average conditions.

5.1.1.c Bigeye (*Thunnus obesus*)

Up to 1993 bigeye were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 30% of its unexploited size. After 1993, purse seining for tunas associated with fish-aggregating devices (FADs) took significant quantities of small and medium-sized bigeye. Currently, after several years of poor recruitment and excessive levels of fishing mortality, the stock size is estimated to be at about 13% of its unexploited size. The biomass estimated for 2005 is near the lowest since 1975, the first year included in the model.

5.1.1.d Albacore (*Thunnus alalunga*)

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. A new assessment by the North Pacific Albacore Workshop in 2004 indicated the North Pacific stock to be at about 45% of its unexploited size.

5.1.2. Billfishes

5.1.2.a Swordfish (*Xiphias gladius*)

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

5.1.2.b Blue marlin (*Makaira nigricans*)

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

5.1.2.c Striped marlin (*Tetrapturus audax*)

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

5.1.2.d Black marlin (*Makaira indica*), sailfish (*Istiophorus platypterus*), and shortbill spearfish (*Tetrapterus angustirostris*)

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

5.1.3. Summary

The estimated catches (including purse-seine discards), in metric tons, of tunas and billfishes in the EPO during 2004 are as follows.

	PS			LP	LL	OTR	Total
	OBJ	NOA	DEL				
Yellowfin tuna	25,720	103,878	141,611	1,905	2,041	1,442	276,597
Skipjack tuna	99,244	106,882	7,205	481	26	17	213,855
Bigeye tuna	65,171	3,385	0	0	39,729	6	108,290
Albacore tuna	0	106	0	0	11,509	7,676	19,291
Swordfish	1	1	1	0	1,916	45	1,964
Blue marlin	308	12	8	0	416	73	817
Striped marlin	8	4	8	0	214	33	267
Black marlin	99	8	16	0	4	0	126
Sailfish	3	19	45	0	48	87	202
Shortbill spearfish	<1	<1	<1	0	0	0	<1

5.2. 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, but after the late 1980s it decreased precipitously. Preliminary mortality estimates of dolphins in the fishery in 2004 are as follows:

Species and stock	Incidental mortality	
	number	metric tons
Offshore spotted dolphin		
Northeastern	250	14
Western/southern	248	14
Spinner dolphin		
Eastern	220	10
Whitebelly	214	10
Common dolphin		
Northern	159	13
Central	100	8
Southern	222	18
Other dolphins[1]	56	3
Total	**1,469**	**90**

[1] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: striped dolphins, 5 (0.5 t); coastal spotted dolphin, 9 (0.5 t), Central American spinner dolphin (*Stenella longirostris centroamericana*) 7 (0.3 t); rough-toothed dolphin (*Steno bredanensis*) 1 (0.2 t); unidentified dolphins, 34 (1.7 t).

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. Populations of dolphins involved in the purse-seine fishery were reduced from their unexploited levels during the 1960s and 1970s, and there is now some evidence of a slow recovery.

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

Scientists of the NMFS have made estimates of the abundances of several other species of marine mammals based on data from research cruises made between 1986 and 2000 in the EPO. The STAR 2003 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 (*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*) 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.

5.3. 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. 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 (4th meeting IATTC Working Group on Bycatch). Of these, 25 and 3,000, respectively, were dead. 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 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 local longline vessels that fish for tunas and billfishes in the EPO.

Sea turtles are occasionally caught in purse seines in the EPO tuna fishery. Most interactions occur when the turtles associate with floating objects (for the most part FADs), 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 that location. The olive Ridley turtle is, by far, the species of sea turtle taken most often by purse seiners. It is followed by the black or green sea turtles (*Chelonia agassizi*), and, very occasionally, by the loggerhead (*Caretta caretta*) and hawksbill (*Eritmochelys imbricata*) turtles. Only one leatherback mortality 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 FADs and drown. In some cases, they are entangled by the fishing gear and may be injured or killed. The estimated mortalities (in numbers) of turtles caused by large purse-seine vessels during 2004 were as follows:

	Set type		
	Floating object	**Unassociated**	**Dolphin**
Olive Ridley	6.0	3.0	2.0
Black or eastern Pacific green	0.0	0.0	0.0
Loggerhead	0.0	0.0	0.0
Hawksbill	0.0	0.0	0.0
Leatherback	0.0	0.0	0.0
Unidentified	4.0	1.9	0.0
Total	**10.0**	**4.9**	**2.0**
Average number of sets	5,083	5,699	11,783

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.

5.4. 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. Longline fisheries also take significant quantities of silky sharks, and a Pacific-wide analysis of longline and purse-seine fishing is necessary to determine the impact of fishing on the stock. Preliminary estimates of indices of relative abundance of large silky sharks based on the purse-seine data show a decreasing trend over the 1993-2003 period for each of the three types of purse-seine sets. It is not known whether this decreasing trend is due to the fisheries, changes in the environment (perhaps associated with the 1997-1998 El Niño), or other processes. The trend does not appear to be due to changes in the density of floating objects.

A stock assessment for blue sharks (*Prionace glauca*) in the North Pacific has been conducted by the NMFS Honolulu Laboratory and the NRIFSF in Shimizu, Japan. Preliminary results provided a range of plausible values for maximum sustainable yield (MSY) of 1.8 to nearly 4 times the current catch of blue shark per year. This work indicates that under the 2001 fishing regime in the North Pacific, the blue shark population appears to be in no danger of collapse.

The discards (in metric tons) of sharks and other large fishes in the EPO during 2004, 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		
	Floating object	**Unassociated**	**Dolphin**
Dorado (*Coryphaena* spp.)	2,246	26	2
Wahoo (*Acanthocybium solandri)*	1,778	5	1
Rainbow runner (*Elagatis bipinnulata*) and yellowtail (*Seriola lalandi*)	191	22	<1
Sharks	432	156	169
Rays (Mobulidae and Dasyatidae)	28	157	51
Billfishes	420	44	78
Other large fishes	5	<1	<1

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

The catch rates of 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, manta rays (Mobulidae), and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets and then floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch figures. The estimated numbers of purse-seine sets of each type in the EPO during 1987-2004 are shown in Table A-8.

6. OTHER ECOSYSTEM COMPONENTS

6.1. Seabirds

There are approximately 100 species of seabirds in the tropical EPO. Some seabirds associate with subsurface predators, such as fishes (especially tunas) and marine mammals. Subsurface predators often drive prey to the surface to trap them against the air-water interface, where the prey become available to the birds. Most species of seabirds take prey within a half meter of the sea surface or in the air (flyingfishes (Exocoetidae) and flying squid (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 at the surface.

Seabirds are affected by the variability of the ocean environment. During the 1982-1983 El Niño, 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 events. 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 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.

Some seabirds are susceptible to being caught on baited hooks in the pelagic longline fisheries. Data on the bycatch of black-footed albatross (*Phoebastria nigripes*) by the U.S. pelagic longline fishery in the central North Pacific Ocean have been analyzed, but comparable data for the longline fisheries in the EPO were not available. In an externally-funded study, the IATTC staff is currently investigating the population status of the black-footed albatross in the entire North Pacific, taking into account the effects of fisheries bycatch.

6.2. Forage

The forage taxa occupying the middle trophic levels in the EPO are obviously an important component of the ecosystem, providing a link between primary production at the base of the food web and the upper-trophic-level predators, such as tunas and billfishes. The indirect effects of environmental variability are transmitted to the upper trophic levels through the forage taxa. Very little is known, however, about fluctuations in abundance of the large variety of prey species in the EPO. Scientists from the NMFS have recorded data on the distributions and abundances of common prey groups, including lanternfishes (Myctophidae), flyingfishes, 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. 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 cruises, and are currently being analyzed.

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 6), 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 local 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. The estimated discards, in metric tons, of small fishes by large purse-seine vessels with observers aboard in the EPO during 2004 were as follows:

	Set type		
	Floating object	**Unassociated**	**Dolphin**
Triggerfishes (Balistidae) and filefishes (Monacanthidae)	255	2	1
Other small fishes	17	1	<1
Frigate and bullet tunas (*Auxis* spp.)	819	156	24

6.3. 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 of 1982-1983, especially west of 120°W. Similarly, surface concentrations of chlorophyll decreased during the 1986-1987 El Niño and increased during the 1988 La Niña due to changes in nutrient availability.

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

7. TROPHIC INTERACTIONS

Tunas and billfishes are wide-ranging, generalist predators with high energy requirements, and as such, are key components of pelagic ecosystems. 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 a reliable understanding of the trophic structure in open-ocean ecosystems, and the natural variability forced by the environment.

Knowledge of the trophic ecology of predator fishes has historically derived from diet studies. 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*). The most-common prey item for yellowfin tuna caught by purse-seine offshore are frigate and bullet, squids and argonauts (cephalopods), and flyingfishes and other epipelagic fishes. Bigeye tuna feed at greater depths than yellowfin and skipjack, and utilize primarily cephalopods and mesopelagic fishes. The most important prey of skipjack are euphausiid crustaceans. Recently, diet studies have become focused on understanding resource partitioning among the predator communities, comprising tunas, sharks, billfishes, dorado, wahoo, rainbow runner, and others, captured by purse-seine. In general, considerable resource partitioning occurs among the components of these communities.

Stomach contents, however, provide only a relative snapshot of the most recent meal at the time of day an animal is captured, and under the conditions required for its capture. A more-recent method utilizes stable isotopes of carbon and nitrogen to investigate trophic relations. Stable carbon and nitrogen isotopes 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. This technology is now being applied in the pelagic EPO, and preliminary results suggest that potentially important components of the food web may not be represented in diet analyses of the principal predators.

8. PHYSICAL ENVIRONMENT[2]

Environmental conditions affect marine ecosystems, the dynamics and catchability of tuna and billfish stocks, and the operations 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 catch rates have declined. Warm sea-surface temperatures (SSTs) can also cause these mobile fishes to move to more favorable habitat.

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 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 weak trade winds, a deep thermocline, and abnormally high SSTs in the equatorial EPO. El Niño's opposite phase, often called La Niña, is characterized by strong trade winds, a shallow thermocline, and low 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, 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 a short time because their life histories are adapted to respond to a variable habitat.

Variability on a decadal scale (*i.e.* 10 to 30 years) also affects the EPO. In the late 1970s in the North Pacific, there was a major shift in physical and biological states. 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

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[2] 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.

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 have indicated that the yellowfin tuna population in the EPO has experienced two different recruitment regimes (1975-1984 and 1985-present). The yellowfin population has been in a high-recruitment regime, which produced greater biomass levels, for approximately the last 16 years. The increased recruitment 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 SSTs and thermocline slope that are similar to those caused by ENSO, but on longer time scales.

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).

9. AGGREGATE INDICATORS

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

Food web diagrams are useful for representing the structure and flows of ecosystems. Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms and to facilitate estimates of energy or mass flow through communities. 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, and seabirds occupy slightly lower TLs. Smaller epipelagic fishes (*e.g*. *Auxis* spp. and flyingfishes), cephalopods, and mesopelagic fishes are the principal forage of many of the upper-level predators in the ecosystem. Small fishes and crustaceans prey on two zooplankton groups, and the herbivorous microzooplankton (TL = 2) feed on the producers, phytoplankton and bacteria (TL = 1).

In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as the ecosystem's apex predators. Over time, fishing can cause the overall size composition of the catch to decline, and, in general, TLs of smaller organisms are lower than those of larger organisms. The mean trophic level of the organisms taken by a fishery is a potentially useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. There has been increasing attention to analyzing the mean TL of fisheries catches and discards since a study demonstrated that, according to FAO landings statistics, the mean TL of the fishes and invertebrates landed globally had declined from 1950 to 1994. Some ecosystems, however, have changed in the other direction, from low TL communities to higher TL communities. Given the potential utility of this approach, TLs were estimated for a time series of annual catches and discards from 1993 to 2003 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The estimates were made by applying the TLs 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 of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year (Figure J-2: Average PS+LP). The TL of the floating-object sets varied more than those of the other fisheries, due to the interannual variability in the sizes of the tunas caught and the species compositions of the bycatches in those sets.

TLs were also estimated separately for the time series of retained and discarded catches by year for the purse-seine fishery from 1993 to 2003 (Figure J-3). The TLs of the retained catches were quite stable from year to year, while the TLs of the discarded catches varied considerably. The greatest variation occurred for sets on unassociated fish. A low TL of the discarded catches by sets on unassociated fish in 1998 was due to increased bycatches of rays, which feed on plankton and other small animals that occupy low TLs. From 1998 to 2001, the discarded catches of rays gradually declined and those of large sharks increased, resulting in a gradually increasing TL of the discarded catches over that interval. To a lesser degree, the average TLs of the discarded catches of sets on floating objects also increased from 1998 to 2001. That increase was due primarily to increasing bycatches of large wahoo and small dorado.

10. ECOSYSTEM MODELING

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

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

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

11. ACTIONS BY THE IATTC AND AIDCP ADDRESSING ECOSYSTEM CONSIDERATIONS

Both the IATTC and the Agreement on the International Dolphin Conservation Program (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:

11.1. 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 mortality of each stock of dolphins has been limited to levels that are insignificant relative to stock sizes.

11.2. Sea turtles

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

b. At its 70th meeting 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 72nd meeting of the IATTC in June 2004. The resolution includes requirements for data collection, mitigation measures, industry education, capacity building and reporting.

c. Resolution C-04-05, adopted at the 72nd meeting of the IATTC in June 2004, 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 directs the Director to study and formulate recommendations regarding the design of FADs, particularly the use of netting attached underwater to FADs.

d. In response to a request made by the Subsecretaría de Recursos Pesqueros of Ecuador, the IATTC began a program, supported by the World Wildlife Fund and the United States, to mitigate the incidental capture of sea turtles, to reduce the mortality of sea turtles due to longline fishing, and to compare the catch rates of tunas, billfishes, and dorado using circle and J hooks of two sizes. Circle hooks do not hook as many turtles as the J hooks currently used in the longline fishery, and the chance of serious injury to the sea turtles that bite the 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. In 2004, observers recorded data on more than 60 fishing trips of the vessels that are testing the different hooks. In addition, workshops and presentations were conducted by IATTC staff and others in Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico, Panama, and Peru.

11.3. Other species

a. At its 66th meeting 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 at the 72nd meeting of the IATTC in June 2004, directs 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 determine the survival rates of released billfishes, sharks, and rays.

11.4. All species

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

12. 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.

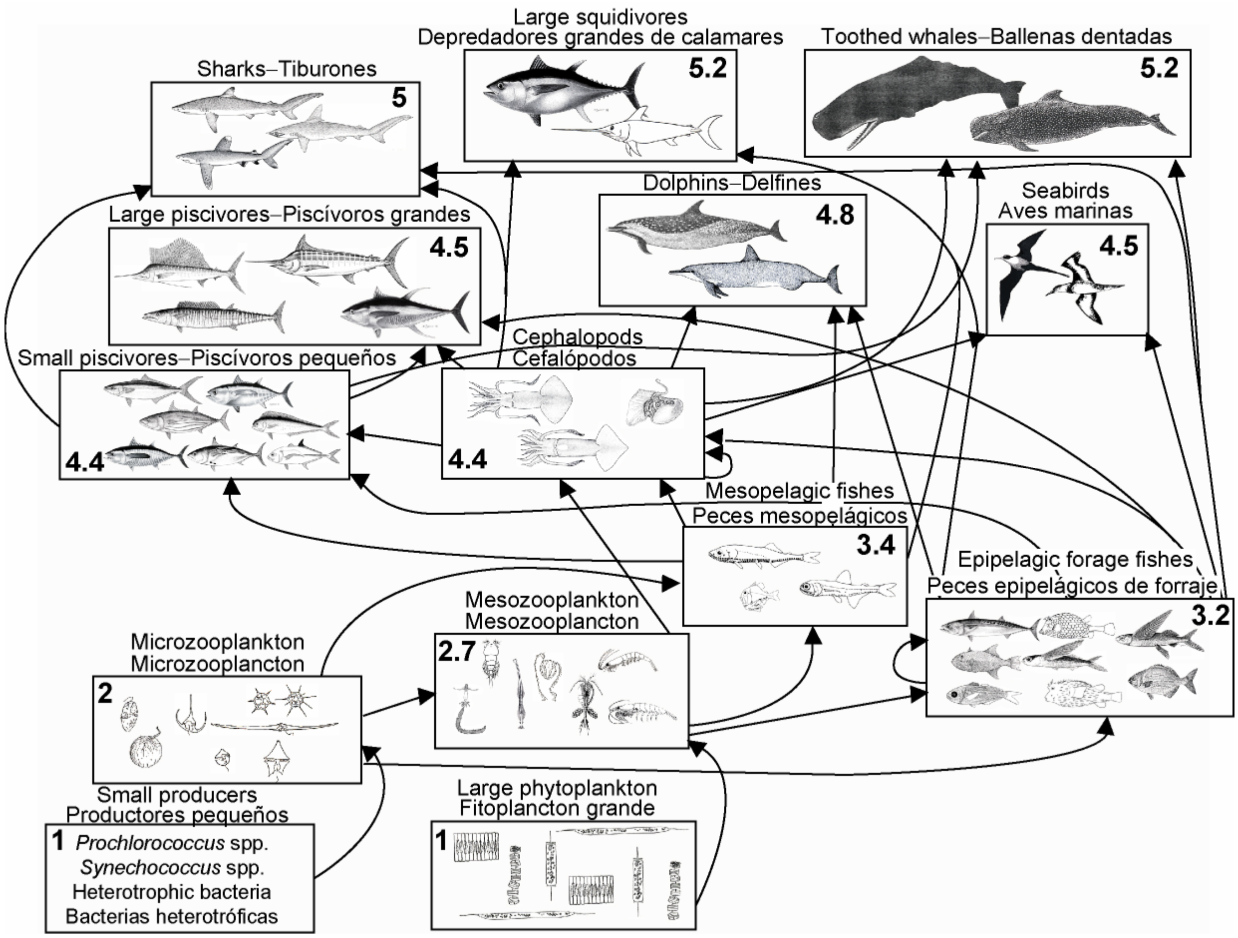

FIGURE J-1. Simplified food-web diagram of the pelagic ecosystem in the tropical eastern Pacific Ocean. The numbers inside the boxes indicate the approximate trophic levels of each group.
FIGURA J-1. Diagrama simplificado de la red trófica del ecosistema pelágico en el Océano Pacífico oriental tropical.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

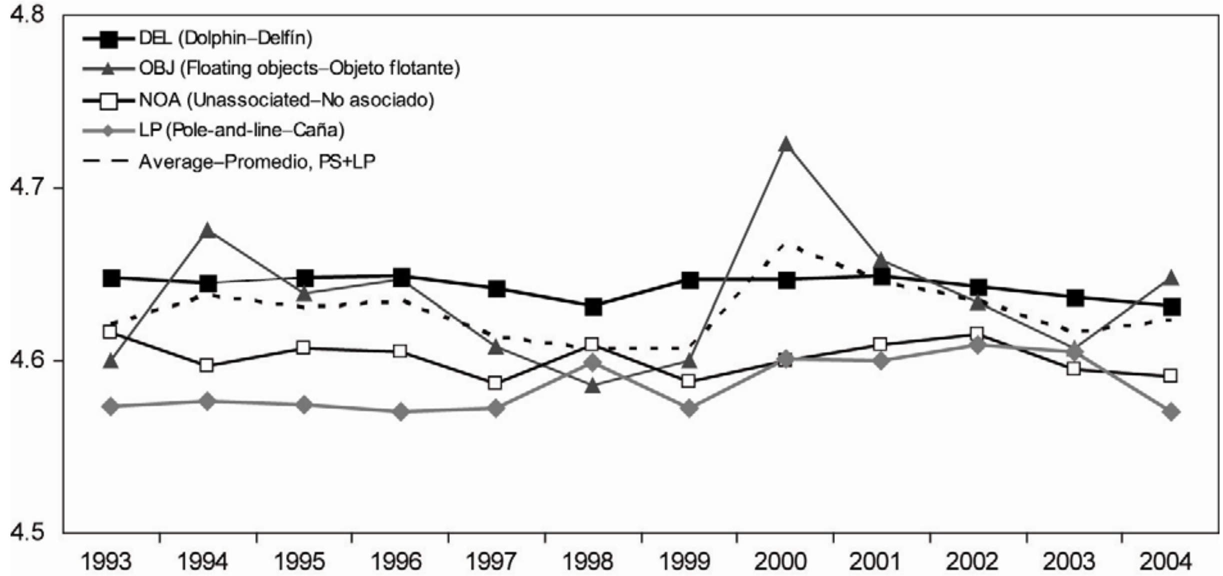

FIGURE J-2. Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine and pole-and-line fisheries in the tropical eastern Pacific Ocean.
FIGURA J-2. Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de las pesquerías cerquera y cañera en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

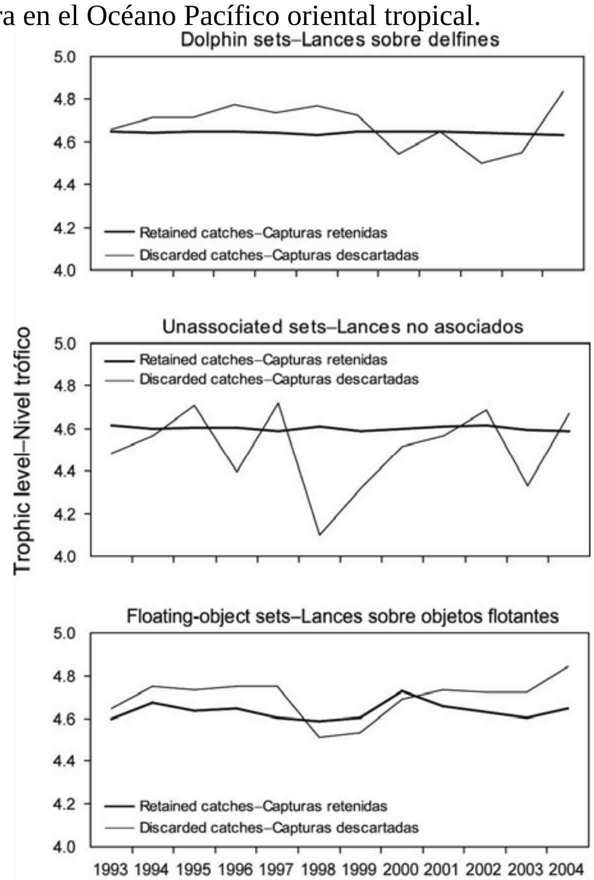

FIGURE J-3. Trophic level estimates of the retained catches and discarded catches by purse-seine fishing modes in the tropical eastern Pacific Ocean.
FIGURA J-3. Estimaciones del nivel trófico de las capturas retenidas y descartadas por modalidad de pesca cerquera en el Océano Pacífico oriental tropical.