SCIENTIFIC COMMITTEE
SIXTH REGULAR SESSION

Nuku'alofa, Tonga
10-19 August 2010

THE FISHERY FOR THE MAJOR STOCKS OF TUNAS IN THE EASTERN PACIFIC OCEAN IN 2009

WCPFC-SC6-2010/GN-WP-2

IATTC[1]

[1] Inter-American Tropical Tuna Commission, La Jolla, USA.

INTER-AMERICAN TROPICAL TUNA COMMISSION

80TH MEETING

LA JOLLA, CALIFORNIA (USA)
8-12 JUNE 2009

DOCUMENT IATTC-80-05

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INTRODUCTION

This report provides a summary of the fishery for tunas in the eastern Pacific Ocean (EPO), assessments of the major stocks of tunas and billfishes that are exploited in the fishery, and an evaluation of the pelagic ecosystem in the EPO, in 2008.

The report is based on data available to the IATTC staff in April 2009. The section on bluefin (E) and the three sections on billfishes (G, H, I) are essentially the same as the corresponding sections of IATTC Fishery Status Report 6, published in 2008, except for updates of the figures.

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

Species:

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

[1] not elsewhere included

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

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

Ocean areas:	
EPO	Eastern Pacific Ocean
WCPO	Western and Central Pacific Ocean

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

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

[2] Used to group known gear types

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

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

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

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

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

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

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

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

Estimating the total catch of a species of fish is difficult, for various reasons. Some fish are discarded at sea, and the data for some gear types are incomplete. Data for fish discarded at sea by purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993, which allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the retained catch) are based principally on data from unloadings. Beginning with Fishery Status Report 3, which reports on the fishery in 2004, the unloading data for purse-seine and pole-and-line vessels have been adjusted, based on the species composition estimates for yellowfin, skipjack, and bigeye tunas. The current species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-2008 are adjusted, based on estimates obtained for each year, by flag. The catch data for the previous years were adjusted by applying the average ratio by species from the 2000-2004 estimates, by flag, and summing over all flags. This has tended to increase the estimated catches of bigeye and decrease those of yellowfin and/or skipjack. These adjustments are all preliminary, and may be improved in the future. All of the purse-seine and pole-and-line data for 2008 are preliminary.

Data on the retained catches of most of the larger longline vessels are obtained from the governments of the nations that fish for tunas in the EPO. Longline vessels, particularly the larger ones, direct their effort primarily at bigeye, yellowfin, albacore, or swordfish. Data from smaller longliners, artisanal vessels, and other vessels that fish for tunas, billfishes, dorado, and sharks in the EPO were gathered either directly from the governments, from logbooks, or from reports published by the governments. Data for the western and central Pacific Ocean (WCPO) were provided by the Ocean Fisheries Programme of the Secretariat of the Pacific Community (SPC). All data for catches in the EPO by longlines and other gears for 2007 and 2008 are preliminary.

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

Estimates of the annual retained and discarded catches of tunas and other species taken by tuna-fishing vessels in the EPO during 1979-2008 are shown in Table A-2. The catches of tunas and bonitos by all gears during 2004-2008 by gear and flag, are shown in Tables A-3a-e, and the purse-seine and pole-and-line catches of tunas and bonitos during 2007-2008 are summarized by flag in Tables A-4a and A-4b. There were no restrictions on fishing for tunas in the EPO during 1988-1997, but the catches of most species have been affected by restrictions on fishing during some or all of the last six months of 1998-2008. Furthermore, regulations placed on purse-seine vessels directing their effort at tunas associated with dolphins have affected the way these vessels operate, especially since the late 1980s, as discussed in Section 3.

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

1.1. Catches by species

1.1.1. Yellowfin tuna

The annual catches of yellowfin during 1979-2008 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased during this period. In the EPO, the El Niño event of 1982-1983 led to a reduction in the catches in those years, whereas the catches in the WCPO were apparently not affected. Although the El Niño episode of 1997-1998 was greater in scope, it did not have the same effect on the yellowfin catches in the EPO. The catch of yellowfin in the EPO, in 2002, 444 thousand t, was the greatest on record, but in 2004, 2005, 2006 and 2007 it decreased substantially, and the catch during 2008, 188 thousand t, was greater than the catches in 2006 and 2007, but less than the catches during 1985-2005. In the WCPO, the catches of yellowfin reached 353 thousand t in 1990, peaked at 457 thousand t in 1998, and remained high through 2003; they fell to 370 thousand t in 2004, increased in 2005 to 436 thousand t, and in 2006 and 2007 to 437 and 433 thousand t, respectively.

The annual retained catches of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1979-2008 are shown in Table A-2a. The average annual retained catch during 1993-2007 was 267 thousand t (range: 167 to 413 thousand t). The preliminary estimate of the retained catch in 2008, 187 thousand t, was 9% greater than that of 2007, but 30% less than the average for 1993-2007. The average amount of yellowfin discarded at sea during 1993-2007 was about 2% of the total purse-seine catch (retained catch plus discards) of yellowfin (range: 1 to 3%) (Table A-2a).

The annual retained catches of yellowfin in the EPO by longliners during 1979-2008 are shown in Table A-2a. During 1993-2007 they remained relatively stable, averaging about 19 thousand t (range: 8 to 30 thousand t), or about 7% of the total retained catches of yellowfin. Yellowfin are also caught by recreational vessels, as incidental catch in gillnets, and by artisanal fisheries. Estimates of these catches are shown in Table A-2a, under "Other gears" (OTR); during 1993-2007 they averaged about 1 thousand t.

1.1.2. Skipjack tuna

The annual catches of skipjack during 1979-2008 are shown in Table A-1. Most of the skipjack catch in the Pacific Ocean is taken in the WCPO. The greatest reported catch in the WCPO, about 1.7 million t, occurred in 2007, and the greatest total catch in the EPO, 311 thousand t, occurred in 2006.

The annual retained catches of skipjack in the EPO by purse-seine and pole-and-line vessels during 1979-2008 are shown in Table A-2a. During 1993-2007 the annual retained catch averaged 181 thousand t (range 73 to 298 thousand t). The preliminary estimate of the retained catch in 2008, 296 thousand t, is 64% greater than the average for 1993-2007, and 1% less than the previous record-high retained catch of 2006. The average amount of skipjack discarded at sea during 1993-2007 was about 11% of the total catch of skipjack (range: 3 to 20%) (Table A-2a).

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

1.1.3. Bigeye tuna

The annual catches of bigeye during 1979-2008 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased, but with considerable fluctuation. The catches in the EPO reached 105 thousand t in 1986, and have fluctuated between about 73 and 148 thousand t since then, with the greatest catch in 2000. In the WCPO the catches of bigeye increased to more than 77 thousand t during the late 1970s, decreased during the 1980s, and then increased, with lesser fluctuations, until 1999, when the catches reached more than 115 thousand t. Catches of bigeye in the WCPO increased significantly in 2004 to 146 thousand t. In 2005, 2006 and 2007 the catches of bigeye in the WCPO were 130, 134, and 138 thousand t, respectively.

Prior to 1994, the average annual retained catch of bigeye taken by purse-seine vessels in the EPO was about 8 thousand t (range 1 to 22 thousand t) (Table A-2a). Following the development of fish-aggregating devices (FADs), placed in the water by fishermen to aggregate tunas, the annual retained catches of bigeye increased from 35 thousand t in 1994 to between 44 and 95 thousand t during 1995-2007. A preliminary estimate of the retained catch in the EPO in 2008 is 76 thousand t. The average amount of bigeye discarded at sea during 1993-2007 was about 5% of the purse-seine catch of the species (range: 2 to 9%). Small amounts of bigeye have been caught in some years by pole-and-line vessels, as shown in Table A-2a.

During 1979-1993, prior to the increased use of FADs and the resulting greater catches of bigeye by purse-seine vessels, the longline catches of bigeye in the EPO ranged from 46 to 104 thousand t (average: 74 thousand t) about 89%, on average, of the retained catches of this species from the EPO. During 1994-2007 the annual retained catches of bigeye by the longline fisheries ranged from about 31 to 74 thousand t (average: 51 thousand t), an average of 45% of the total catch of bigeye in the EPO (Table A-2a). The preliminary estimate of the longline catch in the EPO in 2008 is 19 thousand t (Table A-2a).

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

1.1.4. Bluefin tuna

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

The catches of Pacific bluefin in the EPO during 1979-2008, by gear, are shown in Table A-2. During 1993-2007 the annual retained catch of bluefin from the EPO by purse-seine and pole-and-line vessels averaged 3,700 t (range 600 t to 10 thousand t). The preliminary estimate of the retained catch of bluefin in 2008, 4,200 t, is 500 t greater than the average for 1993-2007. Small amounts of bluefin are discarded at sea by purse-seine vessels (Table A-2a).

1.1.5. Albacore tuna

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

1.1.6. Other tunas and tuna-like species

While yellowfin, skipjack, and bigeye tunas comprise the most significant portion of the retained catches of the purse-seine and pole-and-line fleets in the EPO, other tunas and tuna-like species, such as black skipjack, bonito, wahoo, and frigate and bullet tunas, contribute to the overall harvest in this area. The estimated annual retained and discarded catches of these species during 1979-2008 are presented in Table A-2a. The catches reported in the unidentified tunas category (TUN) in Table A-2a contain some catches reported by species (frigate or bullet tunas) along with the unidentified tunas. The total retained catch of these other species by these fisheries was about 11 thousand t in 2008, which is greater than the 1993-2007 annual average retained catch of about 4 thousand t (range: 500 t to 19 thousand t).

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

1.1.7. Billfishes

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

Swordfish are caught in the EPO with large-scale and artisanal longline gear, gillnets, harpoons, and occasionally with recreational gear. The average annual longline catch of swordfish during 1993-2007 was 10 thousand t, but during 2001-2004 was about 17 thousand t. It is not clear whether this is due to increased abundance of swordfish or increased effort directed toward that species.

Other billfishes are caught with large-scale and artisanal longline gear and recreational gear. The average annual longline catches of blue marlin and striped marlin during 1993-2007 were about 5 thousand and 3 thousand t, respectively. Smaller amounts of other billfishes are taken by longline.

Unfortunately, little information is available on the recreational catches of billfishes, but they are believed to be substantially less than the commercial catches for all species.

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

1.1.8. Other species

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

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

1.2. Distributions of the catches of tunas

1.2.1. Purse-seine catches

The average annual distributions of the purse-seine catches of yellowfin, skipjack, and bigeye, by set type, in the EPO during 1998-2007, are shown in Figures A-1a, A-2a, and A-3a, and preliminary estimates for 2008 are shown in Figures A-1b, A-2b, and A-3b. The catch of yellowfin in 2008, as in 2006 and 2007, was significantly less than the average of 1998-2007. Yellowfin catches from sets associated with dolphins in the Northern areas off Mexico and Central America have been significantly lower for the past several years. The yellowfin catches in the Equatorial region off South America decreased in 2008, as they did in 2007. The skipjack catch in 2008 was greater than the average of 1998-2007. Significant catches of skipjack were taken in unassociated sets around the Galapagos Islands and in the nearshore areas off Ecuador and Peru. Greater catches of skipjack were also observed in floating-object sets in the offshore areas between 0° and 10°S and around 140°W to 150°W. The bigeye catch in 2008 was greater than that of 2007, and was also greater than the 1998-2007 average. Bigeye are not often caught north of about 7°N, and the catches of bigeye have decreased in the inshore areas off South America for several years. With the development of the fishery for tunas associated with FADs, the relative importance of the inshore areas has decreased, while that of the offshore areas has increased. Most of the bigeye catches are taken in sets on FADs between 5°N and 5°S.

1.2.2. Longline catches

Data on the spatial and temporal distributions of the catches in the EPO by the distant-water longline fleets of China, Chinese Taipei, French Polynesia, Japan, the Republic of Korea, Spain, the United States, and Vanuatu are maintained in databases of the IATTC. Bigeye and yellowfin tunas make up the majority of the catches by most of these vessels. The distributions of the catches of bigeye and yellowfin tunas in the Pacific Ocean by Japanese, Korean, and Chinese Taipei longline vessels during 2003-2007 are shown in Figure A-4. Data for the Japanese longline fishery in the EPO during 1956-2003 are available in IATTC Bulletins describing that fishery.

1.3. Size compositions of the catches of tunas

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

Length-frequency samples are the basic source of data used for estimating the size and age compositions of the various species of fish in the landings. This information is necessary to obtain age-structured estimates of the populations for various purposes, including the integrated modeling that the staff has employed during the last several years. The results of such studies have been described in several IATTC Bulletins, in its Annual Reports for 1954-2002, and in its Stock Assessment Reports.

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

The methods for sampling the catches of tunas are described in the IATTC Annual Report for 2000 and in IATTC Stock Assessment Reports 2 and 4. Briefly, the fish in a well of a purse-seine or pole-and-line vessel are selected for sampling only if all the fish in the well were caught during the same calendar month, in the same type of set (floating-object, unassociated school, or dolphin), and in the same sampling area. These data are then categorized by fishery (Figure A-5), based on the staff's most recent stock assessments.

Data for fish caught during the 2003-2008 period are presented in this report. Two sets of length-frequency histograms are presented for each species, except bluefin and black skipjack; the first shows the data by stratum (gear type, set type, and area) for 2008, and the second shows the combined data for each year of the 2003-2008 period. For bluefin, the histograms show the 2003-2008 catches by commercial and recreational gear combined. For black skipjack, the histograms show the 2003-2008 catches by commercial gear. Only a small amount of catch was taken by pole-and-line vessels in 2008, and no samples were obtained from these vessels.

For stock assessments of yellowfin, nine purse-seine fisheries (four associated with floating objects, three associated with dolphins, and two unassociated) and one pole-and-line fishery are defined (Figure A-5). The last fishery includes all 13 sampling areas. Of the 1,027 wells sampled, 630 contained yellowfin. The estimated size compositions of the fish caught during 2008 are shown in Figure A-6a. The majority of the yellowfin catch was taken in sets associated with dolphins and in unassociated sets. Most of the larger yellowfin (>100 cm) were caught throughout the year in the Inshore dolphin fishery, during the first, second, and third quarters in the Northern dolphin-associated fishery, and during the first and fourth quarters in the Southern dolphin-associated fishery. Larger yellowfin were also caught during the first and fourth quarters in the Southern unassociated fishery. A small amount of large yellowfin was taken in the Southern floating-object fishery throughout the year, and in the Equatorial floating-object fishery in the first and second quarters. Yellowfin, ranging from 40 to 60 cm in length, was evident in all the floating-object fisheries during the year, and in the first, second and third quarters in the Northern unassociated fishery. Small amounts of yellowfin in the 50- to 70-cm size range were taken by pole-and-line vessels, mostly during the third and fourth quarters.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2003-2008 are shown in Figure A-6b. The average weights of the yellowfin caught in 2008 were greater than those of 2006 and 2007, but considerably less than those of the 2003-2004 period.

For stock assessments of skipjack, seven purse-seine fisheries (four associated with floating objects, two unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last two fisheries include all 13 sampling areas. Of the 1,027 wells sampled, 837 contained skipjack. The estimated size compositions of the fish caught during 2008 are shown in Figure A-7a. Large amounts of skipjack in the 40- to 50-cm size range were caught in all of the floating-object fisheries and in the Southern unassociated fishery throughout the year. Larger skipjack in the 50- to 70-cm size range were caught primarily during the third and fourth quarters in all of the floating-object fisheries. Negligible amounts of skipjack were caught by pole-and-line vessels.

The estimated size compositions of the skipjack caught by all fisheries combined during 2003-2008 are shown in Figure A-7b. The average weight of skipjack in 2008, 2.2 kg, was less than the average weights for the previous five years.

For stock assessments of bigeye, six purse-seine fisheries (four associated with floating objects, one unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last three fisheries include all 13 sampling areas. Of the 1,027 wells sampled, 271 contained bigeye. The estimated size compositions of the fish caught during 2008 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 2008, as in 2004-2007, nearly equal amounts of bigeye were taken in the Northern, Equatorial, and Southern floating-object fisheries. Smaller bigeye in the 40- to 80-cm size range were caught throughout the year in the Southern floating-object fishery, in the second quarter in the Equatorial floating-object fishery, and during the second, third and fourth quarters in the Northern floating-object fishery. Larger bigeye (>100 cm.) were caught primarily in the first and second quarters in the Equatorial and Southern floating-object fisheries. Small amounts of bigeye were caught in unassociated sets, and in floating-object sets in the Inshore area. There were no recorded catches of bigeye by pole-and-line vessels.

The estimated size compositions of the bigeye caught by all fisheries combined during 2003-2008 are shown in Figure A-8b. The average weight of bigeye in 2008 was considerably higher than in the previous 5 years.

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 2008 bluefin were caught between 26°N and 32°N from May through September. The majority of the catches of bluefin by both commercial and recreational vessels were taken during May, June and July. Prior to 2004, the sizes of the fish in the commercial and recreational catches have been reported separately. During 2004-2008, however, small sample sizes made it infeasible to estimate the size compositions separately. Therefore, the sizes of the fish in the commercial and recreational catches of bluefin were combined for each year of the 2003-2008 period. The average weight of the fish caught during 2008 was considerably less than those of the previous five years. The estimated size compositions are shown in Figure A-9.

Black skipjack are caught incidentally by fishermen who direct their effort toward yellowfin, skipjack, and bigeye tuna. The demand for this species is low, so most of the catches are discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. Twenty-nine samples of black skipjack were taken in 2008. The estimated size compositions for each year of the 2003-2008 period are shown in Figure A-10.

1.3.2. Longline fishery

The estimated size compositions of the catches of yellowfin and bigeye by the Japanese longline fishery in the EPO during 2003-2007 are shown in Figures A-11 and A-12. The average weights of both yellowfin and bigeye taken by that fishery have remained about the same throughout its existence. Information on the size compositions of fish caught by the Japanese longline fishery in the EPO during 1958-2003 is available in IATTC Bulletins describing that fishery.

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

The annual retained catches of tunas and bonitos in the EPO during 2004-2008, by flag and gear, are shown in Tables A-3a-e. These tables include all of the known catches of tunas and bonitos compiled from various sources, including vessel logbooks, observer data, unloading records provided by canners and other processors, export and import records, estimates derived from the species and size composition sampling program, reports from governments and other entities, and estimates derived from the species- and size-composition sampling program. Similar information on tunas and bonitos prior to 2001, and historic data for tunas, billfishes, sharks, carangids, dorado, and miscellaneous fishes are available on the IATTC web site. The purse-seine and pole-and-line catches of tunas and bonitos in 2007 and 2008, by flag, are summarized in Tables A-4a and A-4b (top panels).

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

The landings are fish unloaded from fishing vessels during a calendar year, regardless of the year of catch. The country of landing is that in which the fish were unloaded or, in the case of transshipments, the country that received the transshipped fish. Preliminary landings data for 2007 and 2008 (Tables A-4a and A-4b, lower panels) indicate that, of the 569 thousand t of tunas and bonitos landed in 2008, 53% was landed in Ecuador and 22% in Mexico. Other countries with significant landings of tunas and bonitos caught in the EPO included Colombia and Venezuela with 10% and 4% respectively. It is important to note that, when final information is available, the landings currently assigned to various countries may change due to exports from storage facilities to processors in other nations.

2. FISHING EFFORT

2.1. Purse seine

Estimates of the numbers of purse-seine sets of each type (associated with dolphins, associated with floating objects, and unassociated) in the EPO during the 1993-2008 period, and the retained catches of these sets, are shown in Table A-7 and in Figure A-1. The estimates for vessels ≤363 t carrying capacity were calculated from logbook data in the IATTC statistical data base, and those for vessels >363 t carrying capacity were calculated from the observer data bases of the IATTC, Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, the United States, and Venezuela. The greatest numbers of sets associated with floating objects and unassociated sets were made from the mid-1970s to the early 1980s. Despite opposition to fishing for tunas associated with dolphins and the refusal of U.S. canners to accept tunas caught during trips during which sets were made on dolphin-associated fish, the numbers of sets associated with dolphins decreased only moderately during the mid-1990s, and in 2003 were the greatest recorded.

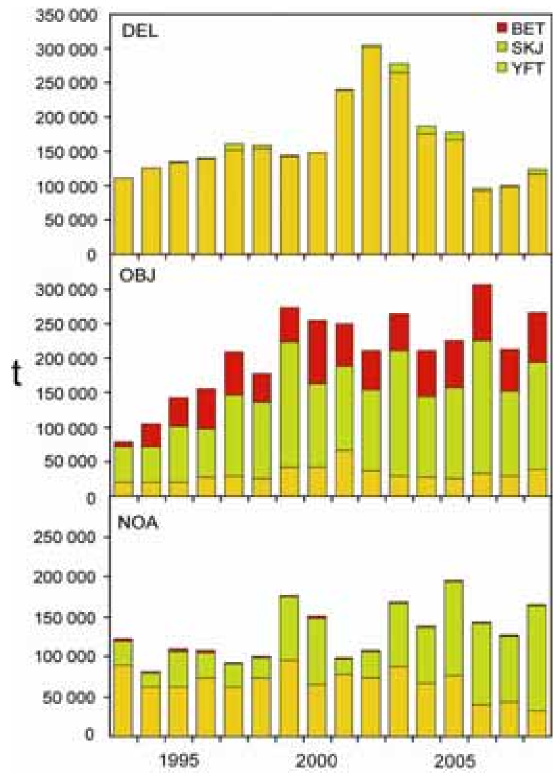


Figure A-1. Purse-seine catches of tunas, by species and set type, 1993-2008

There are two types of floating objects, flotsam and FADs. The occurrence of the former is unplanned from the point of view of the fishermen, whereas the latter are constructed by fishermen specifically for the purpose of attracting fish. FADs have been widely used for about 14 years, and their relative importance has increased during this period, while that of flotsam has decreased, as shown by the data in Table A-8.

2.2. Longline

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

3. THE FLEETS

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

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

Historically, the owner's or builder's estimates of carrying capacities of individual vessels, in tons of fish, were used until landing records indicated that revision of these estimates was required.

Since 2000, the IATTC has used well volume, in cubic meters (m^3), instead of weight, in metric tons (t), to measure the carrying capacities of the vessels. Since a well can be loaded with different densities of fish, measuring carrying capacity in weight is subjective, as a load of fish packed into a well at a higher density weighs more than a load of fish packed at a lower density. Using volume as a measure of capacity eliminates this problem.

The IATTC staff began collecting capacity data by volume in 1999, but has not yet obtained this information for all vessels. For vessels for which reliable information on well volume is not available, the estimated capacity in metric tons was converted to cubic meters.

Until about 1960, fishing for tunas in the EPO was dominated by pole-and-line vessels operating in coastal regions and in the vicinity of offshore islands and banks. During the late 1950s and early 1960s most of the larger pole-and-line vessels were converted to purse seiners, and by 1961 the EPO fishery was dominated by these vessels. From 1961 to 2008 the number of pole-and-line vessels decreased from 93 to

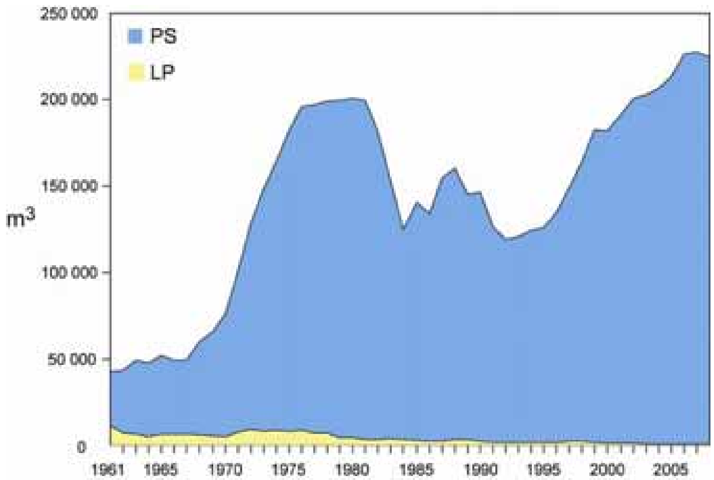


Figure A-2. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2008

4, and their total well volume from about 11 thousand to about 380 m^3. During the same period the number of purse-seine vessels increased from 125 to 218, and their total well volume from about 32 thousand to about 225 thousand m^3, an average of about 1,000 m^3 per vessel. An earlier peak in numbers and total well volume of purse seiners occurred from the mid-1970s to the early 1980s, when the number of vessels reached 282 and the total well volume about 195 thousand m^3, an average of about 700 m^3 per vessel (Table A-10; Figure A-2).

The catch rates in the EPO were low during 1978-1981, due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume of purse-seine and pole-and-line vessels then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 122 thousand m^3. In early 1990 the U.S. tuna-canning industry adopted a policy of not purchasing tunas caught during trips during which sets on tunas associated with dolphins were made. This caused many U.S.-flag vessels to leave the EPO, with a consequent reduction in the fleet to about 117 thousand m^3 in 1992. With increases in participation of vessels of other nations in the fishery, the total well volume has increased steadily since 1992, and in 2008 was 225 thousand m^3.

The 2007 and preliminary 2008 data for numbers and total well volumes of purse-seine and pole-and-line vessels that fished for tunas in the EPO are shown in Tables A-11a and A-11b. During 2008, the fleet was dominated by vessels operating under the Ecuadorian and Mexican flags, with about 27% and 24%, respectively, of the total well volume; they were followed by Panama (16%), Venezuela (13%), Colombia (7%), Spain (5%), El Salvador, and Nicaragua, (3% each), and Vanuatu (2%).

The cumulative capacity at sea during 2008 is compared to those of the previous five years in Figure A-3.

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 1998-2007, and the 2008 values, are shown in Table A-12. The monthly values are averages of the VAS estimated at weekly intervals by the IATTC staff. The fishery was regulated during some or all of the last four months of 1998-

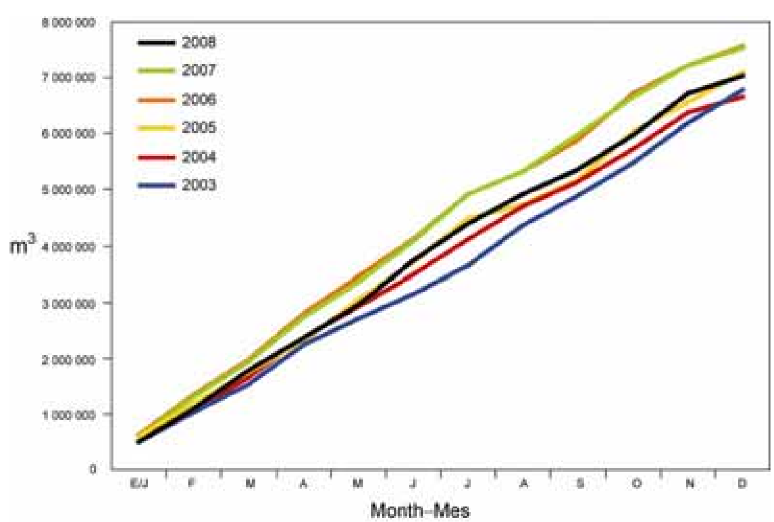


Figure A-3. Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2003-2008

2008, so the VAS values for September-December 2008 are not comparable to the average VAS values for those months of 1998-2007. The average VAS values for 1998-2007 and 2008 were 122 thousand m^3 (61% of total capacity) and 135 thousand m^3 (60% of total capacity), respectively.

3.2. Other fleets of the EPO

Information on other types of vessels that fish for tunas in the EPO is available on the IATTC's Regional Vessel Register, on the IATTC web site. The Register is incomplete for small vessels. In some cases, particularly for large longline vessels, the Register contains information for vessels authorized to fish not only in the EPO, but also in other oceans, and which may not have fished in the EPO during 2008, or ever.

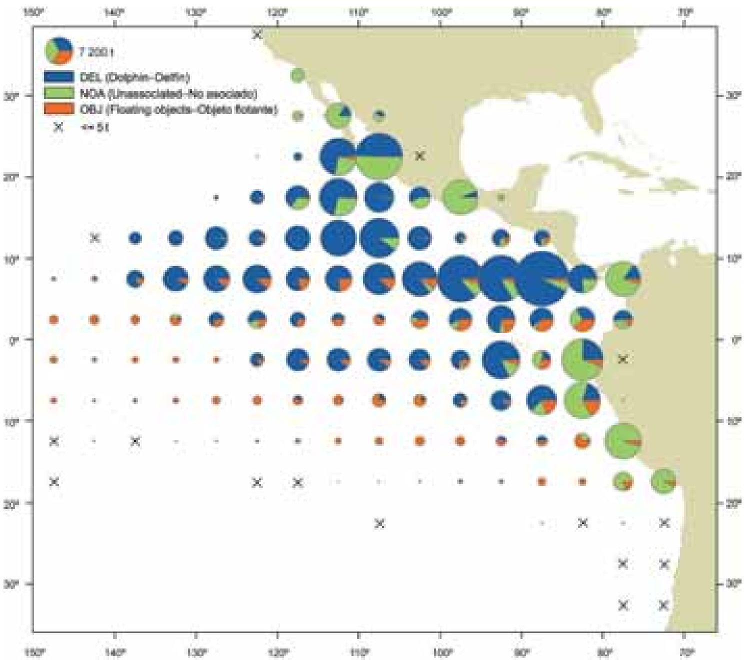


FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 1998-2007. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 1998-2007. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

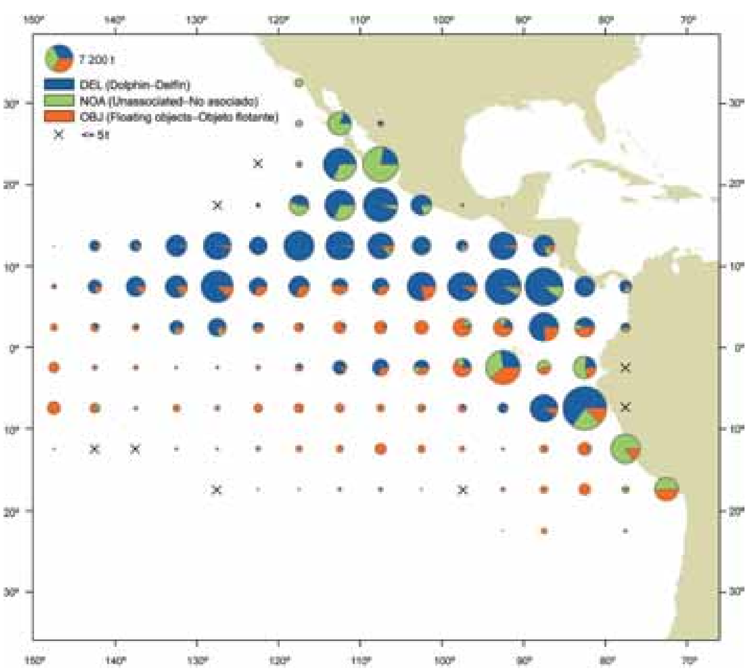


FIGURE A-1b. Annual distributions of the purse-seine catches of yellowfin, by set type, 2008. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2008. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

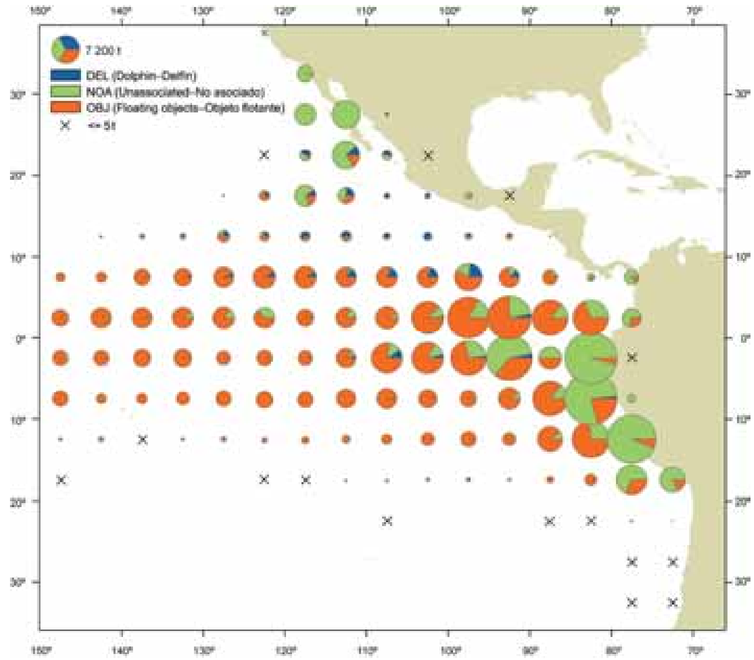


FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 1998-2007. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 1998-2007. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

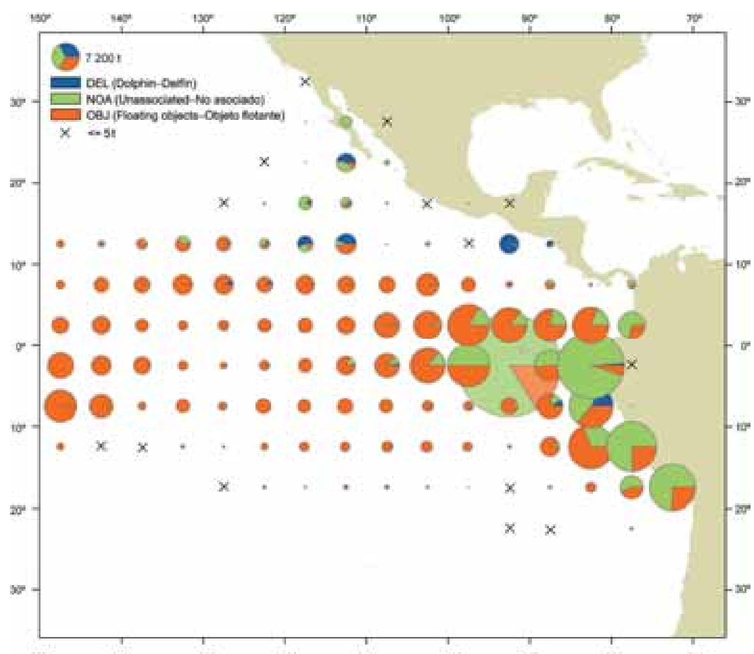


FIGURE A-2b. Annual distributions of the purse-seine catches of skipjack, by set type, 2008. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2b. Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2008. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

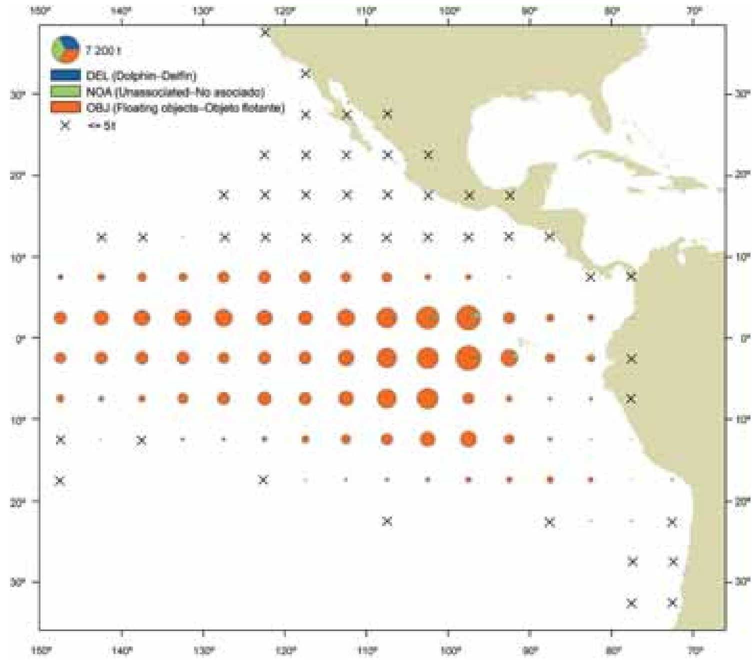


FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 1998-2007. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 1998-2007. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

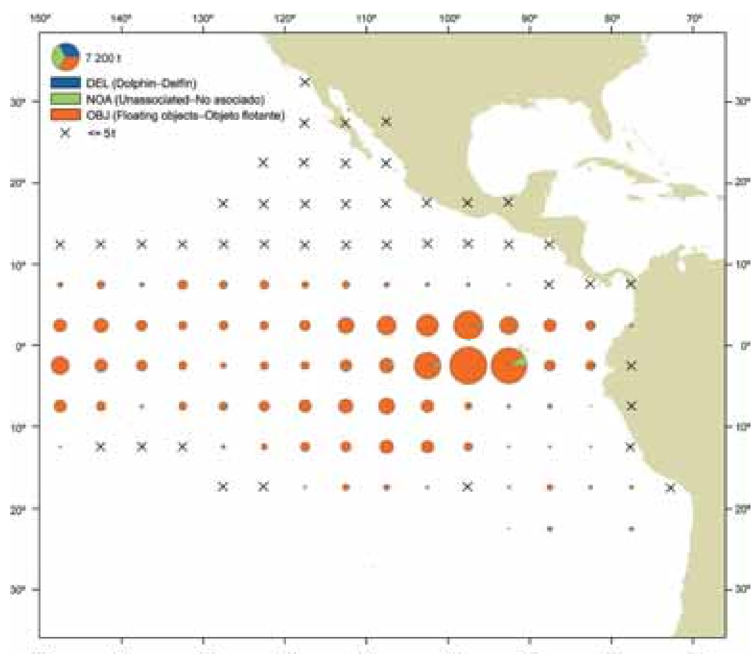


FIGURE A-3b. Annual distributions of the purse-seine catches of bigeye, by set type, 2008. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3b. Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2008. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

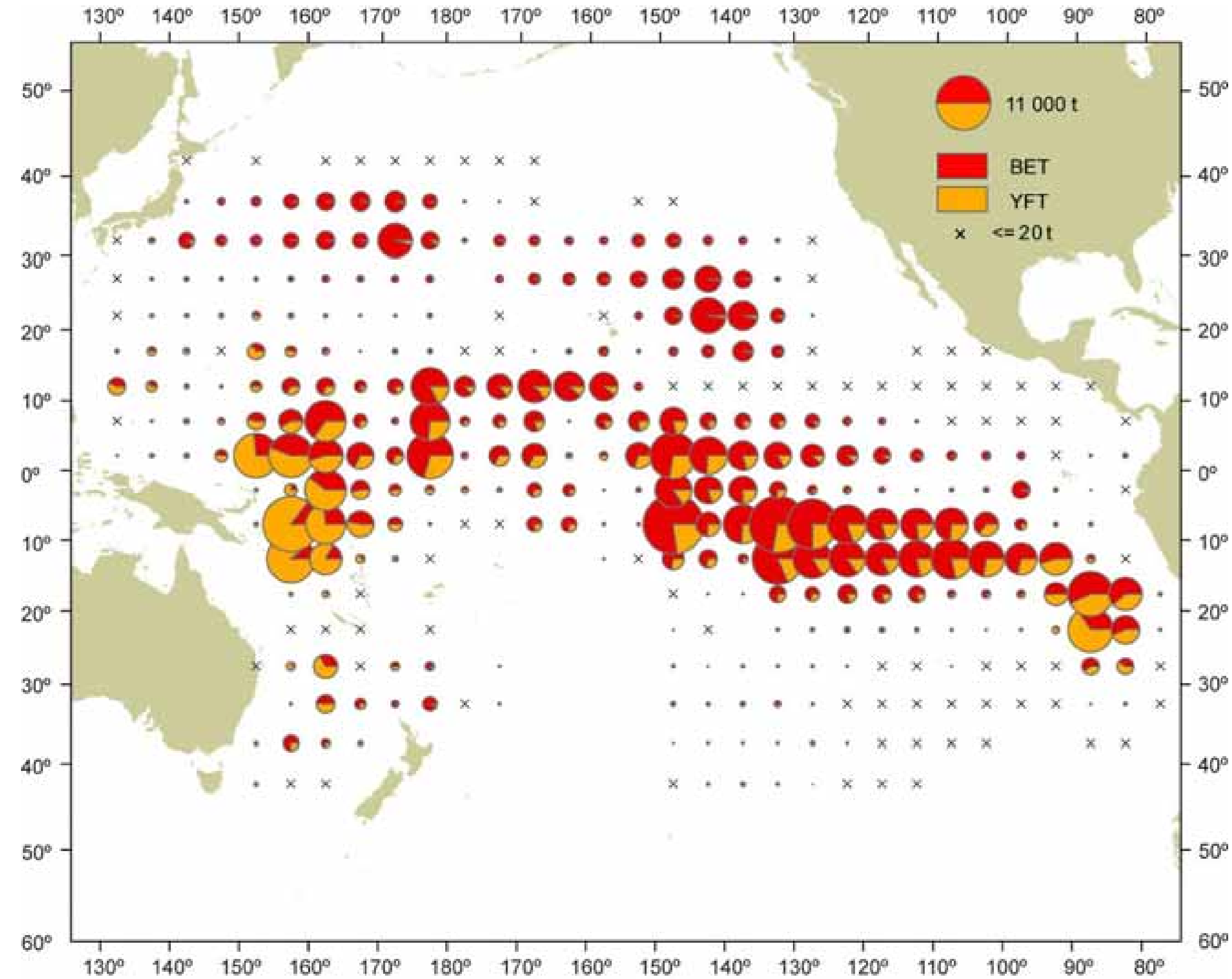


FIGURE A-4. Distributions of the average annual catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by Chinese Taipei, Japanese and Korean longline vessels, 2003-2007. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.

FIGURA A-4. Distribución de las capturas anuales medias de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por buques palangreros de Corea, Japón y Taipei Chino 2003-2007. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

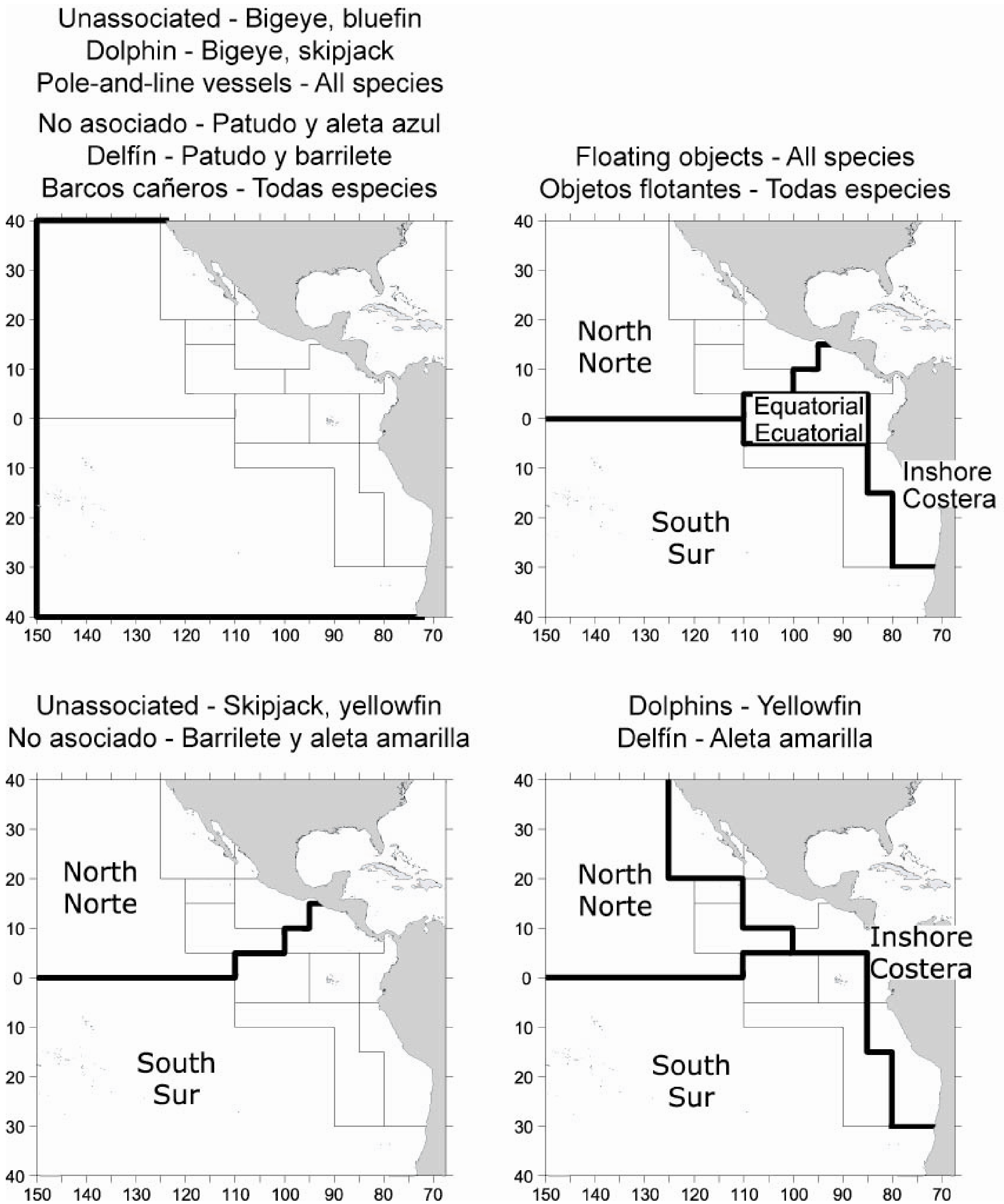


FIGURE A-5. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

FIGURA A-5. Las pesquerías definidas por el personal de la CIAT para la evaluación de las poblaciones de atún aleta amarilla, barrilete, y patudo en el OPO. Las líneas delgadas indican los límites de las 13 zonas de muestreo de frecuencia de tallas, y las líneas gruesas los límites de las pesquerías.

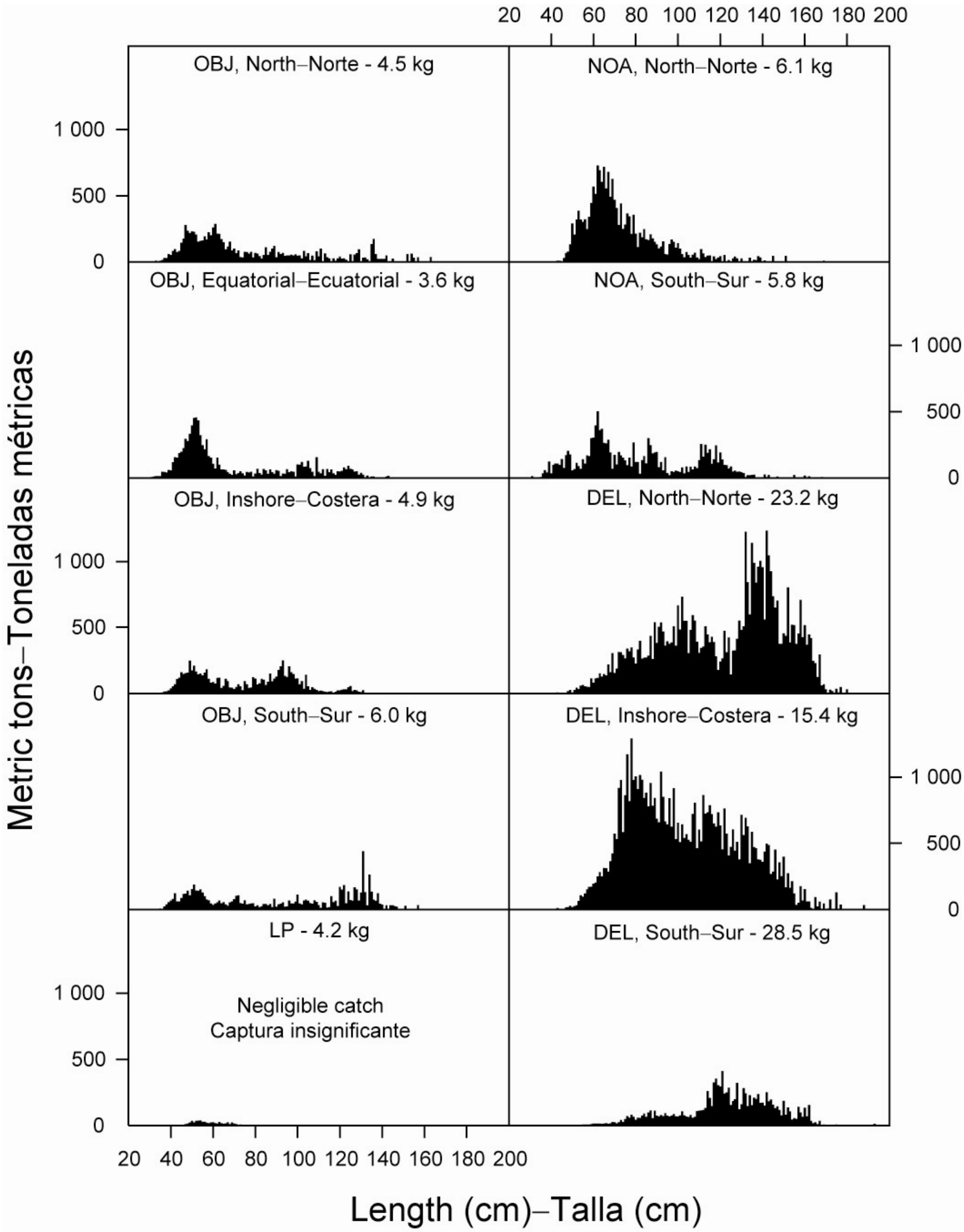


FIGURE A-6a. Estimated size compositions of the yellowfin caught in the EPO during 2008 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2008 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

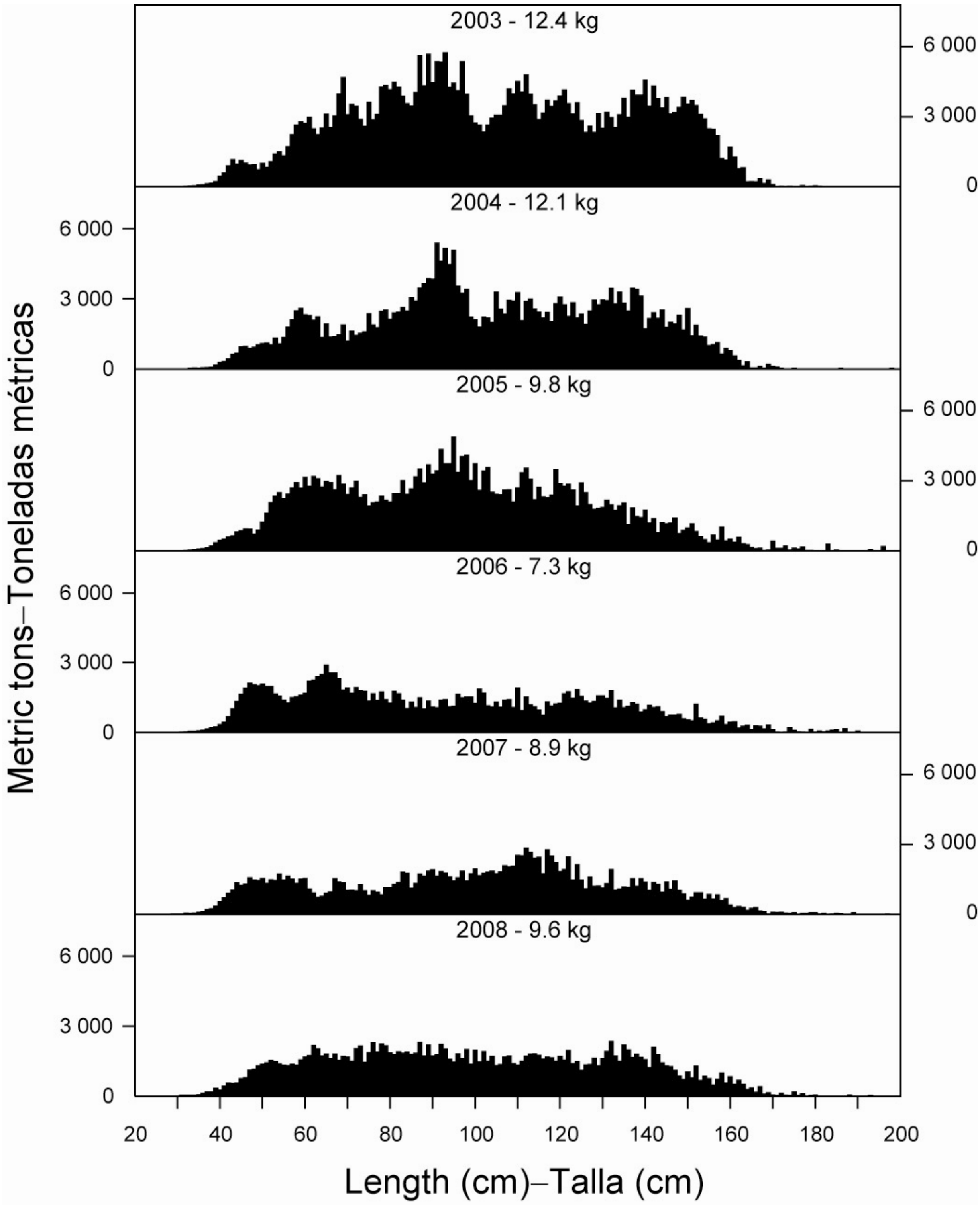


FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2003-2008. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2003-2008. En cada recuadro se detalla el peso promedio de los peces en las muestras.

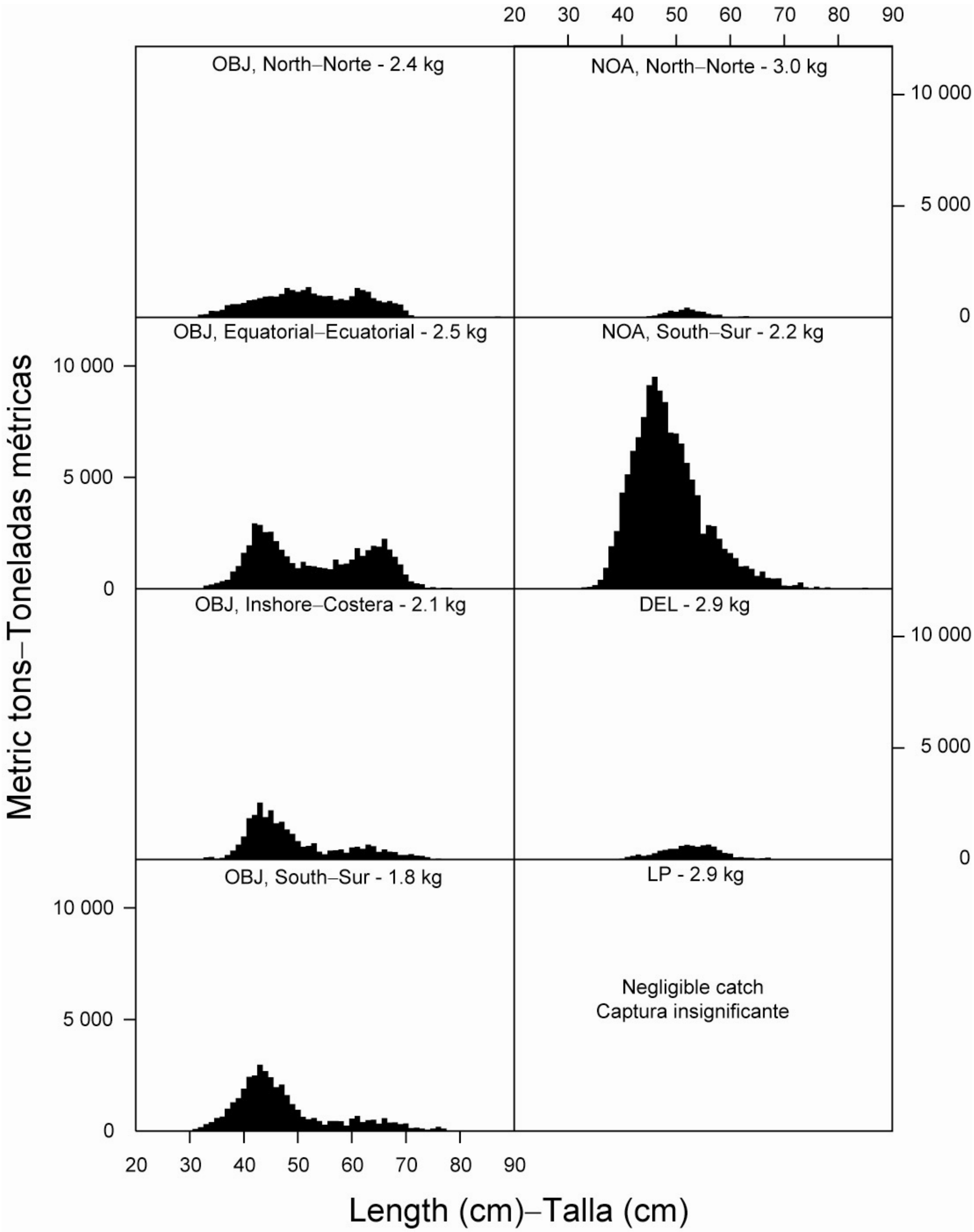


FIGURE A-7a. Estimated size compositions of the skipjack caught in the EPO during 2008 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7a. Composición por tallas estimada del barrilete capturado en el OPO durante 2008 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

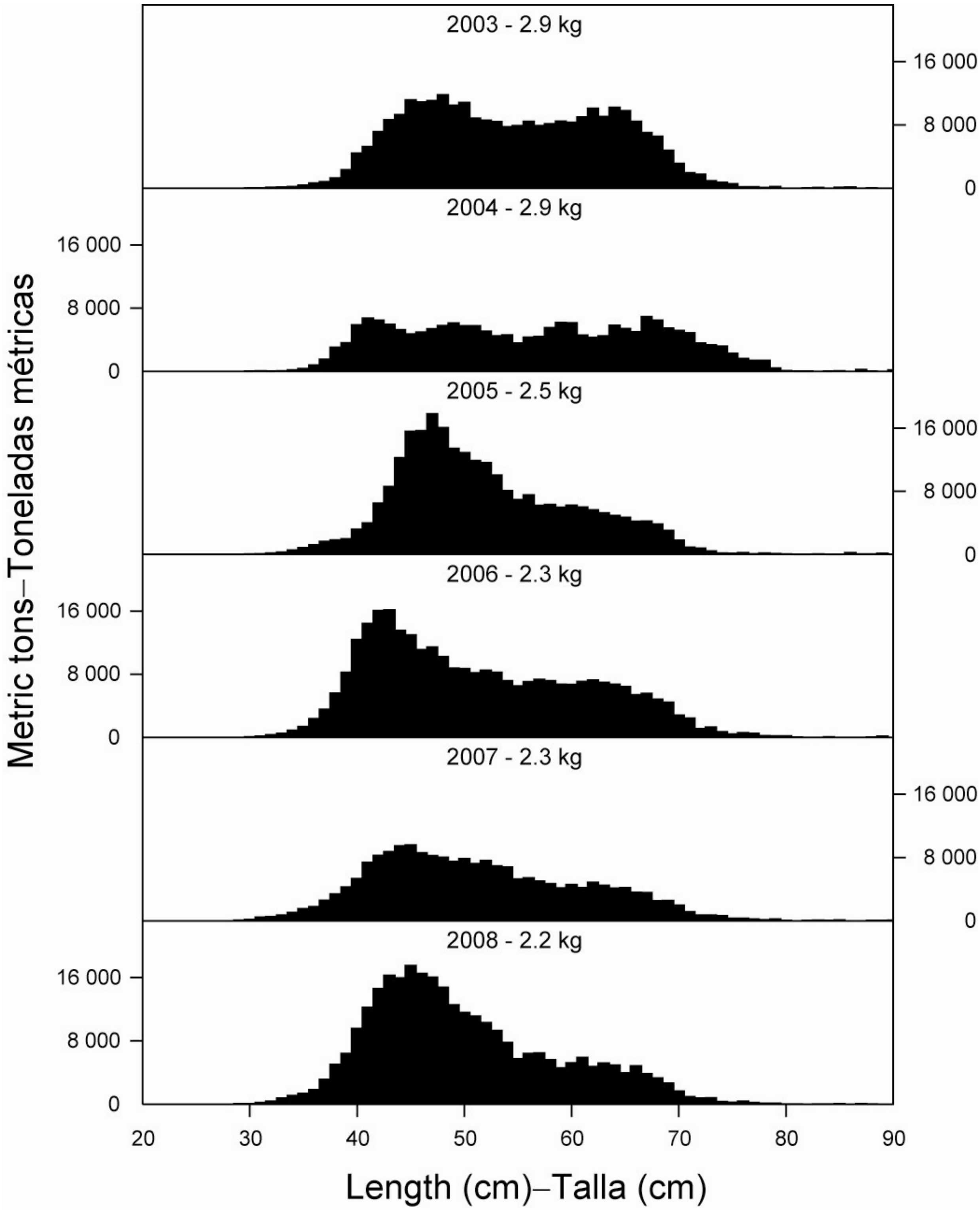


FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2003-2008. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2003-2008. En cada recuadro se detalla el peso promedio de los peces en las muestras.

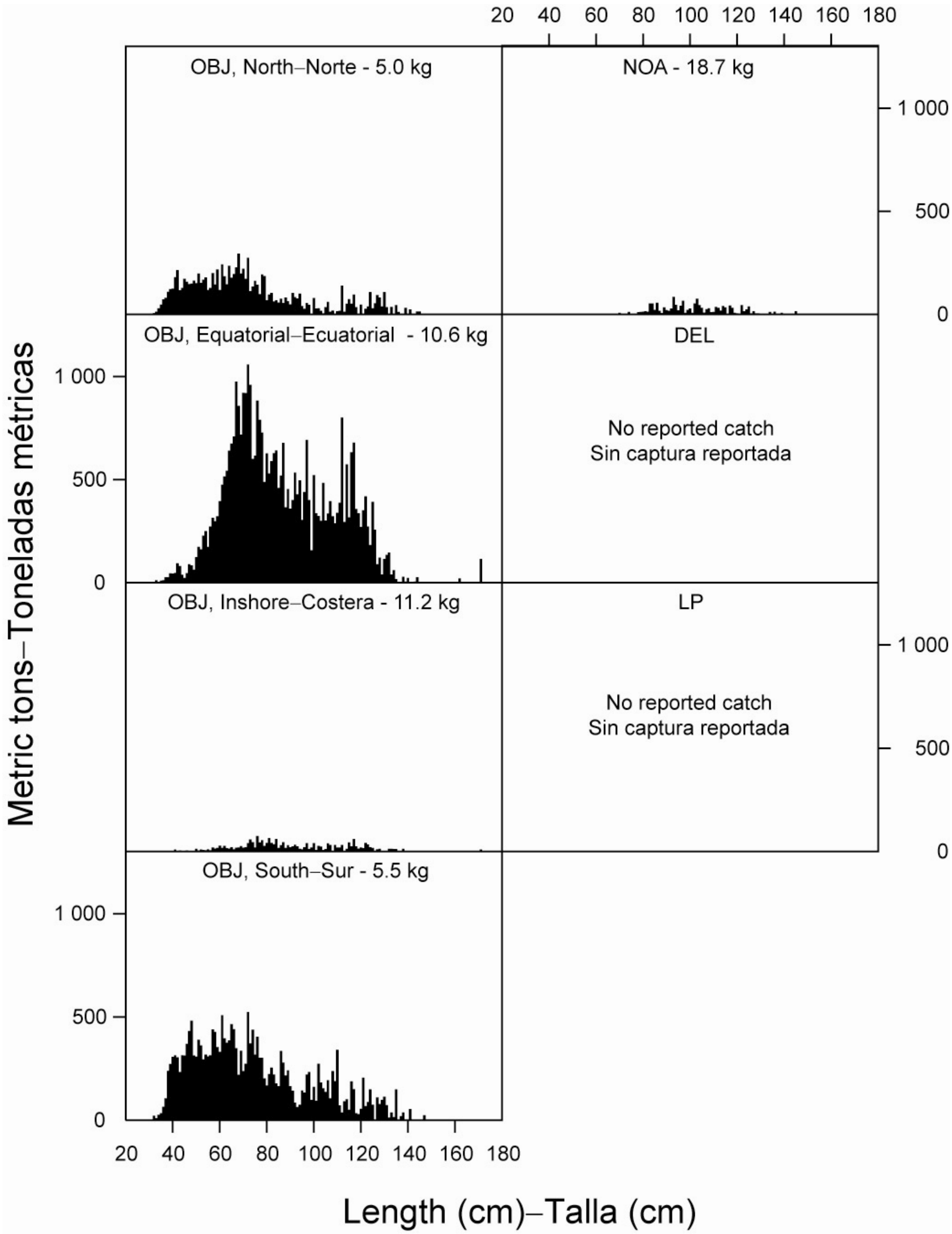


FIGURE A-8a. Estimated size compositions of the bigeye caught in the EPO during 2008 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-8a. Composición por tallas estimada del patudo capturado e en el OPO durante 2008 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

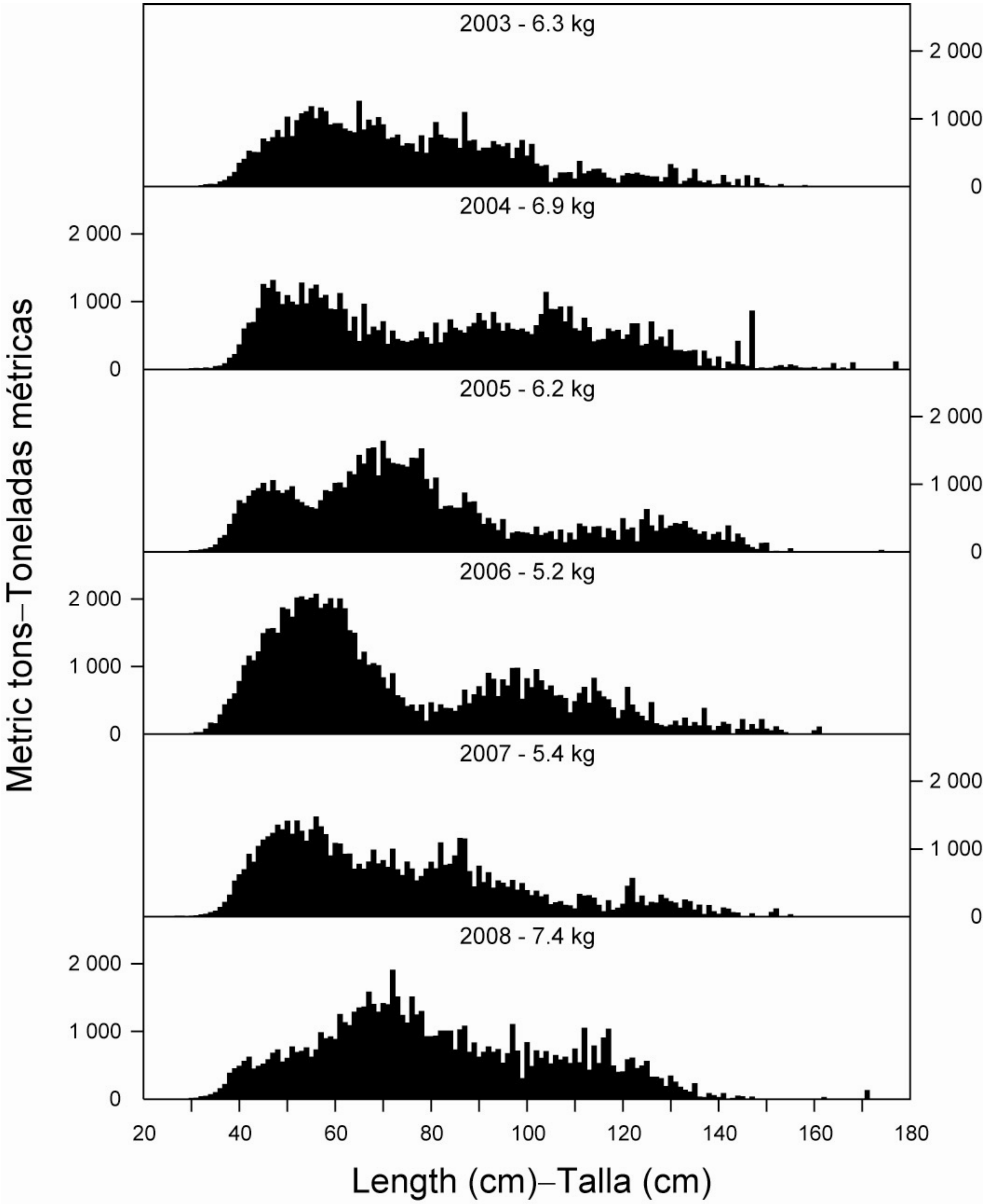


FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2003-2008. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2003-2008. En cada recuadro se detalla el peso promedio de los peces en las muestras.

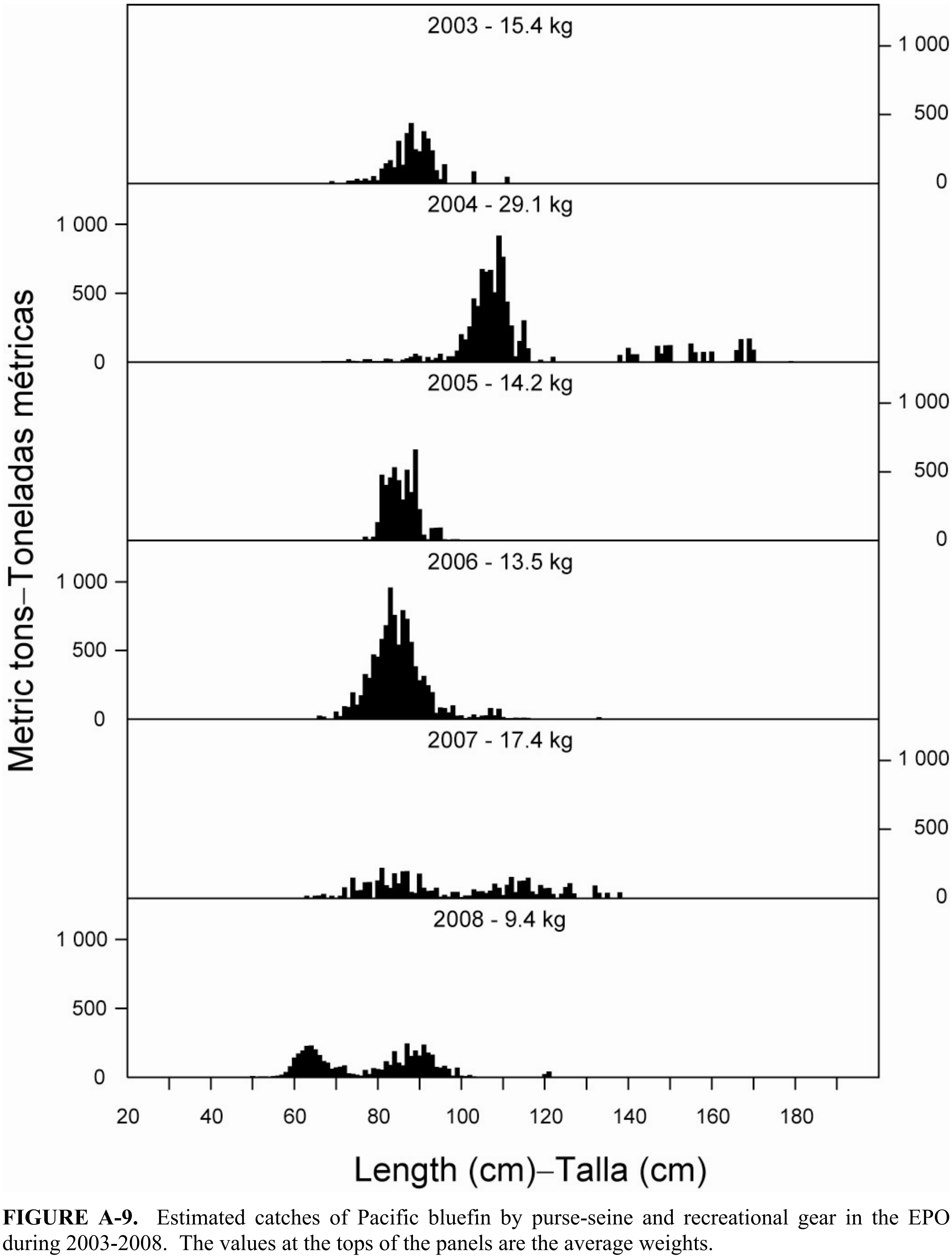


FIGURE A-9. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 2003-2008. The values at the tops of the panels are the average weights.
FIGURA A-9. Captura estimada de aleta azul del Pacífico con arte de cerco y deportiva en el OPO durante 2003-2008. El valor en cada recuadro representa el peso promedio.

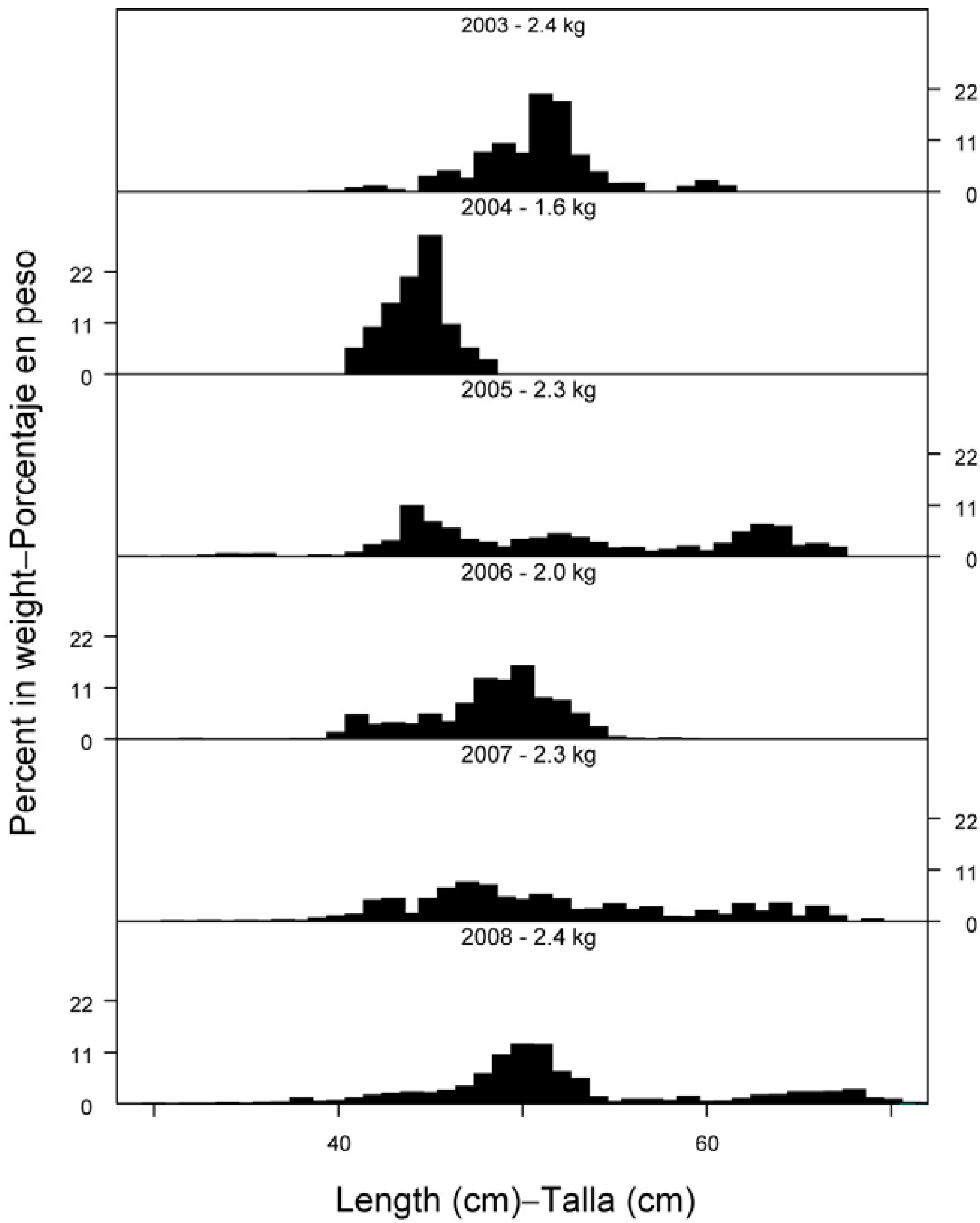


FIGURE A-10. Estimated size compositions of the catches of black skipjack by purse-seine vessels in the EPO during 2003-2008. The values at the tops of the panels are the average weights.

FIGURA A-10. Composición por tallas estimada del barrilete negro capturado por buques cerqueros en el OPO durante 2003-2008. El valor en cada recuadro representa el peso promedio.

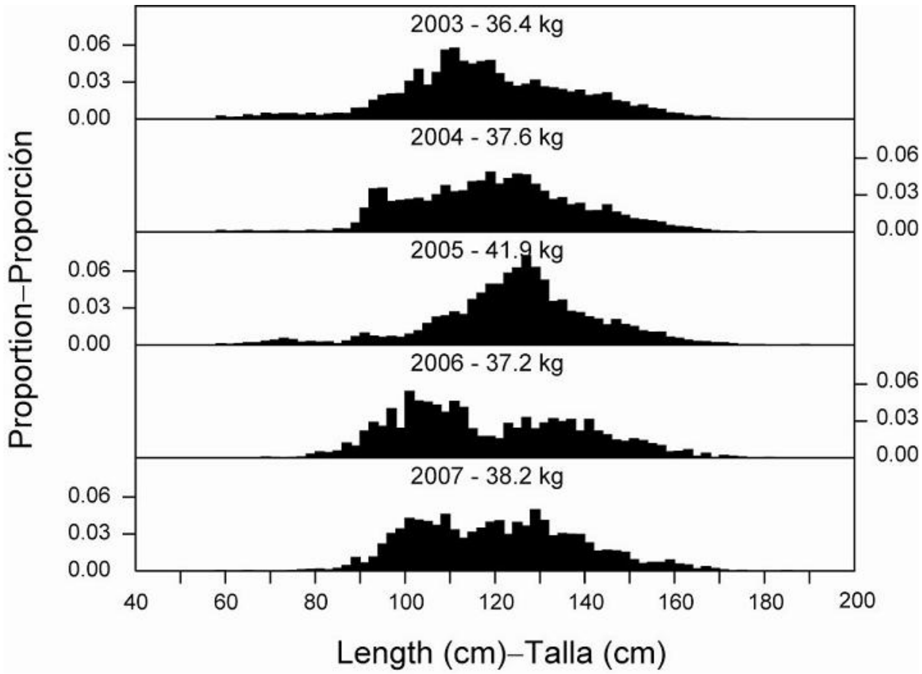


FIGURE A-11. Estimated size compositions of the catches of yellowfin tuna by the Japanese longline fishery in the EPO, 2003-2007.

FIGURA A-11. Composición por tallas estimada de las capturas de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 2003-2007.

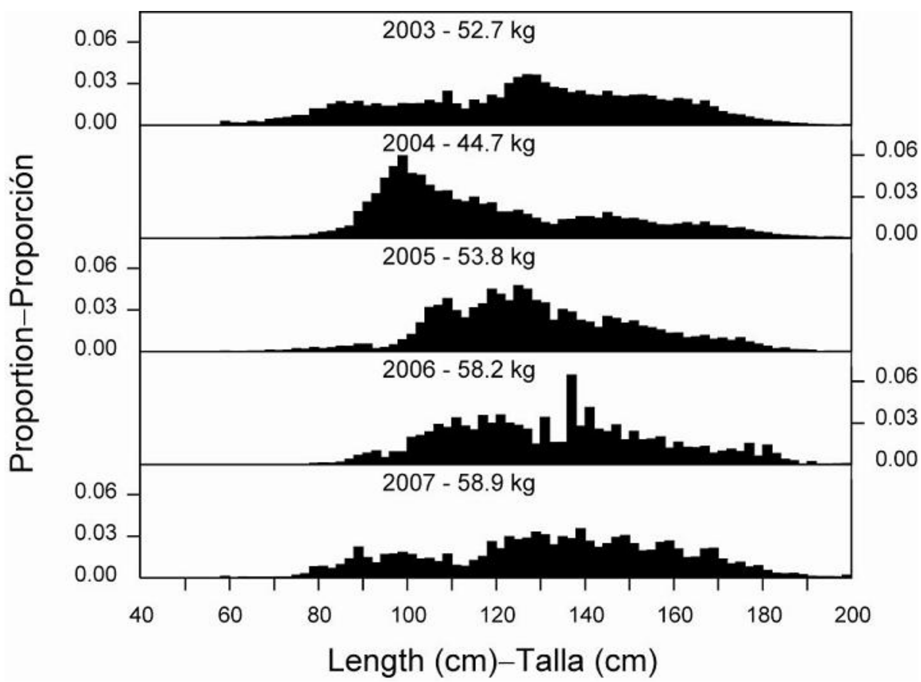


FIGURE A-12. Estimated size compositions of the catches of bigeye tuna by the Japanese longline fishery in the EPO, 2003-2007.

FIGURA A-12. Composición por tallas estimada de las capturas de atún patudo por la pesquería palangrera japonesa en el OPO, 2003-2007.

TABLE A-1. Annual catches of yellowfin, skipjack, and bigeye, by all types of gear combined, in the Pacific Ocean, 1979-2008. The EPO totals for 1993-2008 include discards from purse-seine vessels with carrying capacities greater than 363 t.

TABLA A-1. Capturas anuales de aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico, 1979-2008. Los totales del OPO de 1993-2008 incluyen los descartes de buques cerqueros de más de 363 t de capacidad de acarreo.

	YFT			SKJ			BET			Total		
	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total
1979	187,124	194,395	381,519	141,503	413,597	555,100	67,533	66,254	133,787	396,160	674,246	1,070,406
1980	158,862	213,090	371,952	138,101	458,623	596,724	86,403	65,087	151,490	383,366	736,800	1,120,166
1981	178,509	225,741	404,250	126,000	435,757	561,757	68,343	53,236	121,579	372,852	714,734	1,087,586
1982	127,532	220,957	348,489	104,669	485,948	590,617	60,350	59,181	119,531	292,551	766,086	1,058,637
1983	99,680	257,066	356,746	61,976	679,103	741,079	64,694	59,809	124,503	226,350	995,978	1,222,328
1984	149,465	256,142	405,607	63,611	755,983	819,594	55,268	64,596	119,864	268,344	1,076,721	1,345,065
1985	225,940	259,424	485,364	52,001	601,112	653,113	72,397	68,589	140,986	350,338	929,125	1,279,463
1986	286,071	250,606	536,677	67,745	748,572	816,317	105,185	63,627	168,812	459,001	1,062,805	1,521,806
1987	286,163	303,522	589,685	66,467	681,282	747,749	101,346	79,186	180,532	453,976	1,063,990	1,517,966
1988	296,430	262,948	559,378	92,126	839,113	931,239	74,313	68,358	142,671	462,869	1,170,419	1,633,288
1989	299,436	313,657	613,093	98,922	814,857	913,779	72,993	76,997	149,990	471,351	1,205,511	1,676,862
1990	301,522	353,442	654,964	77,107	880,186	957,293	104,850	90,356	195,206	483,479	1,323,984	1,807,463
1991	265,969	394,567	660,536	65,890	1,106,567	1,172,457	109,120	73,474	182,594	440,979	1,574,608	2,015,587
1992	252,514	400,879	653,393	87,294	1,007,389	1,094,683	92,000	91,032	183,032	431,808	1,499,300	1,931,108
1993	256,226	386,565	642,791	100,601	915,467	1,016,068	82,838	79,665	162,503	439,665	1,381,697	1,821,362
1994	248,078	395,543	643,621	84,695	1,018,470	1,103,165	109,336	89,662	198,998	442,109	1,503,675	1,945,784
1995	244,640	380,555	625,195	150,661	1,050,872	1,201,533	108,209	83,057	191,266	503,510	1,514,484	2,017,994
1996	266,928	317,180	584,108	132,342	1,022,072	1,154,414	114,705	84,107	198,812	513,975	1,423,359	1,937,334
1997	277,572	436,882	714,454	188,285	964,679	1,152,964	122,274	113,444	235,718	588,131	1,515,005	2,103,136
1998	280,606	456,651	737,257	165,490	1,309,168	1,474,658	93,954	113,293	207,247	540,050	1,879,112	2,419,162
1999	304,636	398,646	703,282	291,249	1,175,078	1,466,327	93,078	115,721	208,799	688,963	1,689,445	2,378,408
2000	288,834	424,097	712,931	229,181	1,237,701	1,466,882	147,915	113,836	261,751	665,930	1,775,634	2,441,564
2001	423,774	420,955	844,729	158,072	1,136,413	1,294,485	131,184	105,238	236,422	713,030	1,662,606	2,375,636
2002	443,677	403,923	847,600	166,804	1,312,532	1,479,336	132,825	120,222	253,047	743,306	1,836,677	2,579,983
2003	413,846	437,147	850,993	301,030	1,314,787	1,615,817	116,297	110,260	226,557	831,173	1,862,194	2,693,367
2004	293,897	370,349	664,246	218,193	1,403,856	1,622,049	113,018	146,069	259,087	625,108	1,920,274	2,545,382
2005	286,097	433,927	720,024	282,318	1,526,860	1,809,178	113,234	129,536	242,770	681,649	2,090,323	2,771,972
2006	178,844	437,199	616,043	311,456	1,590,656	1,902,112	120,330	134,369	254,699	610,630	2,162,224	2,772,854
2007	182,292	432,750	615,042	216,619	1,717,301	1,933,920	95,062	137,927	232,989	493,973	2,287,978	2,781,951
2008	187,797	*	187,797	305,524	*	305,524	97,330	*	97,330	590,651	*	590,651

TABLE A-2a. Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels with carrying capacities greater than 363 t only, of tunas and bonitos, in metric tons, in the EPO, 1979-2008 The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary. The data for 2006-2008 are preliminary.
TABLA A-2a. Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de atunes y bonitos, en toneladas métricas, en el OPO, 1979-2008. 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 2006-2008 son preliminares.

	Yellowfin—Aleta amarilla						Skipjack—Barrilete						Bigeye—Patudo					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1979	170,650	-	4,789	11,473	212	187,124	133,695	-	6,346	33	1,429	141,503	12,097	-	-	55,435	1	67,533
1980	143,042	-	1,481	13,477	862	158,862	130,912	-	5,225	26	1,938	138,101	21,938	-	-	64,335	130	86,403
1981	168,234	-	1,477	7,999	799	178,509	119,165	-	5,906	20	909	126,000	14,921	-	-	53,416	6	68,343
1982	114,755	-	1,538	10,961	278	127,532	100,499	-	3,760	28	382	104,669	6,939	-	42	53,365	4	60,350
1983	83,929	-	4,007	10,895	849	99,680	56,851	-	4,387	28	710	61,976	4,575	-	39	60,043	37	64,694
1984	135,785	-	2,991	10,345	344	149,465	59,859	-	2,884	32	836	63,611	8,861	-	2	46,394	11	55,268
1985	211,459	-	1,070	13,198	213	225,940	50,829	-	946	44	182	52,001	6,056	-	2	66,325	14	72,397
1986	260,512	-	2,537	22,808	214	286,071	65,634	-	1,921	58	132	67,745	2,686	-	-	102,425	74	105,185
1987	262,008	-	5,107	18,911	137	286,163	64,019	-	2,233	37	178	66,467	1,177	-	-	100,121	48	101,346
1988	277,293	-	3,723	14,660	754	296,430	87,113	-	4,325	26	662	92,126	1,535	-	5	72,758	15	74,313
1989	277,996	-	4,145	17,032	263	299,436	94,934	-	2,940	28	1,020	98,922	2,030	-	-	70,963	0	72,993
1990	263,253	-	2,676	34,633	960	301,522	74,369	-	823	41	1,874	77,107	5,921	-	-	98,871	58	104,850
1991	231,257	-	2,856	30,899	957	265,969	62,228	-	1,717	36	1,909	65,890	4,870	-	31	104,195	24	109,120
1992	228,121	-	3,789	18,646	1,958	252,514	84,283	-	1,957	24	1,030	87,294	7,179	-	-	84,808	13	92,000
1993	219,492	4,741	4,951	24,009	3,033	256,226	83,830	10,682	3,772	61	2,256	100,601	9,657	648	-	72,498	35	82,838
1994	208,408	4,532	3,625	30,026	1,487	248,078	70,126	10,526	3,240	73	730	84,695	34,899	2,271	-	71,360	806	109,336
1995	215,434	5,275	1,268	20,596	2,067	244,640	127,047	16,373	5,253	77	1,911	150,661	45,321	3,251	-	58,269	1,368	108,209
1996	238,607	6,312	3,762	16,608	1,639	266,928	103,973	24,503	2,555	52	1,259	132,342	61,311	5,689	-	46,958	747	114,705
1997	244,878	5,516	4,418	22,163	597	277,572	153,456	31,338	3,260	135	96	188,285	64,272	5,402	-	52,580	20	122,274
1998	253,959	4,698	5,085	15,336	1,528	280,606	140,631	22,644	1,684	294	237	165,490	44,129	2,822	-	46,375	628	93,954
1999	281,920	6,547	1,783	11,682	2,704	304,636	261,565	26,046	2,044	201	1,393	291,249	51,158	4,932	-	36,450	538	93,078
2000	255,231	6,207	2,431	23,855	1,110	288,834	204,307	24,508	231	68	67	229,181	94,640	5,417	-	47,605	253	147,915
2001	382,702	7,028	3,916	29,608	520	423,774	143,561	12,815	448	1,214	34	158,072	61,156	1,254	-	68,755	19	131,184
2002	412,507	4,140	950	25,531	549	443,677	153,303	12,506	616	261	118	166,804	57,440	949	-	74,424	12	132,825
2003	381,107	5,950	470	25,174	1,145	413,846	274,529	22,453	638	634	2,776	301,030	54,174	2,326	-	59,776	21	116,297
2004	269,597	3,009	1,884	18,779	628	293,897	198,664	17,182	528	713	1,106	218,193	67,592	1,749	-	43,483	194	113,018
2005	267,599	2,929	1,821	11,895	1,853	286,097	261,780	17,228	1,300	231	1,779	282,318	69,826	1,952	-	41,432	24	113,234
2006	166,330	1,665	686	8,706	1,457	178,844	297,408	12,403	435	224	986	311,456	83,978	2,385	-	33,927	40	120,330
2007	170,264	1,946	894	7,922	1,266	182,292	208,290	7,159	276	107	787	216,619	63,074	1,039	-	30,905	44	95,062
2008	185,846	965	812	2	172	187,797	295,530	9,217	499	*	278	305,524	75,653	2,372		19,305	*	97,330

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

	Pacific bluefin—Aleta azul del Pacífico						Albacore—Albacora						Black skipjack—Barrilete negro					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1979	6,102	-	5	6	26	6,139	148	-	179	5,583	5,043	10,953	1,334	-	30	-	-	1,364
1980	2,909	-	-	-	31	2,940	194	-	407	5,319	5,649	11,569	3,653	-	27	-	-	3,680
1981	1,085	-	-	4	7	1,096	99	-	608	7,275	12,301	20,283	1,908	-	3	-	-	1,911
1982	3,145	-	-	7	6	3,158	355	-	198	8,407	3,562	12,522	1,338	-	-	-	-	1,338
1983	836	-	-	2	37	875	7	-	449	7,433	7,840	15,729	1,222	-	0	-	13	1,235
1984	839	-	0	3	51	893	3910	-	1441	6,712	9,794	21,857	662	-	-	-	3	665
1985	3,996	-	-	1	77	4,074	42	-	877	7,268	6,654	14,841	288	-	0	-	7	295
1986	5,040	-	-	1	64	5,105	47	-	86	6,450	4,701	11,284	569	-	-	-	18	587
1987	980	-	-	3	89	1,072	1	-	320	9,994	2,662	12,977	571	-	-	-	2	573
1988	1,379	-	-	2	52	1,433	17	-	271	9,934	5,549	15,771	956	-		-	311	1,267
1989	1,103	-	5	4	91	1,203	1	-	21	6,784	2,695	9,501	801	-	0	-	-	801
1990	1,430	-	61	12	101	1,604	39	-	170	6,536	4,105	10,850	787	-	-	-	4	791
1991	419	-	-	5	55	479	-	-	834	7,893	2,754	11,481	421	-	-	-	25	446
1992	1,928	-	-	21	146	2,095	-	-	255	17,080	5,740	23,075	105	-	-	3	-	108
1993	580	-	-	11	325	916	-	-	1	11,194	4,410	15,605	104	4,137	-	31	-	4,272
1994	969	-	-	12	110	1,091	-	-	85	10,390	10,143	20,618	188	861	-	40	-	1,089
1995	629	-	-	25	299	953	-	-	465	6,185	7,425	14,075	203	1,448	-	-	-	1,651
1996	8,223	-	-	19	85	8,327	11	-	72	7,631	8,398	16,112	704	2,304	-	12	-	3,020
1997	2,607	3	2	14	244	2,870	1	-	59	9,678	7,541	17,279	100	2,512	-	11	-	2,623
1998	1,772	-	0	94	526	2,392	42	-	81	12,635	13,155	25,913	489	1,876	39	-	-	2,404
1999	2,553	54	5	152	564	3,328	47	-	227	11,633	14,557	26,464	171	3,412	-	-	-	3,583
2000	3,712	0	61	46	378	4,197	71	-	86	9,663	13,455	23,275	293	1,995	-	-	-	2,288
2001	1,155	3	1	148	401	1,708	3	-	157	19,410	13,766	33,336	2,258	1,019	-	-	-	3,277
2002	1,758	6	3	71	652	2,490	31	-	381	15,289	14,453	30,154	1,459	2,283	8	-		3,750
2003	3,233	-	3	87	403	3,726	34	-	59	24,901	20,544	45,538	433	1,535	6	13	117	2,104
2004	8,880	19	-	16	62	8,977	105	-	126	18,444	22,159	40,834	884	387	-	27	862	2,160
2005	4,743	15	-	0	85	4,843	2	-	66	8,861	15,635	24,564	1,472	2,124	-	-	22	3,618
2006	9,806	-	-	0	101	9,907	109	-	1	10,642	18,968	29,720	1,999	1,977	-	-	-	3,976
2007	4,189	-	-	-	15	4,204	117	-	21	8,955	18,704	27,797	2,262	1,625	-	-	48	3,935
2008	4,392	14	15	*	*	4,421	10	-	*	73	*	83	3,585	2,560	*	*	7	6,152

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

	Bonitos						Unidentified tunas—Atunes no identificados						Total					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1979	1,801	-	3	-	2,658	4,462	558	-	-	-	3,016	3,574	326,385	-	11,353	72,530	12,385	422,653
1980	6,089	-	36	-	2,727	8,852	442	-	-	-	836	1,278	309,179	-	7,176	83,157	12,173	411,685
1981	5,690	-	27	-	4,609	10,326	213	-	3	-	1,109	1,325	311,315	-	8,024	68,714	19,740	407,793
1982	2,122	-	-	-	6,776	8,898	47	-	-	-	382	429	229,200	-	5,538	72,768	11,390	318,896
1983	3,827	-	2	-	7,291	11,120	60	-	-	-	4,711	4,771	151,307	-	8,884	78,401	21,488	260,080
1984	3,514	-		-	7,291	10,805	6	-	-	-	2,524	2,530	213,436	-	7,318	63,486	20,854	305,094
1985	3,599	-	5	-	7,869	11,473	19	-	-	-	678	697	276,288	-	2,900	86,836	15,694	381,718
1986	232	-	258	-	1,889	2,379	177	-	4	-	986	1,167	334,897	-	4,806	131,742	8,078	479,523
1987	3,195	-	121	-	1,782	5,098	481	-	-	-	2,043	2,524	332,432	-	7,781	129,066	6,941	476,220
1988	8,811	-	739	-	947	10,497	79	-	-	-	2,939	3,018	377,183	-	9,063	97,380	11,229	494,855
1989	11,278	-	818	-	465	12,561	36	-	-	-	626	662	388,179	-	7,929	94,811	5,160	496,079
1990	13,641	-	215	-	371	14,227	200	-	-	3	692	895	359,640	-	3,945	140,096	8,165	511,846
1991	1,207	-	82	-	242	1,531	4	-	-	29	192	225	300,406	-	5,520	143,057	6,158	455,141
1992	977	-	-	-	318	1,295	24	-	-	27	1,071	1,122	322,617	-	6,001	120,609	10,276	459,503
1993	599	12	1	-	436	1,048	9	2,022	-	10	4,082	6,123	314,271	22,242	8,725	107,814	14,577	467,629
1994	8,331	147	362	-	185	9,025	9	498	-	1	464	972	322,930	18,835	7,312	111,902	13,925	474,904
1995	7,929	55	81	-	54	8,119	11	626	-	0	1,004	1,641	396,574	27,028	7,067	85,152	14,128	529,949
1996	647	1	7	-	16	671	37	1,028	-	0	1,038	2,103	413,513	39,837	6,396	71,281	13,182	544,209
1997	1,097	4	8	-	34	1,143	71	3,383	-	7	1,437	4,898	466,482	48,158	7,747	84,588	9,969	616,944
1998	1,330	4	7	-	588	1,929	13	1,233	-	24	18,158	19,428	442,365	33,277	6,896	74,758	34,820	592,116
1999	1,719	0	-	24	369	2,112	27	3,092	-	2,113	4,279	9,511	599,160	44,083	4,059	62,255	24,404	733,961
2000	636	-		75	56	767	190	1,410	-	1,992	1,468	5,060	559,080	39,537	2,809	83,304	16,787	701,517
2001	17	-	0	34	19	70	191	679	-	2,448	55	3,373	591,043	22,798	4,522	121,617	14,814	754,794
2002	-	-	-	-	1	1	576	1,863	-	482	1,422	4,343	627,074	21,747	1,958	116,058	17,207	784,044
2003	-	-	1	-	25	26	80	1,238	-	215	750	2,283	713,590	33,502	1,177	110,800	25,781	884,850
2004	15	35	1	8	3	62	256	973	-	349	258	1,836	545,993	23,354	2,539	81,819	25,272	678,977
2005	313	18	0	-	11	342	190	1,922	-	363	427	2,902	605,925	26,188	3,187	62,782	19,836	717,918
2006	3,507	80	12	-	3	3,602	49	1,910	-	21	193	2,173	563,186	20,420	1,134	53,520	21,748	660,008
2007	15,847	628	107	-	0	16,582	600	1,221	-	2,196	189	4,206	464,643	13,618	1,298	50,085	21,053	550,697
2008	7,063	65	9	*	*	7,137	135	2,026	*	933	113	3,207	572,214	17,219	1,335	20,313	570	611,651

TABLE A-2b. Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with carrying capacities greater than 363 t only, of billfishes, in metric tons, in the EPO, 1979-2008 Data for 2006-2008 are preliminary. PS dis. = discards by purse-seine vessels.

TABLA A-2b. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes, por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de peces picudos, en toneladas métricas, en el OPO, 1979-2008. Los datos de 2006-2008 son preliminares. PS dis. = descartes por buques cerqueros.

	Swordfish—Pez espada				Blue marlin—Marlín azul				Black marlin—Marlín negro				Striped marlin—Marlín rayado			
	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total
1979	-	2,658	614	3,272	-	4,528	-	4,528	-	332	-	332	-	4,137	-	4,137
1980	-	3,746	1107	4,853	-	4,016	-	4,016	-	335	-	335	-	4,827	-	4,827
1981	-	3,070	1134	4,204	-	4,476	-	4,476	-	247	-	247	-	4,876	-	4,876
1982	-	2,604	1551	4,155	-	4,745	-	4,745	-	213	-	213	-	4,711	-	4,711
1983	-	3,341	2338	5,679	-	4,459	-	4,459	-	240	-	240	-	4,472	-	4,472
1984	-	2,752	3336	6,088	-	5,197	-	5,197	-	248	-	248	-	2,662	-	2,662
1985	-	1,885	3768	5,653	-	3,588	-	3,588	-	180	-	180	-	1,599	-	1,599
1986	-	3,286	3294	6,580	-	5,278	-	5,278	-	297	-	297	-	3,540	-	3,540
1987	-	4,676	3740	8,416	-	7,282	-	7,282	-	358	-	358	-	7,647	-	7,647
1988	-	4,916	5642	10,558	-	5,662	-	5,662	-	288	-	288	-	5,283	-	5,283
1989	-	5,202	6072	11,274	-	5,392	-	5,392	-	193	-	193	-	3,473	-	3,473
1990	-	5,807	5066	10,873	-	5,540	-	5,540	-	223	-	223	-	3,260	-	3,260
1991	17	10,671	4307	14,995	69	6,719	-	6,788	58	246	-	304	76	2,993	-	3,069
1992	4	9,820	4267	14,091	52	6,627	-	6,679	95	228	-	323	69	3,054	-	3,123
1993	5	6,187	4414	10,606	106	6,571	-	6,677	93	217	-	310	71	3,575	-	3,646
1994	4	4,990	3822	8,816	97	9,027	-	9,124	72	256	-	328	37	3,396	-	3,433
1995	4	4,495	2974	7,473	99	7,288	-	7,387	76	158	-	234	24	3,249	-	3,273
1996	1	7,071	2486	9,558	84	3,596	-	3,680	79	99	-	178	25	3,218	-	3,243
1997	4	10,580	1781	12,365	149	5,808	-	5,957	100	153	-	253	28	4,473	-	4,501
1998	3	9,800	3246	13,049	152	5,057	-	5,209	102	168	-	270	21	3,558	-	3,579
1999	2	7,569	1965	9,536	210	3,690	-	3,900	114	94	-	208	36	2,621	0	2,657
2000	2	8,930	2383	11,315	146	3,634	-	3,780	92	105	-	197	19	1,889	0	1,908
2001	4	16,007	1964	17,975	171	4,197	-	4,368	123	123	-	246	21	1,961	0	1,982
2002	1	17,598	2119	19,718	230	3,481	-	3,711	126	78	-	204	77	2,159	1	2,237
2003	4	18,161	354	18,519	206	4,016	-	4,222	146	72	-	218	33	1,906	6	1,945
2004	2	15,372	309	15,683	165	3,782	-	3,947	75	41	-	116	22	1,548	-	1,570
2005	2	8,910	4304	13,216	227	3,328	-	3,555	107	37	-	144	38	1,521	-	1,559
2006	7	8,916	3800	12,723	196	2,061	105	2,362	142	32	-	174	55	1,500	-	1,555
2007	4	4,353	4377	8,734	137	2,295	106	2,538	83	37	-	120	36	1,400	6	1,442
2008	6	125	19	150	149	*	*	149	78	*	-	78	38	*	*	38

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

	Shortbill spearfish—Marlín trompa corta				Sailfish—Pez vela				Unidentified istiophorid billfishes—Picudos istiofóridos no identificados				Total billfishes—Total de peces picudos			
	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total
1979	-	-	-	-	-	251	-	251	-	6	-	6	-	11,912	614	12,526
1980	-	-	-	-	-	244	-	244	-	0	-	-	-	13,168	1,107	14,275
1981	-	-	-	-	-	379	-	379	-	9	-	9	-	13,057	1,134	14,191
1982	-	-	-	-	-	1,084	-	1,084	-	3	-	3	-	13,360	1,551	14,911
1983	-	-	-	-	-	890	-	890	-	2	-	2	-	13,404	2,338	15,742
1984	-	-	-	-	-	345	-	345	-	-	-	-	-	11,204	3,336	14,540
1985	-	-	-	-	-	395	-	395	-	1	-	1	-	7,648	3,768	11,416
1986	-	5	-	5	-	583	-	583	-	1	-	1	-	12,990	3,294	16,284
1987	-	15	-	15	-	649	-	649	-	398	-	398	-	21,025	3,740	24,765
1988	-	13	-	13	-	649	-	649	-	368	-	368	-	17,179	5,642	22,821
1989	-	-	-	-	-	192	-	192	-	51	-	51	-	14,503	6,072	20,575
1990	-	-	-	-	-	6	-	6	-	125	-	125	-	14,961	5,066	20,027
1991	-	1	-	1	40	717	-	757	-	112	-	112	-	21,459	4,307	26,026
1992	-	1	-	2	41	1,351	-	1,392	-	1,123	-	1,123	260	22,204	4,267	26,733
1993	1	1	-	1	58	2,266	-	2,324	97	1,650	-	1,747	262	20,467	4,414	25,311
1994	0	144	-	144	38	1,682	-	1,720	23	1,028	-	1,051	430	20,523	3,822	24,616
1995	0	155	-	156	28	1,351	-	1,379	12	232	-	244	271	16,928	2,974	20,146
1996	1	126	-	127	22	738	-	760	19	308	1	328	244	15,156	2,487	17,874
1997	1	141	-	142	24	1,217	-	1,241	8	1,324	-	1,332	231	23,696	1,781	25,791
1998	1	200	-	200	58	1,382	-	1,440	13	575	54	642	314	20,740	3,300	24,389
1999	0	278	-	279	40	1,216	-	1,256	16	1,136	0	1,152	349	16,604	1,965	18,988
2000	1	285	-	286	48	1,380	-	1,428	8	879	136	1,023	419	17,102	2,519	19,937
2001	1	304	-	305	63	1,477	325	1,865	6	1,742	204	1,952	316	25,811	2,493	28,693
2002	1	273	-	274	35	1,792	17	1,844	9	1,862	14	1,885	389	27,243	2,151	29,873
2003	1	290	-	294	86	1,174	0	1,260	10	1,389	-	1,399	479	27,008	360	27,857
2004	4	207	-	208	32	1,400	17	1,449	9	1,384	-	1,393	489	23,734	326	24,366
2005	1	229	-	230	44	805	15	864	8	900	-	908	306	15,730	4,319	20,476
2006	1	234	-	236	43	745	35	823	25	491	1	517	427	13,979	3,941	18,390
2007	2	252	-	253	50	790	32	872	17	104	15	136	470	9,231	4,536	14,095
2008	1	*	*	1	43	*	32	75	20	8	*	28	328	133	51	519

TABLE A-2c. Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels of more than 363 t carrying capacity only, of other species, in metric tons, in the EPO, 1979-2008 The data for 2006-2008 are preliminary.

TABLA A-2c. Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de otras especies, en toneladas métricas, en el OPO, 1979-2008. Los datos de 2006-2008 son preliminares.

	Carangids—Carángidos						**Dorado (*Coryphaena* spp.)**						**Elasmobranchs—Elasmobranquios**						**Other fishes—Otros peces**					
	PS		**LP**	**LL**	**OTR**	**Total**	**PS**		**LP**	**LL**	**OTR**	**Total**	**PS**		**LP**	**LL**	**OTR**	**Total**	**PS**		**LP**	**LL**	**OTR**	**Total**
	Ret.	**Dis.**					**Ret.**	**Dis.**					**Ret.**	**Dis.**					**Ret.**	**Dis.**				
1979	81	-	-	-	-	81	124	-	-	-	927	1,051	7	-	-	17	1,290	1,314	478	-	-	7	-	485
1980	224	-	2	-	-	226	124	-	-	-	1,001	1,125	16	-	-	7	858	881	301	-	-	-	-	301
1981	111	-	17	-	-	128	410	-	-	-	628	1,038	49	-	-	120	1,211	1,380	201	-	3	51	-	255
1982	122	-		-	-	122	274	-	-	-	980	1,254	22	-	30	215	864	1,131	288	-	-	59	-	347
1983	1,240	-	-	-	-	1,240	88	-	-	-	3,374	3,462	34	-	-	85	695	814	288	-	1	-	-	289
1984	414	-	-	-	-	414	103	-	-	-	202	305	47	-	-	6	1,039	1,092	415	-	-	-	3	418
1985	317	-	4	-	-	321	93	-	-	-	108	201	27	-	-	13	481	521	77	-	-	7	-	84
1986	188	-	19	-	-	207	632	-	-	-	1,828	2,460	29	-	-	1	1,979	2,009	94	-	-	0	-	94
1987	566	-	5	-	-	571	271	-	-	-	4,272	4,543	96	-	-	87	1,020	1,203	210	-	-	535	-	745
1988	825	-	1	-	-	826	69	-	-	-	1,560	1,629	1	-	-	23	1,041	1,065	321	-	-	360	-	681
1989	60	-	2	-	-	62	210	-	-	-	1,680	1,890	29	-	-	66	1,025	1,120	670	-	-	152	-	822
1990	234	-		-	1	235	63	-	-	-	1,491	1,554	-	-	-	280	1,095	1,375	433	-	--	260	14	707
1991	116	-	-	-	-	116	57	-	-	-	613	677	1	-	6	1112	1,346	2,465	462	-	1	457	0	920
1992	116	-	-	-	-	116	69	-	-	7	708	814		-	-	2,293	1,190	3,483	555	-		182	-	737
1993	17	64	-	-	2	83	36	722	-	37	724	1,499	24	1,268	-	1,026	916	3,234	227	642	2	184	-	1,055
1994	7	40	-	-	16	63	279	1,245	-	17	3,459	5,029	113	1,125	-	1,234	1,314	3,786	10	807	-	251	-	1,068
1995	11	48	-	-	9	68	110	1,097	-	46	2,127	3,373	20	1,215	-	922	1,075	3,232	1	940	-	210	-	1,151
1996	55	216	-	-	57	328	119	1,331	-	39	183	1,676	3	1,062	-	1,121	2,151	4,337	5	625	-	456	-	1,086
1997	2	149	-	-	39	190	36	1,237	-	43	3,109	11,248	22	1,499	-	956	2,328	4,805	17	903	-	848	-	1,768
1998	57	175	-	-	4	236	15	835	-	6,866	9,167	12,545	6	1,555	-	2,099	4,393	8,053	67	1,378	-	1,340	-	2,785
1999	35	210	1	-	-	246	75	1,243	-	2,528	1,160	8,762		970	-	5,995	2,088	9,053	88	916	-	975	-	1,979
2000	57	106		4	4	171	109	1,490	-	6,284	1,041	6,177	3	933	-	8,621	405	9,962	1	559	-	1,490	-	2,050
2001	-	161	-	18	26	205	148	2,222	-	3,537	2,825	21,136	-	751	-	12,551	107	13,409	15	1,511	-	1,726	1	3,253
2002	-	131	-	15	20	166	45	1,825	-	15,941	4,137	15,471	-	808	-	12,040	99	12,947		1,083	-	1,914	0	2,997
2003	-	154	-	54	-	208	23	905	-	9,464	288	6,517	-	845	-	14,881	372	16,098	1	693	-	4,681	-	5,375
2004	-	144	-	1	-	145	99	1,037	-	5,301	4,645	9,767	-	634	9	11,295	164	12,102	18	1,061	-	671	-	1,750
2005	61	100	-		-	161	111	1,048	-	3,986	8,667	13,680	-	359	4	12,105	220	12,688	195	618	-	558	-	1,371
2006	133	393	-	-	-	526	132	1,256	2	3,854	13,110	16,934	-	428	7	6,033	252	6,720	560	729	-	262	100	1,651
2007	108	272	9	-	8	403	333	1,281	-	2,434	4,831	9,346	5	296	10	8,541	404	9,256	920	716	-	581	120	2,337
2008	34	111	*	*	4	151	108	1,166	*	2,901	2,996	4,631	*	342	*	1,045	87	1,474	898	493	*	4	*	1,395

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

2004		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	190	26	120	-	296	-	-	-	632
CAN	LTL	-	-	-	-	7,676	-	-	-	7,676
CHL	LL	86	-	9	-	8	27	8	-	138
CHN	LL	798	-	2,645	-	590	-	-	-	4,033
CRI	LL	1,701	-	21	-	-	-	-	-	1,722
ECU	LL	-	-	312	-	-	-	-	-	312
	NK	-	-	185	-	-	-	-	-	185
	PS	40,839	89,120	31,368	-	-	97	7	8	161,439
ESP	LL	-	-	5	-	-	-	-	318	323
HND	PS	1,056	3,602	1,830	-	-	-	-	1	6,489
JPN	LL	7,338	97	21,236	2	2,264	-	-	-	30,937
KOR	LL	2,997	31	10,729	-	783	-	-	-	14,540
MEX	LL	32	-	-	14	-	-	-	-	46
	LP	1,882	528	-	-	-	-	-	-	2,410
	PS	90,902	24,968	0	8,880	104	418	8	54	125,334
NIC	LL	43	-	-	-	-	-	-	-	43
PAN	LL	2,802	148	48	-	143	-	-	-	3,141
	PS	31,236	20,184	11,261	-	-	25	-	2	62,708
PER	NK	291	1,098	-	-	-	862	-	258	2,509
PYF	LL	767	56	405	-	1,802	-	-	-	3,030
SLV	LL	9	-	4	-	-	-	-	-	13
TWN	LL	1,824	339	7,384	-	9,988	-	-	-	19,535
USA	GN	1	-	-	10	12	-	3	-	26
	LL	6	3	149	-	8	-	-	-	166
	LP	2	-	-	-	126	-	1	-	129
	LTL	1	-	-	-	12,718	-	-	-	12,719
	PS	2,523	5,071	3,689	-	1	296	-	178	11,758
	RG	334	7	9	52	1,506	-	-	-	1,908
VEN	PS	54,095	12,942	1,040	-	-	47	-	1	68,125
VUT	LL	171	-	407	-	2,554	-	-	-	3,132
	PS	1,621	8,313	5,096	-	-	-	-	0	15,030
OTR[1]	LL[2]	15	13	9	-	255	-	-	31	323
	PS[3]	47,325	34,464	13,308	-	-	1	-	12	95,110

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

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

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

2005		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	164	16	112	-	46	-	-	-	338
CAN	LTL	-	-	-	-	4,799	-	-	-	4,799
CHL	NK	110	-	24	-	7	22	11	-	174
CHN	LL	682	-	2,104	-	895	-	-	-	3,681
CRI	LL	1,791	-	23	-	-	-	-	-	1,814
ECU	LL	-	-	39	-	-	-	-	-	39
	PS	40,754	138,609	32,680	-	-	141	40	28	212,252
ESP	LL	-	-	-	-	-	-	-	362	362
HND	PS	2,215	5,406	3,618	-	-	0	-	0	11,239
JPN	LL	3,966	40	19,113	0	2,593	-	-	-	25,712
KOR	LL	532	-	11,580	-	172	-	-	-	12,284
MEX	LP	1,821	1,300	-	-	-	-	-	-	3,121
	PS	111,458	31,685	0	4,542	-	1,193	273	92	149,243
NIC	LL	18	-	-	-	-	-	-	-	18
	PS	6,912	2,469	33	-	-	0	-	0	9,414
PAN	LL	1,782	94	30	-	91	-	-	-	1,997
	PS	29,897	28,055	13,026	-	-	8	0	8	70,994
PER	NK	458	365	-	-	-	-	-	427	1,250
	OTR	708	1,398	-	-	-	-	-	-	2,106
PYF	LL	530	14	398	-	1,572	-	-	-	2,514
SLV	PS	6,905	5,258	989	-	-	73	-	60	13,285
TWN	LL	2,422	66	6,441	-	3,300	-	-	-	12,229
USA	GN	2	-	-	5	20	-	-	-	27
	LL	7	1	536	-	13	-	-	-	557
	LP	-	-	-	-	66	-	-	-	66
	LTL	-	-	-	-	9,033	-	-	-	9,033
	NK	-	-	-	3	-	-	-	-	3
	RG	574	17	1	77	1,719	-	-	-	2,388
VEN	PS	41,604	14,015	116	-	-	41	-	2	55,778
VUT	LL	-	-	1,056	-	179	-	-	-	1,235
OTR[1]	LL	2	-	-	-	57	-	-	2	61
	PS[2]	27,854	36,283	19,364	201	2	16	-	-	83,720

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

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

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

2006		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	105	13	75	-	8	-	-	-	201
CAN	LTL	-	-	-	-	5,819	-	-	-	5,819
CHL	NK	79	-	36	-	5	-	3	-	123
CHN	LL	246	-	709	-	14	-	-	-	969
CRI	LL	951	-	12	-	-	-	-	-	963
ECU	LL	-	-	120	-	-	-	-	-	120
	PS	25,544	140,610	38,597	-	-	80	-	17	204,848
HND	PS	1,492	6,270	3,832	-	-	-	-	-	11,594
JPN	LL	3,008	17	16,460	0	2,242	-	-	-	21,727
KOR	LL	-	-	8,694	-	58	-	-	-	8,752
MEX	LP	686	435	-	-	-	-	12	-	1,133
	PS	67,958	18,220	59	9,806	109	1,897	3,259	31	101,339
NIC	LL	3	-	-	-	-	-	-	18	21
	PS	7,201	4,886	2,486	-	-	0	-	1	14,574
PAN	LL	2,164	114	37	-	110	-	-	-	2,425
	PS	23,516	44,013	13,247	-	-	8	-	0	80,784
PER	NK	595	73	-	-	-	-	-	192	860
PYF	LL	537	22	388	-	2,273	-	-	-	3,220
	NK	434	899	-	-	114	-	-	-	1,447
TWN	LL	1,671	57	6,412	-	4,235	-	-	-	12,375
USA	GN	1	2	4	0	3	-	-	1	11
	LL	21	1	85	-	14	-	-	-	121
	LTL	-	-	-	-	12,524	-	-	-	12,524
	RG	349	12	0	101	296	-	-	-	758
VEN	PS	17,916	23,804	3,729	-	-	9	248	0	45,706
VUT	LL	-	-	935	-	1,688	-	-	-	2,623
OTR[1]		-	-	-	-	208	-	-	3	211
	PS[2]	22,703	59,605	22,028	-	-	5	-	-	104,341

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

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

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

2007		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	42	11	93	-	1	-	-	-	147
CAN	LTL	-	-	-	-	6,112	-	-	-	6,112
CHL	NK	76	-	37	-	-	-	-	-	113
CHN	LL	224	-	2,324	-	76	-	-	-	2,624
CRI	LL	1,080	-	14	-	-	-	-	-	1,094
ECU	PS	19,741	93,510	40,424	-	-	662	1,361	14	155,712
JPN	LL	5,004	33	14,958	-	1,997	-	-	-	21,992
KOR	LL	353	0	5,611	-	73	-	-	-	6,037
MEX	LL	8	0	-	-	-	0	0	0	8
	LP	894	276	-	-	-	-	107	-	1,277
	PS	64,940	21,694	0	4,147	40	1,449	14,459	345	107,074
NIC	LL	48	-	-	-	-	-	-	2	50
	PS	5,449	2,964	503	-	-	0	-	0	8,916
PAN	LL	-	-	-	-	-	-	-	2,194	2,194
	PS	28,853	23,052	8,855	-	-	92	23	3	60,878
PER	NK	693	73	-	-	-	48	-	189	1,003
PYF	LL	408	22	361	-	2,962	-	-	-	3,753
	NK	406	713	-	-	87	-	-	-	1,206
TWN	LL	745	40	6,057	-	2,656	-	-	-	9,498
USA	GN	0	0	4	2	4	-	-	-	10
	LL	10	1	414	0	7	-	-	-	432
	LTL	-	-	-	-	11,436	-	-	-	11,436
	NK	1	-	3	0	1	-	-	-	5
	RG	91	1	-	14	1,064	-	-	-	1,170
VEN	PS	23,992	21,604	1,193	-	-	23	4	6	46,822
VUT	LL	-	-	1,073	-	1,183	-	-	-	2,256
OTR[1]	PS[2]	27,289	45,466	12,099	42	98	36	0	232	85,262

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

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

TABLE A-3e. Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2008. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.
TABLA A-3e. Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2008 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.

2008		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
CHN	LL	*	*	885	*	*	*	*	*	885
ECU	PS	18,800	144,058	41,162	*	*	110	23	88	204,241
JPN	LL	*	*	11,938	*	66	*	*	*	12,004
KOR	LL	*	*	4,150	*	7	*	*	*	4,157
MEX	LL	2	*	*	0	*	*	*	*	2
	LP	812	499	*	15	*	*	9	*	1,335
	PS	84,703	21,432	328	4,392	10	3,366	6,960	40	121,231
NIC	PS	5,831	6,003	846	*	*	3	0	0	12,683
PAN	LL	*	*	*	*	*	*	*	933	933
	PS	27,152	42,452	11,357	*	*	47	66	4	81,078
PER	NK	172	278	*	*	*	7	*	113	570
TWN	LL	*	*	1,986	*	*	*	*	*	1,986
VEN	PS	21,257	26,910	3,179	*	*	57	9	3	51,415
VUT	LL	*	*	346	*	*	*	*	*	346
OTR[1]	PS[2]	28,103	54,675	18,781	*	*	2	5	0	101,566

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

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

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

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

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches–Capturas retenidas									
ECU	19,741	93,510	40,424	*	*	662	1,361	14	155,712	33.4
MEX	65,834	21,970	0	4,147	40	1,449	14,566	345	108,351	23.3
NIC	5,449	2,964	503	*	*	*	*	*	8,916	1.9
PAN	28,853	23,052	8,855	*	*	92	23	3	60,878	13.1
VEN	23,992	21,604	1,193	*	*	23	4	6	46,822	10.0
OTR[1]	27,289	45,466	12,099	42	98	36	0	232	85,262	18.3
Total	171,158	208,566	63,074	4,189	138	2,262	15,954	600	465,941	
	Landings–Descargas									
COL	36,544	20,963	3,671	*	*	*	*	*	61,178	13.0
ECU	37,272	136,383	50,011	*	*	777	1,554	18	226,015	48.1
MEX	59,669	21,839	137	4,144	40	1,419	14,373	343	101,964	21.7
VEN	9,532	10,207	394	*	*	22	4	5	20,164	4.3
OTR[2]	33,933	22,460	3,715	45	98	42	23	232	60,548	12.9
Total	176,950	211,852	57,928	4,189	138	2,260	15,954	598	469,869	

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

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

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

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

TABLE A-4b. Preliminary estimates of the retained catches and landings, in metric tons, of tunas and bonitos caught by purse-seine and pole-and-line vessels in the EPO in 2008, by species and vessel flag (upper panel) and locations where processed (lower panel). The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates, and are preliminary.

TABLA A-4b. Estimaciones preliminares de las capturas retenidas y descargas, en toneladas métricas, de atunes y bonitos efectuadas por buques cerqueros y cañeros en el OPO en 2008, por especie y bandera del buque (panel superior) y localidad donde fueron procesadas (panel inferior). Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a las estimaciones de composición por especie, y son preliminares.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches–Capturas retenidas									
ECU	18,800	144,058	41,162	*	*	110	23	88	204,241	35.6
MEX	85,515	21,931	328	4,407	10	3,366	6,969	40	122,566	21.4
NIC	5,831	6,003	846	*	*	3	*	*	12,683	2.2
PAN	27,152	42,452	11,357	*	*	47	66	4	81,078	14.1
VEN	21,257	26,910	3,179	*	*	57	9	3	51,415	9.0
OTR[1]	28,103	54,675	18,781	*	*	2	5	0	101,566	17.7
Total	186,658	296,029	75,653	4,407	10	3,585	7,072	135	573,549	
	Landings–Descargas									
COL	27,723	26,579	4,792	*	*	22	*	1	59,117	10.4
ECU	38,395	202,425	60,031	*	*	139	94	70	301,154	52.9
MEX	84,574	26,179	2,026	4,407	10	3,364	6,975	39	127,574	22.4
VEN	9,171	13,048	1,568	*	*	52	9	3	23,851	4.2
OTR[2]	23,297	27,037	6,745	*	*	6	*	5	57,090	10.0
Total	183,160	295,268	75,162	4,407	10	3,583	7,078	118	568,786	

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

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

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

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

TABLE A-5. Annual retained catches of Pacific bluefin tuna, by gear type and flag, in metric tons. The data for 2006 and 2007 are preliminary.
TABLA A-5. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas métricas. Los datos de 2006 y 2007 son preliminares.

PBF	Western Pacific flags—Banderas del Pacífico occidental[1]										Eastern Pacific flags—Banderas del Pacífico oriental						Total
	JPN				KOR[1]		TWN			Sub-total	USA		MEX		OTR	Sub-total	
	PS	LP	LL	OTR	PS	OTR	PS	LL	OTR		PS	OTR	PS	OTR	OTR		
1979	13,881	1,250	764	9,642	-	-	-	58	-	25,595	5,889	17	213	-	-	6,119	31,715
1980	11,327	1,392	851	6,004	-	-	-	114	5	19,693	2,327	31	582	-	-	2,940	22,634
1981	25,422	754	618	6,559	-	-	-	179	-	33,532	867	24	218	-	-	1,109	34,641
1982	19,234	1,777	737	4,239	31	-	-	207	2	26,228	2,639	13	506	-	-	3,159	29,387
1983	14,774	356	224	4,116	13	-	9	175	2	19,670	629	44	214	-	-	887	20,557
1984	4,433	587	164	4,977	4	-	5	477	8	10,655	673	78	166	-	-	917	11,573
1985	4,154	1,817	115	5,587	1	-	80	210	11	11,975	3,320	117	676	-	-	4,113	16,089
1986	7,412	1,086	116	5,100	344	-	16	70	13	14,157	4,851	69	189	-	-	5,109	19,266
1987	8,653	1,565	244	3,524	89	-	21	365	14	14,474	861	54	119	-	-	1,033	15,507
1988	3,605	907	187	2,464	32	-	197	108	62	7,562	923	56	447	1	-	1,427	8,989
1989	6,190	754	241	1,933	71	-	259	205	54	9,707	1,046	134	57	-	-	1,236	10,943
1990	2,989	536	336	2,421	132	-	149	189	315	7,067	1,380	157	50	-	-	1,587	8,653
1991	9,808	286	238	4,204	265	-	-	342	119	15,262	410	98	9	-	2	519	15,781
1992	7,162	166	529	3,205	288	-	73	464	8	11,896	1,928	171	-	-	0	2,099	13,995
1993	6,600	129	822	1,759	40	-	1	471	3	9,825	580	401	-	-	6	986	10,811
1994	8,131	162	1,226	5,667	50	-	-	559	-	15,795	906	148	63	2	2	1,120	16,916
1995	18,909	270	688	7,224	821	-	-	335	2	28,248	657	308	11	-	2	977	29,225
1996	7,644	94	909	5,360	102	-	-	956	-	15,066	4,639	110	3,700	-	4	8,453	23,519
1997	13,152	34	1,312	4,354	1054	-	-	1,814	-	21,720	2,240	290	367	-	14	2,911	24,632
1998	5,390	85	1,266	4,439	188	-	-	1,910	-	13,277	1,771	694	1	0	20	2,487	15,764
1999	16,173	35	1,174	5,192	256	-	-	3,089	-	25,919	184	625	2,369	35	21	3,234	29,153
2000	16,486	102	960	6,935	1,976	-	-	2,780	2	29,240	693	404	3,025	99	21	4,242	33,482
2001	7,620	180	797	5,477	968	10	-	1,839	4	16,895	292	404	863	-	50	1,609	18,504
2002	9,273	99	846	4,158	767	1	-	1,523	4	16,671	50	666	1,708	2	66	2,491	19,162
2003	6,344	44	1,249	3,124	2,141	-	-	1,863	21	14,786	22	412	3,211	43	60	3,748	18,534
2004	7,369	132	1,855	3,592	636	-	-	1,714	3	15,301	-	60	8,880	14	77	9,031	24,333
2005	11,260	549	1,950	6,136	594	-	-	1,368	-	21,857	201	85	4,542	-	27	4,855	26,712
2006	7,161	108	1,151	3,742	949	-	-	1,149	1	14,261	-	98	9,706	-	24	9,828	24,089
2007	5,692	236	1,056	4,989	946	-	-	1,401	10	14,330	42	16	4,005	*	*	4,063	18,393

[1] Source: International Scientific Committee, 8th Plenanary Meeting, Pacific Bluefin Tuna, July 2008, —Fuente: Comité Científico Internacional , 8ª Reunión Plenaria, Atún Aleta Azul del Pacífico, julio de 2008

TABLE A-6a. Annual retained catches of North Pacific albacore by region and gear, in metric tons, compiled from IATTC data (EPO) and SPC data (WCPO). The data for 2007 and 2008 are preliminary.
TABLA A-6a. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas, compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2007 y 2008 son preliminares.

ALB (N)	Eastern Pacific Ocean Océano Pacífico oriental						Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LP	LTL	PS	OTR	Subtotal	LL	LP	LTL	OTR	Subtotal	
1979	1,394	179	4,955	148	74	6,750	13,238	44,786	2,347	4,137	64,508	71,258
1980	1,268	407	5,421	194	168	7,458	14,328	46,717	2,347	4,539	67,931	75,389
1981	2,040	608	12,039	99	227	15,013	16,661	27,566	798	11,299	56,324	71,337
1982	1,971	198	3,303	355	257	6,084	15,783	29,841	3,410	13,706	62,740	68,824
1983	1,572	449	7,751	7	87	9,866	14,502	21,256	1,833	7,589	45,180	55,046
1984	2,592	1,441	8,343	3,910	1,427	17,713	13,070	25,602	1,011	17,243	56,926	74,639
1985	1,313	877	5,308	42	1,176	8,716	13,336	21,335	1,163	13,771	49,605	58,321
1986	698	86	4,282	47	196	5,309	12,442	16,442	456	10,742	40,082	45,391
1987	1,114	320	2,300	1	171	3,906	14,239	18,920	570	11,338	45,067	48,973
1988	899	271	4,202	17	64	5,453	14,554	6,543	165	18,904	40,166	45,619
1989	952	21	1,852	1	160	2,986	13,045	8,662	148	19,826	41,681	44,667
1990	1,143	170	2,440	39	24	3,816	15,117	8,477	465	26,135	50,194	54,010
1991	1,514	834	1,783	-	6	4,137	16,194	6,269	201	10,792	33,456	37,593
1992	1,635	255	4,515	-	2	6,407	18,054	13,633	419	16,578	48,684	55,091
1993	1,772	1	4,331	-	25	6,129	29,127	12,796	2,417	4,087	48,427	54,556
1994	2,356	85	9,574	-	106	12,121	28,386	26,304	3,560	3,380	61,630	73,751
1995	1,380	465	7,306	-	102	9,253	31,493	20,596	3,452	1,622	57,163	66,416
1996	1,675	72	8,195	11	88	10,041	37,614	20,224	13,654	982	72,474	82,515
1997	1,365	59	6,056	1	1,018	8,499	46,520	32,252	12,618	1,718	93,108	101,607
1998	1,730	81	11,936	42	1,208	14,997	46,097	22,924	8,138	2,028	79,187	94,184
1999	2,701	227	10,831	47	3,621	17,427	43,360	50,202	3,022	7,534	104,118	121,545
2000	1,880	86	10,875	71	1,798	14,710	38,990	21,533	4,370	3,187	68,080	82,790
2001	1,822	157	11,597	3	1,635	15,214	34,466	29,412	5,141	1,367	70,386	85,600
2002	1,227	381	11,906	31	2,357	15,902	31,220	48,451	4,417	3,862	87,950	103,852
2003	1,126	59	17,786	32	2,228	21,231	30,342	36,114	4,100	956	71,512	92,743
2004	854	126	20,196	105	1,518	22,799	23,381	32,254	1,977	7,459	65,071	87,870
2005	582	66	13,708	2	1,739	16,097	27,601	16,133	1,016	1,444	46,194	62,291
2006	3,797	1	18,501	109	299	22,707	24,901	15,410	447	837	41,595	64,302
2007	2,980	21	17,548	117	1,069	21,735	27,321	15,390	605	67	43,383	65,118
2008	73	*	*	10	*	83	*	*	*	*	*	83

TABLE A-6b. Annual retained catches of South Pacific albacore by region, in metric tons, compiled from IATTC data (EPO) and SPC data (WCPO). The data for 2007and 2008 are preliminary.
TABLA A-6b. Capturas retenidas anuales de atún albacora del Pacífico Sur por región, en toneladas métricas, compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2007 y 2008 son preliminares.

ALB (S)	Eastern Pacific Ocean Océano Pacífico oriental				Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LTL	OTR	Subtotal	LL	LP	LTL	OTR	Subtotal	
1979	4,189	-	14	4,203	21,973	100	814	-	22,887	27,090
1980	4,051	-	60	4,111	26,921	101	1,468	-	28,490	32,601
1981	5,235	-	35	5,270	27,459	-	2,085	5	29,549	34,819
1982	6,436	-	2	6,438	21,911	1	2,434	4	24,350	30,788
1983	5,861	-	2	5,863	18,448	-	744	37	19,229	25,092
1984	4,120	-	24	4,144	16,220	2	2,773	1,565	20,560	24,704
1985	5,955	-	170	6,125	21,183	-	3,253	1,767	26,203	32,328
1986	5,752	74	149	5,975	26,889	-	1,929	1,797	30,615	36,590
1987	8,880	188	3	9,071	13,090	9	1,946	927	15,972	25,043
1988	9,035	1,282	-	10,317	19,249	-	3,014	5,283	27,546	37,863
1989	5,832	593	90	6,515	12,392	-	7,777	21,878	42,047	48,562
1990	5,393	1,336	306	7,035	13,975	245	5,639	7,232	27,091	34,126
1991	6,379	795	170	7,344	17,006	14	7,010	1,319	25,349	32,693
1992	15,445	1,205	18	16,668	15,147	11	5,373	47	20,578	37,246
1993	9,422	35	19	9,476	20,808	74	4,261	51	25,194	34,670
1994	8,034	442	22	8,498	26,085	67	6,722	67	32,941	41,439
1995	4,805	2	15	4,822	24,536	139	7,714	89	32,478	37,300
1996	5,956	94	21	6,071	17,861	30	7,285	135	25,311	31,382
1997	8,313	466	-	8,779	18,791	21	4,213	133	23,158	31,937
1998	10,905	12	-	10,917	26,892	36	6,268	85	33,281	44,198
1999	8,932	97	7	9,036	22,978	138	3,322	67	26,505	35,541
2000	7,783	779	3	8,565	26,185	102	5,490	136	31,913	40,478
2001	17,588	528	5	18,121	31,050	37	4,614	194	35,895	54,016
2002	14,062	150	40	14,252	46,528	18	4,424	112	51,082	65,334
2003	23,775	530	3	24,308	31,841	12	5,082	135	37,070	61,378
2004	17,590	445	-	18,035	42,993	110	4,086	124	47,313	65,348
2005	8,279	181	7	8,467	48,438	22	3,270	130	51,860	60,327
2006	6,845	49	119	7,013	59,327	26	2,758	78	62,189	69,202
2007	5,975	*	87	6,062	50,849	26	2,093	101	53,069	59,131
2008	*	*	*	*	*	*	*	*	*	*

TABLE A-7. Estimated numbers of sets, by set type and vessel capacity category, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2008 are preliminary. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary.
TABLA A-7. Números estimados de lances, por tipo de lance y categoría de capacidad de buque, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de 2008 son preliminares. Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a la estimación de composición por especie, y son preliminares.

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Vessel capacity—Capacidad del buque		Total	YFT	SKJ	BET
	≤363 t	>363 t				
DEL	**Sets on fish associated with dolphins / Lances sobre peces asociados con delfines**					
1993	34	6,953	6,987	110,893	587	51
1994	5	7,804	7,809	125,345	1,106	1
1995	0	7,185	7,185	132,710	2,548	1
1996	14	7,472	7,486	138,466	1,761	57
1997	43	8,977	9,020	152,228	8,157	0
1998	0	10,645	10,645	154,528	4,998	6
1999	0	8,648	8,648	143,166	1,705	5
2000	0	9,235	9,235	147,776	539	15
2001	0	9,876	9,876	238,145	1,808	6
2002	0	12,290	12,290	301,480	3,177	2
2003	0	13,760	13,760	264,035	13,354	1
2004	0	11,783	11,783	175,856	10,796	3
2005	0	12,173	12,173	166,163	12,078	2
2006	0	8,923	8,923	91,987	4,806	0
2007	0	8,871	8,871	97,351	3,285	7
2008	0	9,201	9,201	115,870	8,802	5
OBJ	**Sets on fish associated with floating objects / Lances sobre peces asociados con objetos flotantes**					
1993	493	2,063	2,556	19,614	53,009	6,141
1994	668	2,770	3,438	20,843	51,125	33,960
1995	707	3,519	4,226	21,146	80,010	41,873
1996	1,230	3,965	5,195	27,842	69,614	58,371
1997	1,699	5,610	7,309	30,007	116,764	62,704
1998	1,198	5,465	6,663	26,286	110,297	41,909
1999	630	4,483	5,113	43,052	181,547	49,330
2000	508	3,713	4,221	42,702	120,616	92,339
2001	827	5,674	6,501	66,598	122,692	60,378
2002	865	5,771	6,636	37,804	116,584	55,919
2003	706	5,457	6,163	30,038	181,551	52,381
2004	615	4,986	5,601	27,587	117,555	66,079
2005	639	4,992	5,631	25,694	132,580	68,141
2006	1,158	6,862	8,020	34,000	191,803	82,273
2007	1,378	5,857	7,235	29,622	122,247	61,821
2008	1,728	6,657	8,385	37,978	155,546	73,860

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

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Vessel capacity—Capacidad del buque		Total	YFT	SKJ	BET
	≤363 t	>363 t				
NOA	Sets on unassociated schools Lances sobre cardúmenes no asociados					
1993	5,739	6,267	12,006	88,985	30,234	3,465
1994	5,440	4,835	10,275	62,220	17,895	938
1995	6,120	4,782	10,902	61,578	44,489	3,447
1996	5,807	5,118	10,925	72,299	32,598	2,883
1997	5,334	4,680	10,014	62,643	28,535	1,568
1998	5,700	4,607	10,307	73,145	25,336	2,214
1999	5,632	6,139	11,771	95,702	78,313	1,823
2000	5,486	5,472	10,958	64,753	83,152	2,286
2001	4,012	3,024	7,036	77,959	19,061	772
2002	4,929	3,442	8,371	73,223	33,542	1,519
2003	7,274	5,131	12,405	87,034	79,624	1,792
2004	4,969	5,696	10,665	66,154	70,313	1,510
2005	6,106	7,816	13,922	75,742	117,122	1,683
2006	6,189	8,443	14,632	40,343	100,799	1,705
2007	4,784	7,211	11,995	43,291	82,758	1,246
2008	4,771	6,220	10,991	31,998	131,182	1,788
ALL	Sets on all types of schools Lances sobre todos tipos de cardumen					
1993	6,266	15,283	21,549	219,492	83,830	9,657
1994	6,113	15,409	21,522	208,408	70,126	34,899
1995	6,827	15,486	22,313	215,434	127,047	45,321
1996	7,051	16,555	23,606	238,607	103,973	61,311
1997	7,076	19,267	26,343	244,878	153,456	64,272
1998	6,898	20,717	27,615	253,959	140,631	44,129
1999	6,262	19,270	25,532	281,920	261,565	51,158
2000	5,994	18,420	24,414	255,231	204,307	94,640
2001	4,839	18,574	23,413	382,702	143,561	61,156
2002	5,794	21,503	27,297	412,507	153,303	57,440
2003	7,980	24,348	32,328	381,107	274,529	54,174
2004	5,584	22,465	28,049	269,597	198,664	67,592
2005	6,745	24,981	31,726	267,599	261,780	69,826
2006	7,347	24,228	31,575	166,330	297,408	83,978
2007	6,162	21,939	28,101	170,264	208,290	63,074
2008	6,499	22,078	28,577	185,846	295,530	75,653

TABLE A-8. Types of floating objects on which sets were made. The 2008 data are preliminary.
TABLA A-8. Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2008 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
1993	1,138	55.2	825	40.0	100	4.8	2,063
1994	773	27.9	1,899	68.6	98	3.5	2,770
1995	728	20.7	2,714	77.1	77	2.2	3,519
1996	538	13.6	3,405	85.9	22	0.6	3,965
1997	829	14.8	4,728	84.3	53	0.9	5,610
1998	751	13.7	4,612	84.4	102	1.9	5,465
1999	831	18.5	3,632	81.0	20	0.4	4,483
2000	488	13.1	3,187	85.8	38	1.0	3,713
2001	592	10.4	5,058	89.1	24	0.4	5,674
2002	778	13.5	4,966	86.1	27	0.5	5,771
2003	715	13.1	4,722	86.5	20	0.4	5,457
2004	586	11.8	4,370	87.6	30	0.6	4,986
2005	603	12.1	4,281	85.8	108	2.2	4,992
2006	697	10.2	6,123	89.2	42	0.6	6,862
2007	597	10.2	5,188	88.6	72	1.2	5,857
2008	549	8.2	6,074	91.2	34	0.5	6,657

TABLE A-9. Reported nominal longline fishing effort (E; 1000 hooks), and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only, by flag, in the EPO.
TABLA A-9. Esfuerzo de pesca palangrero nominal reportado (E; 1000 anzuelos), y captura (C; toneladas métricas) de atunes aleta amarilla, barrilete, patudo, aleta azul del Pacífico, y albacora solamente, por bandera, en el OPO.

LL	CHN		JPN		KOR		PYF		TWN		USA		OTR[1]
	E	C	E	C	E	C	E	C	E	C	E	C	C
1979	-	-	137,776	67,932	5,021	2,305	-	-	3,138	2,293	-	-	-
1980	-	-	138,143	75,639	11,788	5,907	-	-	3,000	1,611	-	-	-
1981	-	-	131,254	59,226	19,731	6,540	-	-	5,952	2,948	-	-	-
1982	-	-	116,210	61,369	18,612	7,489	-	-	8,117	3,910	-	-	-
1983	-	-	127,177	69,563	14,675	6,478	-	-	4,850	2,311	-	-	49
1984	-	-	119,628	57,262	11,767	4,490	-	-	3,730	1,734	-	-	-
1985	-	-	106,761	74,347	19,785	10,508	-	-	3,126	1,979	-	-	2
1986	-	-	160,572	111,673	30,765	17,432	-	-	4,874	2,569	-	-	68
1987	-	-	188,386	104,053	36,436	19,405	-	-	12,267	5,335	-	-	273
1988	-	-	182,709	82,384	43,056	10,172	-	-	9,567	4,590	-	-	234
1989	-	-	170,370	84,961	43,365	4,879	-	-	16,360	4,962	-	-	9
1990	-	-	178,414	117,923	47,167	17,415	-	-	12,543	4,755	-	-	-
1991	-	-	200,374	112,337	65,024	24,644	-	-	17,969	5,862	42	12	173
1992	-	-	191,300	93,011	45,634	13,104	500	88	33,025	14,142	325	106	128
1993	-	-	159,956	87,976	46,375	12,843	2,605	80	18,064	6,566	415	81	227
1994	-	-	163,999	92,606	44,788	13,249	3,410	574	12,588	4,883	303	26	523
1995	-	-	129,599	69,435	54,979	12,778	3,452	559	2,910	1,639	828	179	562
1996	-	-	103,649	52,298	40,290	14,120	4,219	931	5,830	3,554	510	181	184
1997	-	-	96,385	59,325	30,493	16,663	5,490	1,941	8,720	5,673	464	216	752
1998	-	-	106,568	50,167	51,817	15,089	6,415	2,858	10,586	5,039	1,008	405	1,176
1999	-	-	80,950	32,886	54,269	13,295	9,190	4,446	23,247	7,865	1,756	470	1,156
2000	-	-	79,327	45,216	33,585	18,758	10,230	4,382	18,152	7,809	736	204	4,868
2001	13,054	5,162	102,220	54,775	72,261	18,200	11,200	5,086	53,224	20,060	1,438	238	15,614
2002	34,894	10,398	103,912	45,401	96,273	14,370	10,700	3,238	77,051	31,773	611	138	10,258
2003	43,290	14,548	101,236	36,187	71,006	15,551	14,048	4,101	74,322	28,328	1,313	262	11,595
2004	15,886	4,033	76,828	30,937	55,861	14,540	17,865	3,030	51,697	19,535	1,047	166	9,194
2005	16,895	3,681	65,085	25,712	15,798	12,284	13,359	2,514	38,536	12,229	2,579	557	5,442
2006	*	969	57,300	21,727	*	8,752	11,783	3,220	38,089	12,375	234	121	6,335
2007	12,229	2,624	49,621	21,992	10,548	6,037	9,669	3,753	19,911	9,498	2,686	432	3,553

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

TABLE A-10. Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet, 1977-2008. The data for 2008 are preliminary.

TABLA A-10. Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO, 1977-2008. Los datos de 2008 son preliminares.

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
1977	253	189,967	116	6,780	369	196,746
1978	271	192,259	118	6,736	389	198,995
1979	282	195,494	50	4,341	332	199,835
1980	270	196,476	50	4,186	320	200,662
1981	251	196,484	41	3,308	292	199,792
1982	223	178,234	40	3,016	263	181,250
1983	215	149,404	60	3,940	275	153,344
1984	175	121,650	40	3,245	215	124,895
1985	178	137,814	25	2,574	203	140,387
1986	166	131,806	17	2,060	183	133,867
1987	177	152,351	29	2,376	206	154,727
1988	189	156,636	36	3,274	225	159,910
1989	178	141,956	30	3,135	208	145,091
1990	172	143,946	23	2,044	195	145,990
1991	155	124,501	19	1,629	174	126,131
1992	160	117,017	19	1,612	179	118,629
1993	152	118,730	15	1,543	167	120,272
1994	167	122,214	20	1,725	187	123,939
1995	175	124,096	20	1,784	195	125,880
1996	183	132,731	17	1,639	200	134,370
1997	194	146,533	23	2,105	217	148,637
1998	203	161,560	22	2,217	225	163,777
1999	208	180,652	14	1,656	222	182,308
2000	205	180,679	13	1,310	218	181,989
2001	205	189,897	10	1,259	215	191,156
2002	218	199,870	6	921	224	200,791
2003	215	202,755	3	338	218	203,093
2004	218	206,473	3	338	221	206,811
2005	222	213,286	4	498	226	213,784
2006	226	225,950	4	498	230	226,448
2007	228	226,878	4	380	232	227,258
2008	218	224,686	4	380	222	225,066

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

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

Flag Bandera	Gear Arte	Well volume —Volumen de bodega (m^3)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m^3)
		Number—Número						
BOL	PS	1	-	-	-	-	1	222
COL	PS	3	1	7	3	-	14	14,689
ECU	PS	35	19	16	4	9	83	59,517
ESP	PS	-	-	-	-	3	3	6,955
GTM	PS	-	-	-	1	-	1	1,475
HND	PS	1	1	1	-	-	3	1,700
MEX	PS	8	10	23	17	-	58	57,859
	LP	4	-	-	-	-	4	380
NIC	PS	-	-	6	-	-	6	7,107
PAN	PS	1	4	9	10	4	28	36,782
PER	PS	-	1	-	-	-	1	542
SLV	PS	-	-	1	-	3	4	7,415
UNK	PS	2	-	-	-	-	2	494
USA	PS	1	-	-	2	-	3	3,288
VEN	PS	-	-	11	9	2	22	29,684
VUT	PS	-	-	1	2	-	3	3,609
Grand total—Total general	PS	51	36	74	46	21	228	
	LP	4	-	-	-	-	4	
	PS + LP	55	36	74	46	21	232	
		Well volume—Volumen de bodega (m^3)						
Grand total—Total general	PS	12,758	20,374	82,227	67,445	44,074		226,878
	LP	380	-	-	-	-		380
	PS + LP	13,138	20,374	82,227	67,445	44,074		227,258

- : none—ninguno

TABLE A-11b. Estimates of the numbers and well volumes (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2008 by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

TABLA A-11b. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2008, por bandera y arte de pesca. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag Bandera	Gear Arte	Well volume —Volumen de bodega (m^3)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m^3)
		Number—Número						
COL	PS	3	2	7	3	-	15	15,110
ECU	PS	35	20	16	4	9	84	60,519
ESP	PS	-	-	-	-	4	4	10,116
GTM	PS	-	-	-	2	-	2	3,056
HND	PS	-	1	1	-	-	2	1,559
MEX	PS	7	7	21	16	-	51	52,920
	LP	4	-	-	-	-	4	380
NIC	PS	-	-	5	-	-	5	6,023
PAN	PS	-	4	9	10	4	27	36,711
PER	PS	-	2	-	-	-	2	1,000
SLV	PS	-	-	1	-	3	4	7,415
USA	PS	1	-	-	-	-	1	170
VEN	PS	-	-	10	8	2	20	28,309
VUT	PS	-	-	1	2	-	3	3,609
Grand total—Total general	PS	45	36	71	44	22	218	
	LP	4	-	-	-	-	4	
	PS + LP	49	36	71	44	22	222	
		Well volume—Volumen de bodega (m^3)						
Grand total—Total general	PS	11,758	20,556	79,357	64,580	48,435		224,686
	LP	380	-	-	-	-		380
	PS + LP	12,138	20,556	79,357	64,580	48,435		225,066

- : none—ninguno

TABLE A-12. Minimum, maximum, and average capacity, in thousands of cubic meters, of purse-seine and pole-and-line vessels at sea in the EPO during l998-2007 and in 2008, by month.

TABLA A-12. Capacidad mínima, máxima, y media, en miles de metros cúbicos, de los buques cerqueros y cañeros en el mar en el OPO durante 1998-2007 y en 2008 por mes.

Month Mes	**1998-2007**			**2008**
	Min	**Max**	**Ave.-Prom.**	
1	69.6	157.7	120.4	121.4
2	104.3	175.3	132.9	151.0
3	98.0	159.9	126.9	139.6
4	101.3	164.2	130.4	143.4
5	95.2	164.4	127.9	146.8
6	103.3	175.0	130.4	155.4
7	87.6	170.4	133.8	166.2
8	62.2	140.2	109.2	102.9
9	92.9	137.7	119.0	114.8
10	93.6	172.2	136.6	151.7
11	77.3	145.0	121.0	150.8
12	33.1	116.4	71.1	77.7
Ave.-Prom.	84.9	156.5	121.6	135.1

B. YELLOWFIN TUNA

An integrated statistical age-structured stock assessment model (Stock Synthesis Version 3; Methot 2005, 2009) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO. This model differs from that used in previous assessments. Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made in the eastern and western regions. The purse-seine catches of yellowfin are relatively low in the vicinity of the western boundary of the EPO. The movements of tagged yellowfin are generally over hundreds, rather than thousands, of kilometers, and exchange between the eastern and western Pacific Ocean appears to be limited. This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at a local level, although there is some genetic evidence for local isolation. Movement rates between the EPO and the western Pacific cannot be estimated with currently-available tagging data.

The stock assessment requires substantial amounts of information, including data on retained catches, discards, indices of abundance, and the size compositions of the catches of the various fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure. The assessment for 2009 differs substantially from that of 2008 because it uses the Stock Synthesis program. Previous assessments have used the A-SCALA program. The main differences include: use of a sex-specific model, inclusion of indices of abundance rather than effort, and use of functional forms for selectivity. The catch and length-frequency data for the surface fisheries have been updated to include new data for 2008. New or updated longline catch data are available for China (2007), Chinese Taipei (2005-2007) and Japan (2003-2007). The catches are shown in Figure B-1.

In general, the recruitment of yellowfin to the fisheries in the EPO is variable, with a seasonal component (Figure B-2). This analysis and previous analyses have indicated that the yellowfin population has experienced two, or possibly three, different recruitment productivity regimes (1975-1982, 1983-2002, and 2003-2006). The productivity regimes correspond to regimes in biomass, higher-productivity regimes producing greater biomass levels. A stock-recruitment relationship is also supported by the data from these regimes, but the evidence is weak, and is probably an artifact of the apparent regime shifts. Larger recruitments in 2007 and 2008 have caused the biomass to increase in recent years.

The average weights of yellowfin taken from the fishery have been fairly consistent over time, but vary substantially among the different fisheries. In general, the floating-object, northern unassociated, and pole-and-line fisheries capture younger, smaller yellowfin than do the southern unassociated, dolphin-associated and longline fisheries. The longline fisheries and the dolphin-associated fishery in the southern region capture older, larger yellowfin than do the northern and coastal dolphin-associated fisheries.

Significant levels of fishing mortality have been estimated for the yellowfin fishery in the EPO (Figure B-3). These levels are highest for middle-aged yellowfin. Despite more catch being taken in schools associated with dolphins than the other fisheries, the floating object and purse seine sets on unassociated schools have a greater impact on the yellowfin spawning biomass (Figure B-4).

The estimated biomass is significantly lower than estimated in the previous assessment indicating that the results are sensitive to the changes in assessment methodology. There is also a large retrospective pattern of overestimating recent recruitment, due to the floating-object size composition data. These, in combination with the large confidence intervals for estimates of recent recruitment, indicate that estimates of recent recruitment and recent biomass are uncertain. The results of the assessment are also particularly sensitive to the level of natural mortality assumed for adult yellowfin.

Historically, the spawning biomass ratio (SBR) of yellowfin in the EPO was below the level corresponding to the maximum sustainable yield (MSY) during the lower productivity regime of 1975-1983 (Section 4.2.1), but above that level for most of the following years, except for the recent period (2004-2007) (Figure B-5). The 1984 increase in the SBR is attributed to the regime change, and the recent decrease may be a reversion to an intermediate productivity regime. The two different productivity regimes may support two different MSY levels and associated SBR levels. The SBR at the start of 2009 is estimated to be above the level corresponding to the MSY. The effort levels are estimated to be less than those that would support the MSY (based on the current distribution of effort among the different fisheries) (Figure B-8), but recent catches are substantially below MSY (Table B-1).

It is important to note that the curve relating the average sustainable yield to the long-term fishing mortality is very flat around the MSY level (Figure B-9). Therefore, changes in the long-term levels of effort will change the long-term catches only marginally, while changing the biomass considerably. Reducing fishing mortality below the level at MSY would provide only a marginal decrease in the long-term average yield, with the benefit of a relatively large increase in the spawning biomass. In addition, fishing at levels corresponding to the MSY estimated from the base case, which assumes that recruitment is independent of spawning biomass, when the true dynamics includes a stock recruitment relationship causes a greater loss in yield than fishing at levels corresponding to MSY estimated from the stock-recruitment relationship sensitivity when recruitment is in fact independent of spawning biomass (Figure B-9).

The MSY calculations indicate that, theoretically, at least, catches could be increased if the fishing effort were directed toward longlining and purse-seine sets on yellowfin associated with dolphins. This would also increase the SBR levels.

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

The SBR corresponding to MSY decreased substantially from the previous assessment indicating that the results are sensitive to the change in methodology. The change is attributed to the method used to model selectivity. However, the SBR relative to SBR corresponding to MSY and the F multiplier are similar to the previous assessment.

If a stock-recruitment relationship is assumed, the outlook is more pessimistic, and current biomass is estimated to be below the level corresponding to the MSY. The status of the stock is also sensitive to the value of adult natural mortality, the method used to model selectivity, and the assumed length of the oldest age modeled (29 quarters).

Under current levels of fishing mortality (2006-2008), the spawning biomass is predicted to slightly decrease, but remain above the level corresponding to MSY (F_{MSY}). It is predicted that the catches will be higher over the near term than in 2008, but will decline slightly in the future (Figure B-6). Fishing at F_{MSY} predicted to reduce the spawning biomass slightly from that under current effort and produces slightly higher catches

Key results

1. The stock assessment method has changed to Stock Synthesis
2. The estimates of the key management quantities are similar to the previous assessments
3. Estimates of absolute biomass are lower than estimated in previous years
4. The SBR corresponding to MSY has reduced substantially from previous assessments and the reduction is attributed to the new method to model selectivity
5. There is uncertainty about recent and future recruitment and biomass levels and there are retrospective patterns of overestimating recent recruitment.
6. The recent fishing mortality rates are close to those corresponding to the MSY and SBR is above the level corresponding to the MSY.
7. Increasing the average weight of the yellowfin caught could increase the MSY.

8. There have been two, and possibly three, different productivity regimes, and the levels of MSY and the biomasses corresponding to the MSY may differ between the regimes. The population may have recently switched from the high to an intermediate productivity regime.
9. The results are more pessimistic if a stock-recruitment relationship is assumed.
10. The results are sensitive to the natural mortality assumed for adult yellowfin, the method used to model selectivity, and the length assumed for the oldest fish.

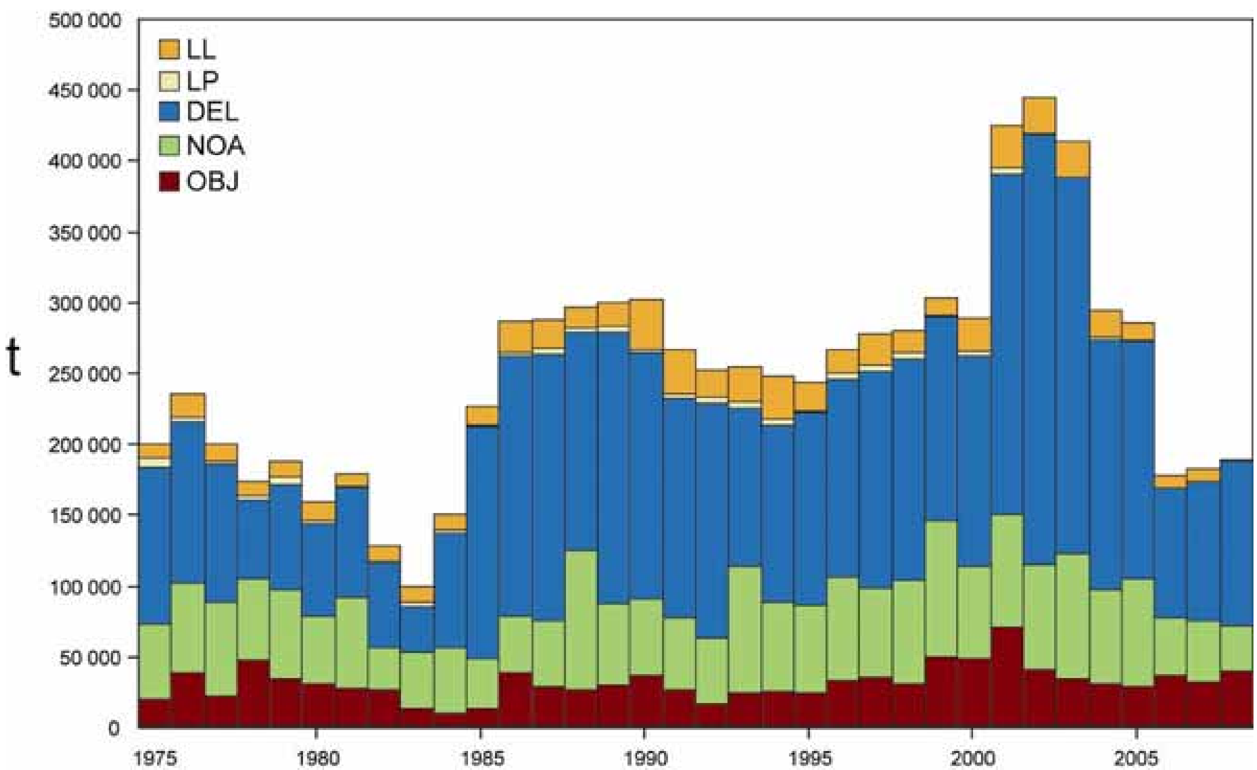


FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2008. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2008 catch data are provisional.
FIGURA B-1. Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco, y capturas retenidas de las pesquerías cañera y palangreras, de atún aleta amarilla en el Océano Pacífico oriental, 1975-2008. Las capturas cerqueras están ajustadas a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de captura de 2008 son provisionales.

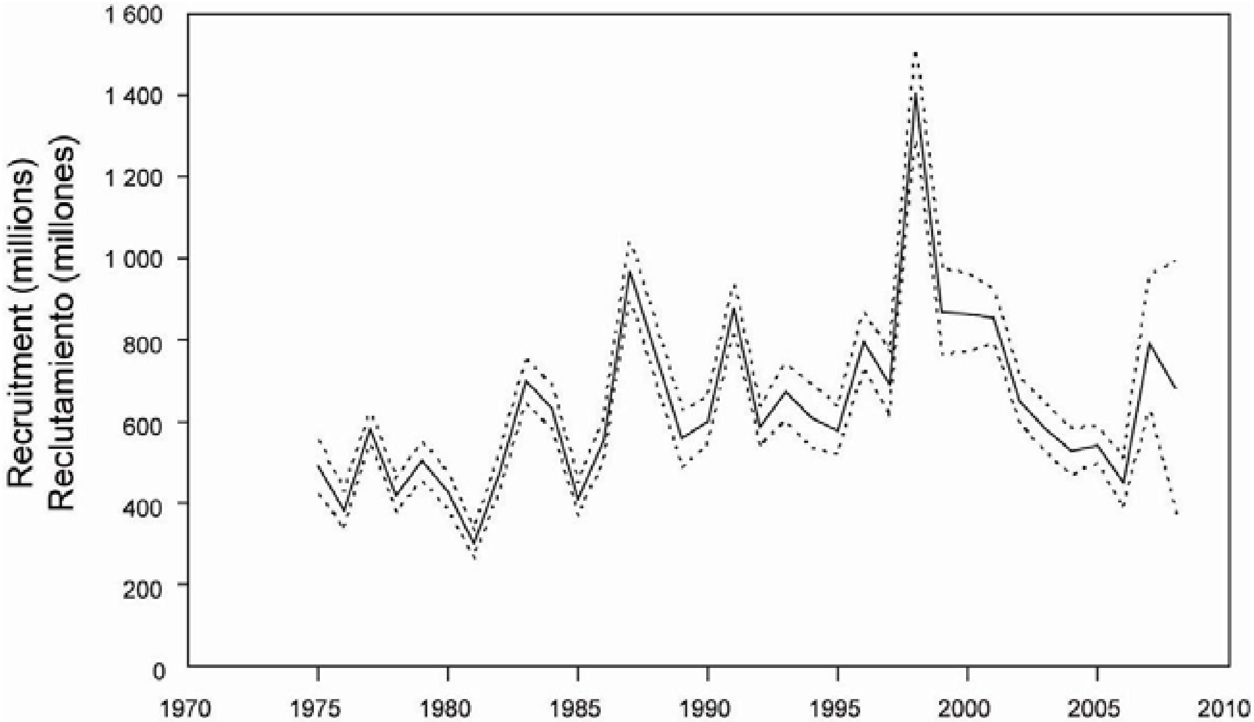


FIGURE B-2. Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.

FIGURA B-2. Reclutamiento estimado de atún aleta amarilla a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea gruesa ilustra las estimaciones de probabilidad máxima del reclutamiento, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

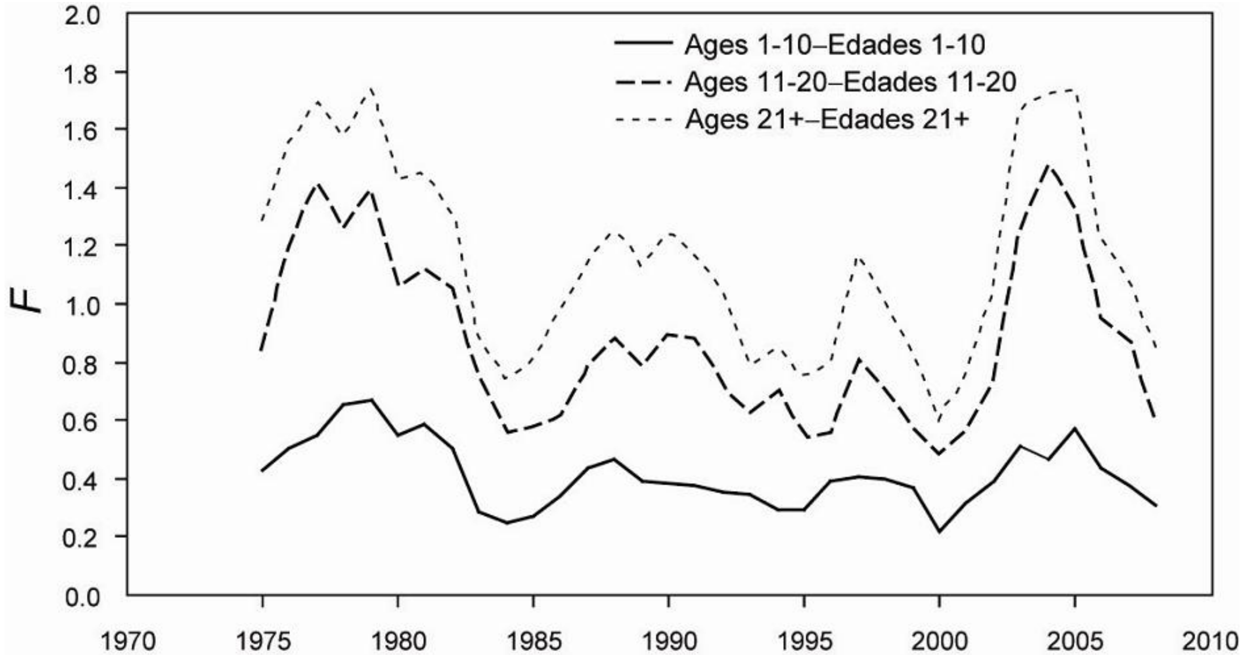


FIGURE B-3. Average total annual fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each line illustrates an average of annual fishing mortality vectors that affected the fish of the age range (in quarters) indicated in the legend.

FIGURA B-3. Mortalidad por pesca anual total media de atún aleta amarilla reclutado a las pesquerías del OPO. Cada línea ilustra un promedio de vectores anuales de mortalidad por pesca que afectaron a los peces de la edad (en trimestres) indicada en la leyenda.

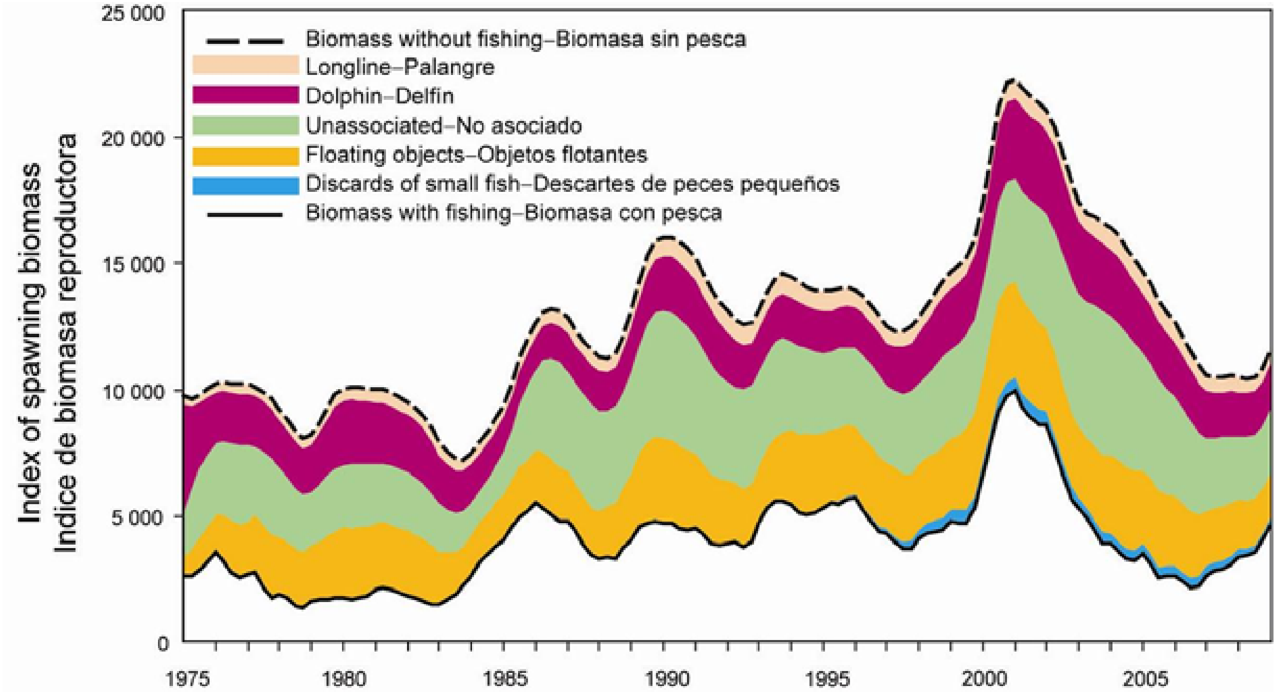


FIGURE B-4. Spawning biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2008 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing method.

FIGURA B-4. Trayectoria de la biomasa reproductora de una población simulada de atún aleta amarilla no explotada durante 1975-2008 (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.

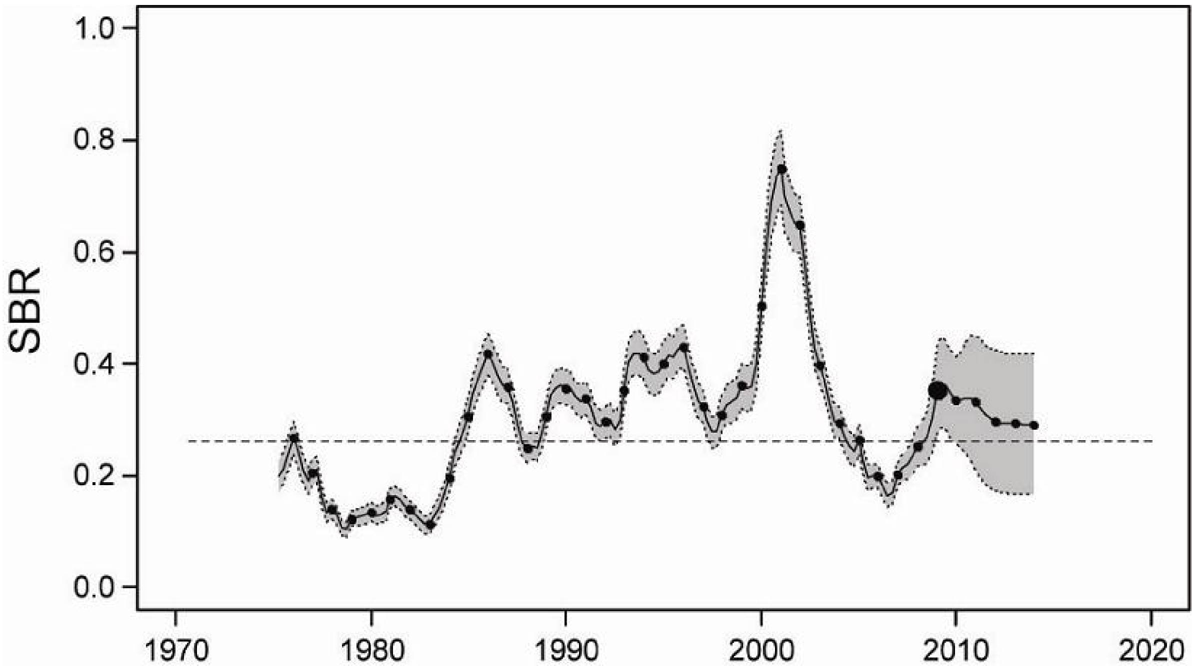


FIGURE B-5. Spawning biomass ratios (SBRs) for 1975-2008 and SBRs projected during 2009-2014 for yellowfin tuna in the EPO. The dashed horizontal line (at 0.27) identifies SBR_{MSY}. The shaded area represents the 95% confidence limits of the estimates. The estimates after 2009 (the large dot represents the start of the second quarter of 2009) indicate the SBR predicted to occur if effort continues at the current level (2006-2008), and average environmental conditions occur during the next five years.

FIGURA B-5. Cocientes de biomasa reproductora (SBR) de 1975-2008 y SBR proyectados durante 2009-2014 para el atún aleta amarilla en el OPO. La línea de trazos horizontal (en 0.27) identifica el SBR_{RMS}. El área sombreada representa los límites de confianza de 95% de las estimaciones. Las estimaciones a partir de 2009 (el punto grande representa el principio del segundo trimestre de 2009) señalan el SBR predicho si el esfuerzo continúa en el nivel actual (2006-2008), y ocurren condiciones ambientales medias en los cinco años próximos.

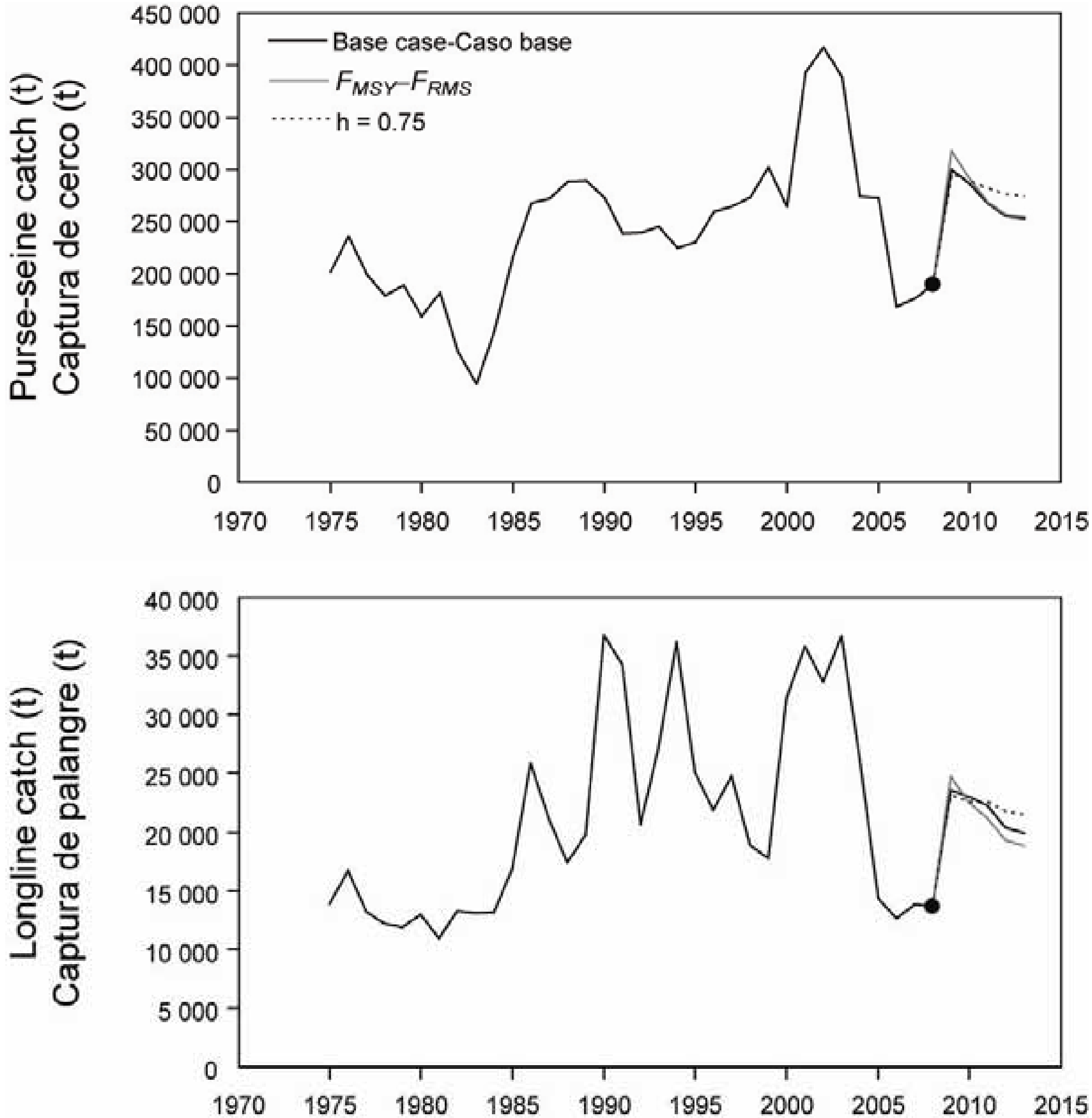


FIGURE B-6. Catches of yellowfin tuna during 1975-2008, and simulated catches of yellowfin tuna during 2009-2013, by the purse-seine and pole-and-line fleets (upper panel) and the longline fleet (lower panel).

FIGURA B-6. Capturas de atún aleta amarilla durante 1975-2008, y capturas simuladas de aleta amarilla durante 2009-2013, por las flotas de cerco y de caña (recuadro superior) y la flota palangrera (recuadro inferior).

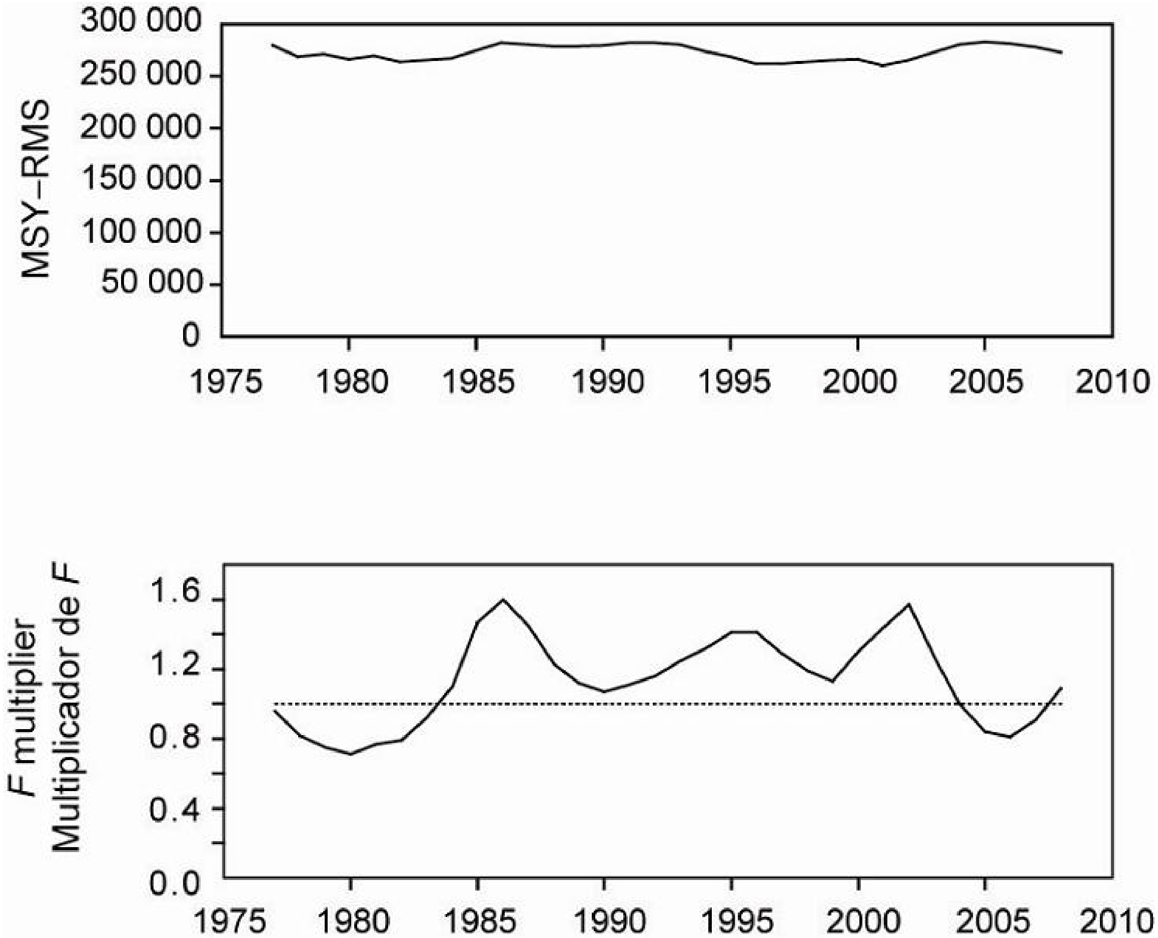


FIGURE B-7. MSY of yellowfin tuna, 1975-2008 (upper panel), and the change (increase or reduction) in the effort corresponding to the MSY (lower panel), estimated separately for each year, using the average age-specific fishing mortality for that year.

FIGURA B-7. RMS de atún aleta amarilla, 1975-2008 (recuadro superior), y cambio (aumento o reducción) del esfuerzo correspondiente al RMS (recuadro inferior), estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

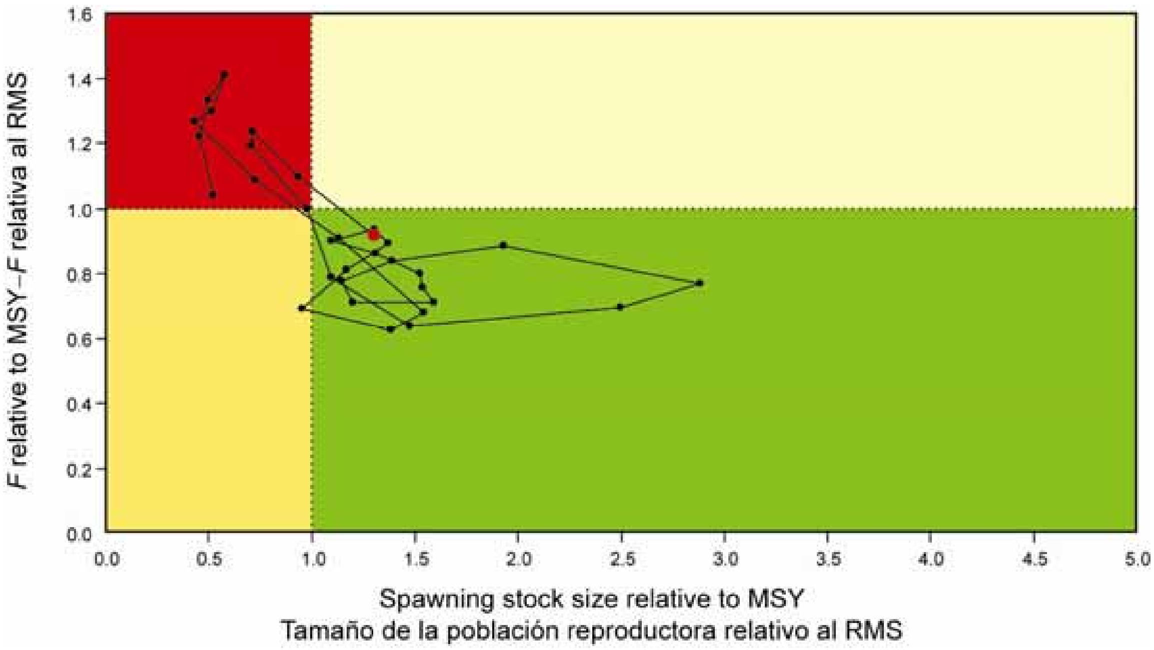


FIGURE B-8. Phase plot of the time series of estimates for stock size and fishing mortality of yellowfin tuna relative to their MSY reference points. Each dot is based on the average exploitation rate over three years; the large dot indicates the most recent estimate. The squares represent approximate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

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

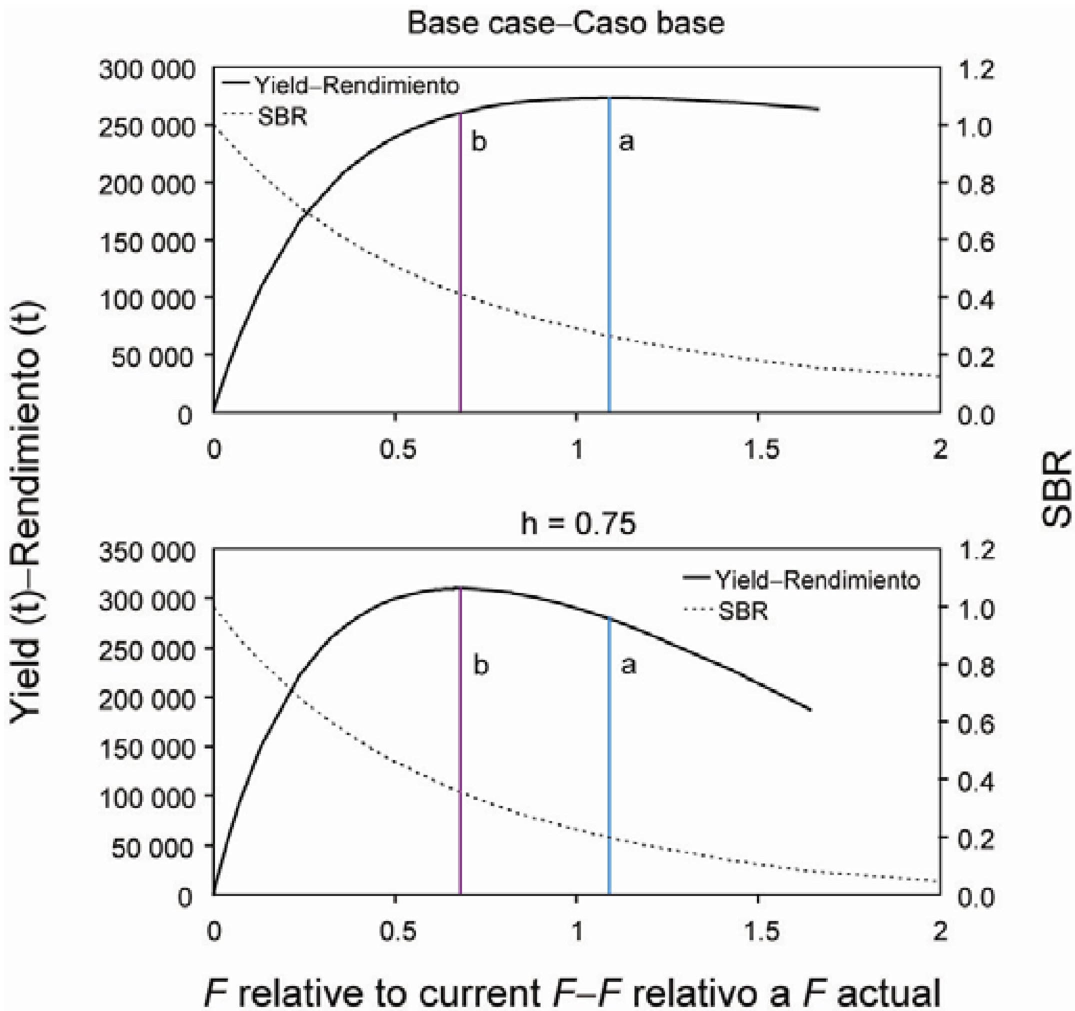


FIGURE B-9. Yield and spawning biomass ratio (SBR) as a function of fishing mortality relative to the current fishing mortality. The vertical lines represent the fishing mortality corresponding to (a) MSY for the base case and (b) the sensitivity analysis that uses a stock-recruitment relationship (h = 0.75).

FIGURA B-9. Rendimiento y cociente de biomasa reproductora (SBR) como función de la mortalidad por pesca relativa a la mortalidad por pesca actual. Las líneas verticales representan la mortalidad por pesca correspondiente a (a) el RMS del caso base y (b) el análisis de sensibilidad que usa una relación población-reclutamiento (h = 0.75).

TABLE B-1. MSY and related quantities for the base case, the stock-recruitment relationship sensitivity analysis, and growth sensitivity analyses. All analyses are based on average fishing mortality for 2006-2008. B_{recent} and B_{MSY} are the biomass of yellowfin tuna 2+ quarters old at the start of 2009 and at MSY, respectively, and S_{2009}, S_{MSY}, and $S_{F=0}$ are indices of spawning biomass (relative number of eggs) at the start of 2009, at MSY, and without fishing, respectively. C_{2008} is the estimated total catch in 2008.

TABLA B-1. El RMS y sus valores asociados para la evaluación del caso base y el análisis de sensibilidad que incluye una relación población-reclutamiento, y análisis de sensibilidad al crecimiento. Todos los análisis se basan en la mortalidad por pesca media de 2006-2008. B_{reciente} y B_{RMS} son la biomasa de atún aleta amarilla de 2+ trimestres de edad al principio de 2009 y en RMS, respectivamente, y S_{2009}, S_{RMS}, y $S_{F=0}$ son índices de la biomasa reproductora (número relativo de huevos) al principio de 2009, en RMS, y sin pesca, respectivamente. C_{2007} es la captura total estimada en 2008.

	Base case Caso base	**h = 0.75**
MSY–RMS	273,159	310,073
B_{MSY} –B_{RMS}	372,909	594,909
S_{MSY} —S_{RMS}	3,522	6,436
C_{2008}/MSY—C_{2008}/RMS	0.75	0.66
$B_{\text{recent}}/B_{\text{MSY}}$ –$B_{\text{reciente}}/B_{\text{RMS}}$	1.27	0.78
S_{2009}/S_{MSY} –S_{2009}/S_{RMS}	1.32	0.71
$S_{\text{MSY}}/S_{F=0}$ –$S_{\text{RMS}}/S_{F=0}$	0.27	0.36
F multiplier—Multiplicador de *F*	1.09	0.68

C. SKIPJACK TUNA

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

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

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

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

Eight data- and model-based indicators are shown in Figure C-2. The standardized effort, which is a measure of exploitation rate, is calculated as the sum of the effort, in days fished, for the floating-object (OBJ) and unassociated (NOA) fisheries. The floating-object effort is standardized to be equivalent to the unassociated effort by multiplying the floating-object effort by the ratio of the average floating-object CPUE to the average unassociated CPUE. The purse-seine catch has been increasing since 1985, and is currently above the upper reference level. Except for a large peak in 1999, the floating-object CPUE has generally fluctuated around an average level since 1990. The unassociated CPUE has been higher than average since about 2003 and was at its highest level in 2008. The standardized effort indicator, which is a measure of exploitation rate has been increasing since about 1991, but declined in recent years. The average weight of skipjack has been declining since 2000, and the 2008 average weight is approaching the lower reference level. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years.

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

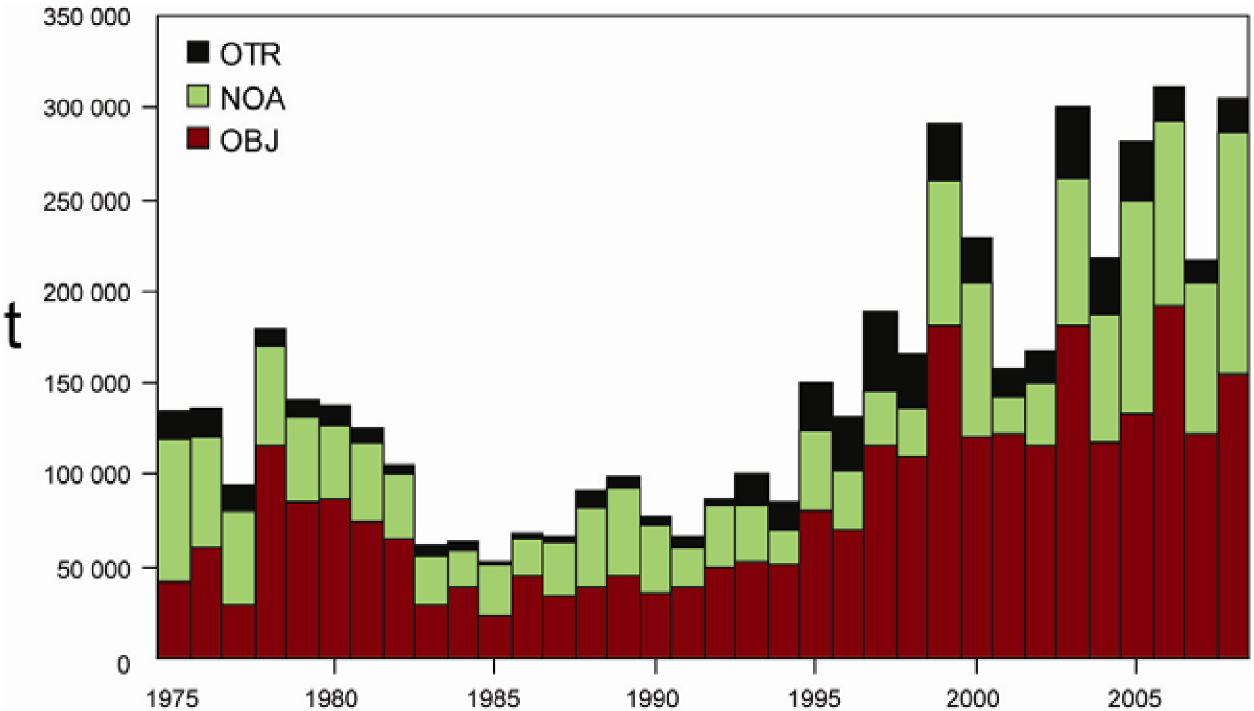


FIGURE C-1. Total catches (retained catches plus discards) of skipjack tuna by the purse-seine fisheries on floating objects and unassociated schools, and by other fisheries combined, in the eastern Pacific Ocean, 1975-2008. The purse-seine catches for 1975-2006 are adjusted to the species composition estimate.

FIGURA C-1. Capturas totales (capturas retenidas más descartes) de atún barrilete por las pesquerías de cerco sobre objetos flotantes y cardúmenes no asociados, y de las demás pesquerías combinadas, en el Océano Pacífico oriental, 1975-2008. Las capturas cerqueras de 1975-2006 fueron ajustadas a la estimación de composición por especies.

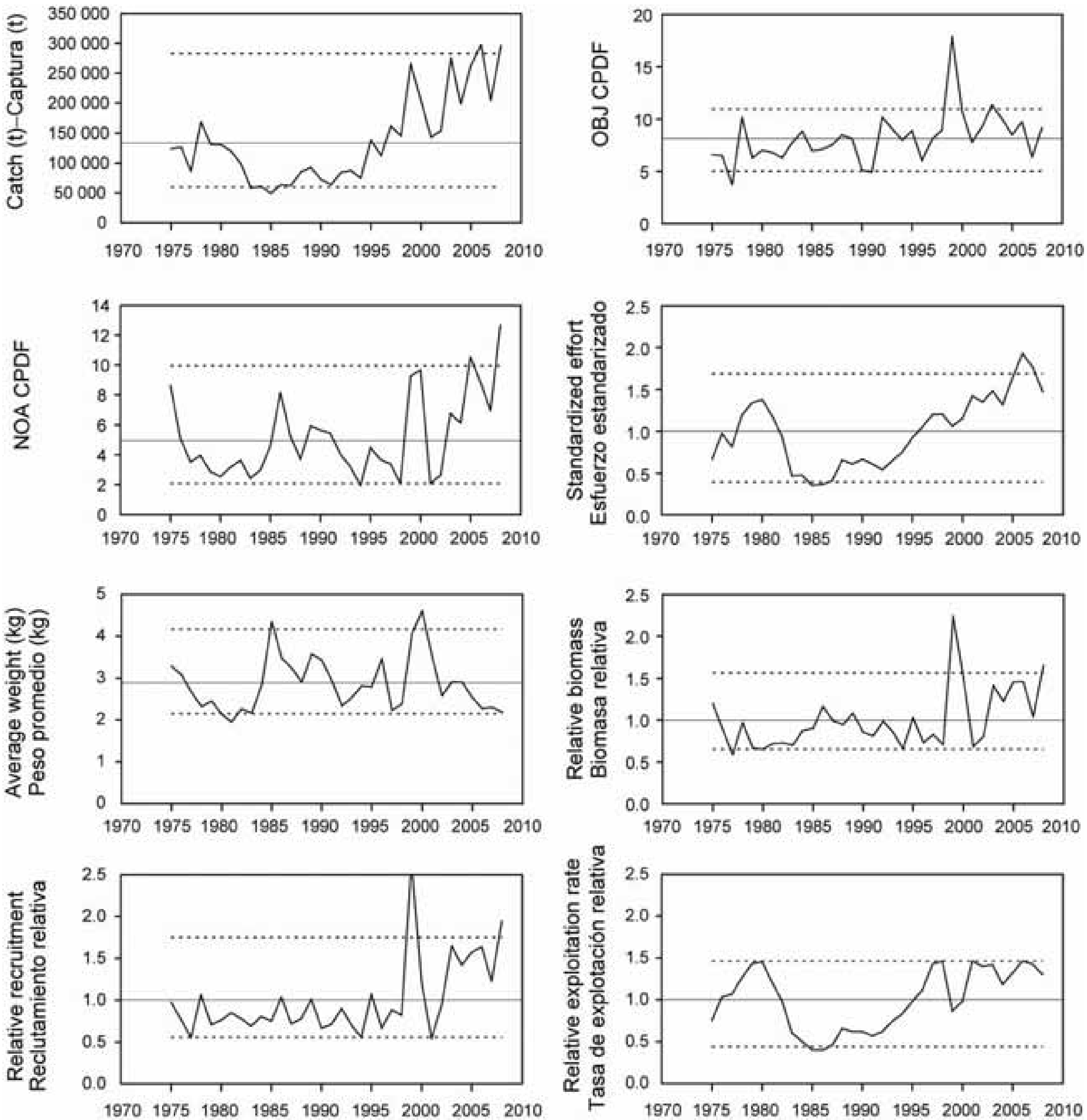


FIGURE C-2. Indicators of the stock status of skipjack tuna based on data and/or a simple stock assessment model. CPDF: catch per day fished.

FIGURA C-2. Indicadores de la condición de la población de atún barrilete basados en datos y/o en un modelo sencillo de evaluación de población. CPDF: captura por día de pesca

D. BIGEYE TUNA

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

The stock assessment requires a substantial amount of information. Data on retained catch, discards, catch per unit of effort (CPUE), and size compositions of the catches from several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, and fishing mortality, have also been made. Catch, CPUE, and length-frequency data for the surface fisheries have been updated to include new data for 2008. New or updated longline catch data are available for Chinese Taipei (2005-2007), the Peoples Republic of China (2007), and Japan (2003-2007).

Bigeye are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. The purse-seine catches of bigeye are substantially lower close to the western boundary (150ºW) of the EPO (Figure A-3); the longline catches are more continuous, but show lower levels between 160ºW and 180º (Figure A-4). Bigeye are not often caught by purse seiners in the EPO north of 10ºN (Figure A-3), but a substantial portion of the longline catches of bigeye in the EPO is made north of that parallel (Figure A-4). Bigeye tuna do not move long distances (95% of tagged bigeye showed net movements of less than 1000 nautical miles), and current information indicates little exchange between the eastern and western Pacific Ocean (Figure D-1). This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at local levels. The assessment is conducted as if there were a single stock in the EPO. Its results are consistent with results of other analyses of bigeye tuna on a Pacific-wide basis. In addition, analyses have shown that the results are insensitive to the spatial structure of the analysis. Currently, there are not enough tagging data to provide adequate estimates of movement between the eastern and western Pacific Ocean.

There have been substantial changes in the bigeye tuna fishery in the EPO. Initially, the majority of the bigeye catch was taken by longline vessels, but with the expansion of the fishery on fish associated with fish-aggregating devices (FADs) since 1993, the purse-seine fishery has taken an increasing proportion of the bigeye catch (Figure D-2). The FAD fishery captures smaller bigeye, and has therefore resulted in important changes in the amount of fishing mortality for bigeye in the EPO. On average, since 1993 the fishing mortality of bigeye less than about 15 quarters old has increased substantially, and that of fish more than about 15 quarters old has increased slightly (Figure D-3).

Over the range of spawning biomasses estimated by the base case assessment, the abundance of bigeye recruits appears to be unrelated to the spawning potential of adult females at the time of hatching.

There are 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 were not catching significant amounts of small bigeye. There was a period of above-average recruitment in 1994-1998, followed by a period of below-average recruitment in 1999-2000. The recruitments have been above average from 2001 to 2006, and were particularly large in 2005 and 2006. The 2007 recruitment was below average, but the recent recruitment in 2008 appears to be particularly high. However, this recent estimate is very uncertain and should be regarded with caution, due to the fact that recently-recruited bigeye are represented in only a few length-frequency samples.

The biomass of 3+-quarter-old bigeye increased during 1975-1986, and reached its peak level of about 630 thousand metric tons (t) in 1986, after which it decreased to an historic low of 287 thousand t at the beginning of 2009. Spawning biomass has generally followed a trend similar to that for the biomass of 3+-quarter-olds, but lagged by 1-2 years. There is uncertainty in the estimated biomasses of both 3+-quarter-old bigeye and spawners. Nevertheless, it is apparent that fishing has reduced the total biomass of

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

bigeye in the EPO. The biomasses of both 3+quarter-old fish and spawners are estimated to have been nearly stable with no trend for the last six years.

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

At the beginning of 2009, the spawning biomass of bigeye tuna in the EPO was near the historic low level (Figure D-6). At that time the spawning biomass ratio (the ratio of the spawning biomass at that time to that of the unfished stock; SBR) was about 0.17, which is about 11% less than the level corresponding to the maximum sustainable yield (MSY). Recent spikes in recruitment are predicted to result in stabilized levels of SBR and increased longline catches for the next few years (Figure D.7). However, high levels of fishing mortality are expected to subsequently reduce the SBR and catches. Under current effort levels, the population is unlikely to remain at levels that support MSY unless fishing mortality levels are greatly reduced or recruitment is above average for several consecutive years. These simulations are based on the assumption that selectivity and catchability patterns will not change in the future. Changes in targeting practices or increasing catchability of bigeye as abundance declines (*e.g.* density-dependent catchability) could result in differences from the outcomes predicted here.

Recent catches are estimated to have been 19% higher than the MSY level (Table D-1). If fishing mortality (F) is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the MSY is about 81% of the current (2006-2008) level of effort. The MSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery that operates south of 15°N because it catches larger individuals that are close to the critical weight. Before the expansion of the floating-object fishery that began in 1993, the MSY was greater than the current MSY and the fishing mortality was less than F_{MSY} (Figure D-8). The base case stock assessment results indicate that the bigeye stock in the EPO is overfished ($S < S_{MSY}$) and that overfishing is taking place ($F > F_{MSY}$) (Figure D-9).

Analyses were carried out to assess the sensitivity of the stock assessment results to: 1) a stock-recruitment relationship; 2) use of a Richards growth curve fit to age at length data derived from otolith data; 3) extending the assumed western limit of the bigeye stock distribution from 150°W to 170°E.

The estimates of biomass are moderately sensitive to the steepness of the stock-recruitment relationship, but the trends are very similar to the base case. The recruitment time series is similar to the base case.

When a Richards growth curve was used, the biomasses were lower than those obtained by base case model which assumes a von Bertalanffy growth function. However, the trends in the biomasses were very similar. The recruitment estimates were also very similar between the two models. The Richards growth curve provided a better fit to the fishery data when compared to the base case model.

When the assumed western limit of the bigeye stock distribution was extended from 150°W to 170°E, and the additional catch taken in the WCPO were included in the model, the recruitments and biomasses were greater than those estimated by the base case. However, the biomass estimates for most years became lower than the base case when the model was also fit to the additional CPUE and size composition data from the WCPO.

All four scenarios considered suggest that, at the beginning of 2009, the spawning biomass (S) was below S_{MSY}. MSY and the 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 F_{MSY}. The management quantities derived from the base case model were the less pessimistic among all scenarios.

Key results

1. The results of this assessment are similar to the previous assessments;

2. There is uncertainty about recent and future recruitment and biomass levels;
3. The recent fishing mortality rates are well above those corresponding to the MSY and this result is consistent across various modeling scenarios;
4. The recent SBR levels are below those corresponding to the MSY and this result is consistent across various modeling scenarios;
5. The results from the base case model are the more optimistic among the various modeling scenarios investigated;
6. The results are more pessimistic if a stock-recruitment relationship is assumed;
7. Assuming a more flexible Richards growth curve improved the model fit to the fishery data. This alternative model could potentially be considered as the base case model in future assessments;
8. The assessment results are more pessimistic if the western limit of the bigeye stock distribution is extended from 150°W to 170°E.

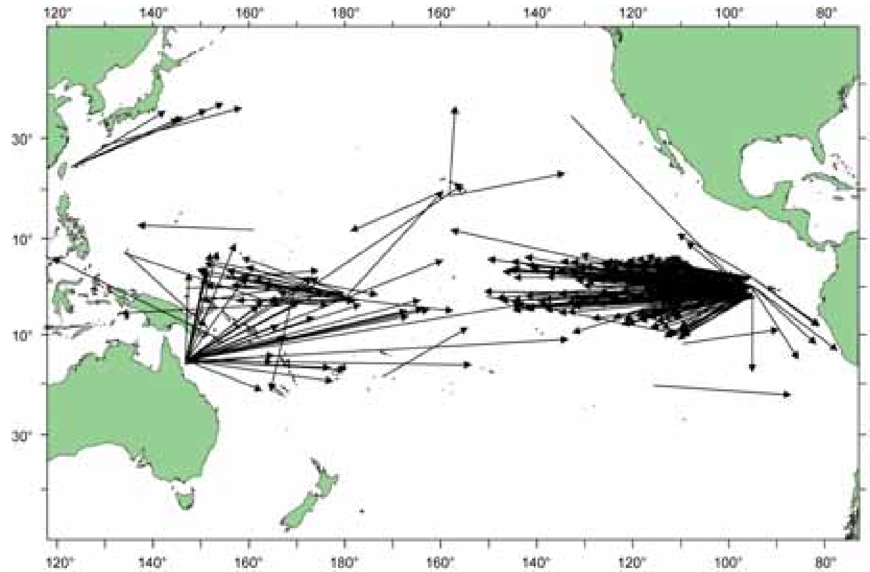


FIGURE D-1. Movements of more than 1000 nm by tagged bigeye tuna in the Pacific Ocean.
FIGURA D-1. Desplazamientos de más de 1000 mn de atunes patudo marcados en el Océano Pacífico.

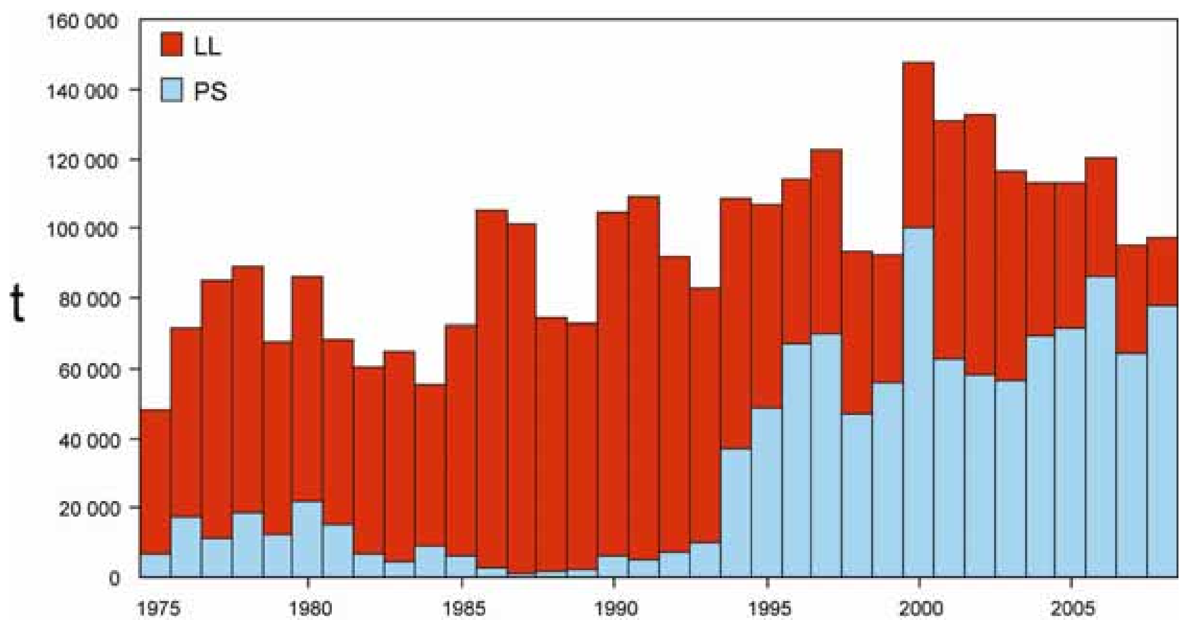


FIGURE D-2. Total catches (retained catches plus discards) of bigeye tuna by the purse-seine fisheries, and retained catches for the longline fisheries, in the eastern Pacific Ocean, 1975-2008. The purse-seine catches are adjusted to the species composition estimate. The 2008 catch data are provisional.
FIGURA D-2. Capturas totales (capturas retenidas más descartes) de atún patudo por las pesquerías de cerco, y capturas retenidas de las pesquerías palangreras en el Océano Pacífico oriental, 1975-2008. Las capturas cerqueras están ajustadas a la estimación de la composición por especie. Los datos de captura de 2008 son provisionales.

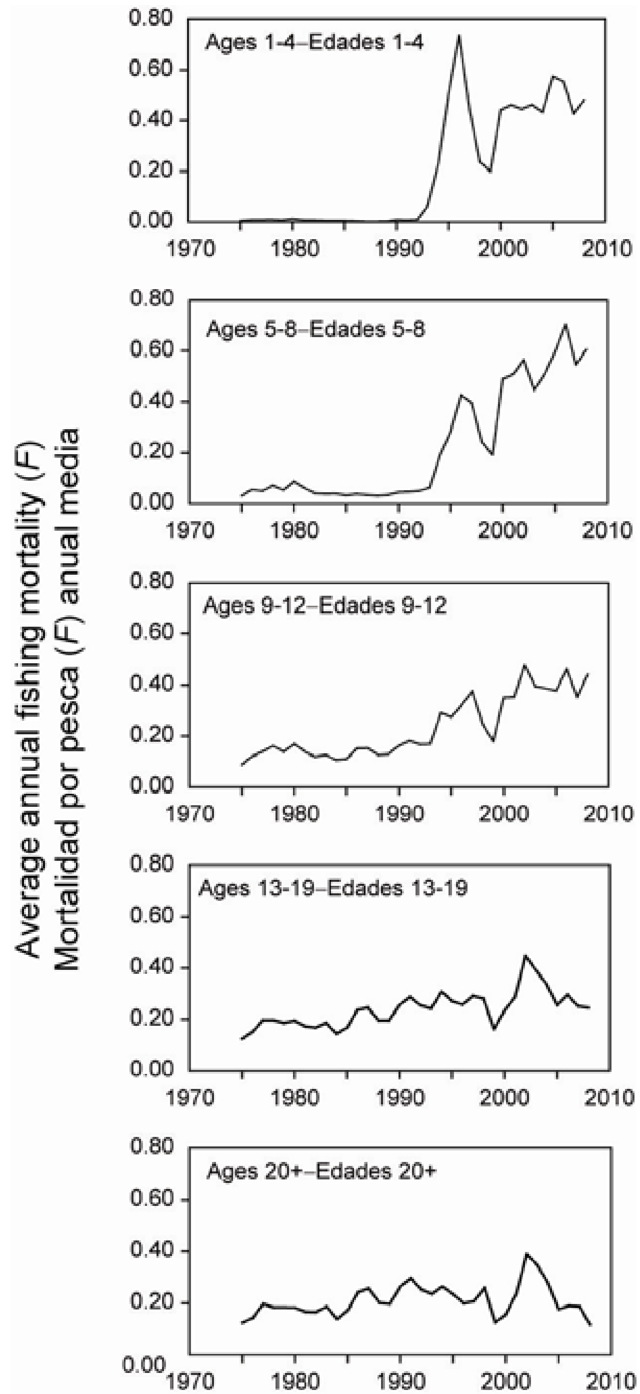


FIGURE D-3. Average annual fishing mortality, by all gears, of bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated in the upper left panel is an average of the fishing mortalities that affected fish that were 1-4 quarters old.

FIGURA D-3. Mortalidad por pesca anual media, por todas las artes, de atún patudo reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores anuales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron a peces de entre 1-4 trimestres de edad.

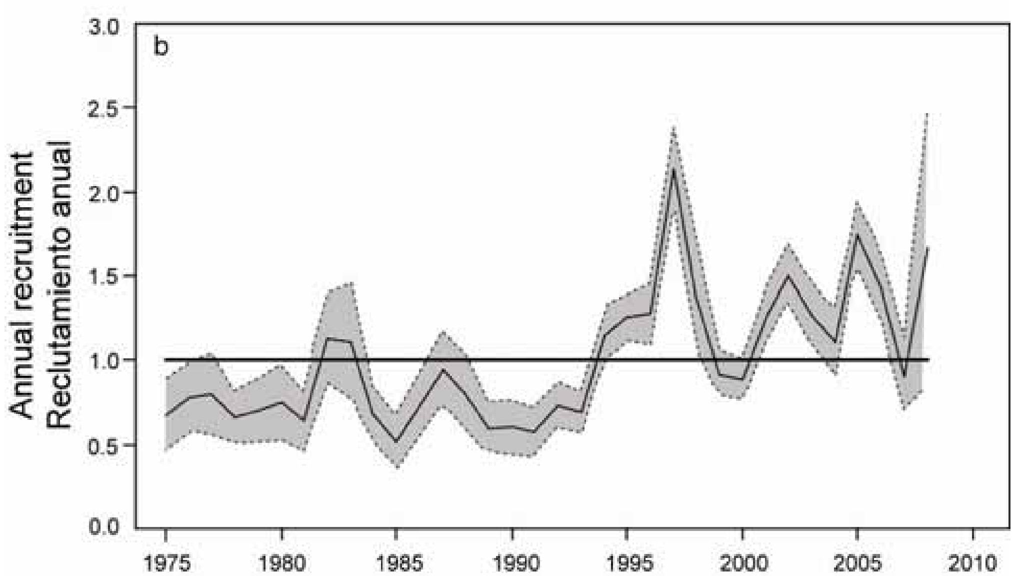


FIGURE D-4. Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The solid line shows the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.

FIGURA D-4. Reclutamiento estimado de atún patudo a las pesquerías del OPO. Se escalan las estimaciones para que la estimación de reclutamiento virgen equivalga a 1,0. La línea sólida indica las estimaciones de reclutamiento de verosimilitud máxima, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

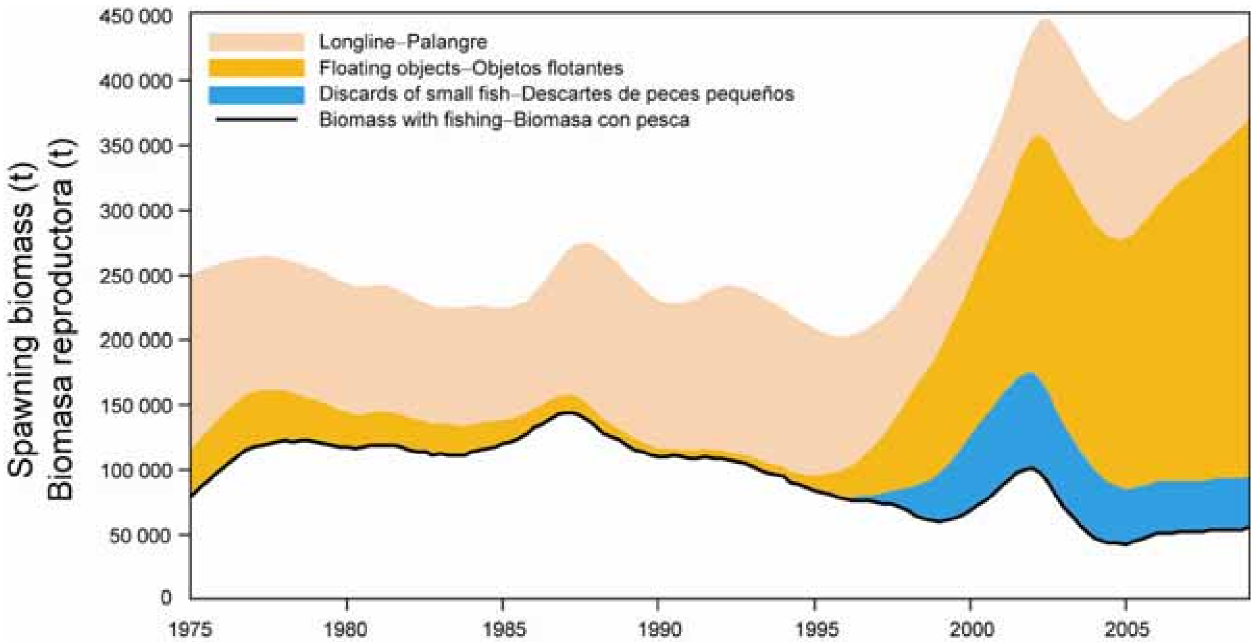


FIGURE D-5. Trajectory of the spawning biomass of a simulated population of bigeye tuna that was not exploited during 1975-2008 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishery.
FIGURA D-5. Trayectoria de la biomasa reproductora de una población simulada de atún patudo no explotada durante 1975-2008 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas sombreadas entre las dos líneas señalan la porción del impacto de la pesca atribuida a cada método de pesca.

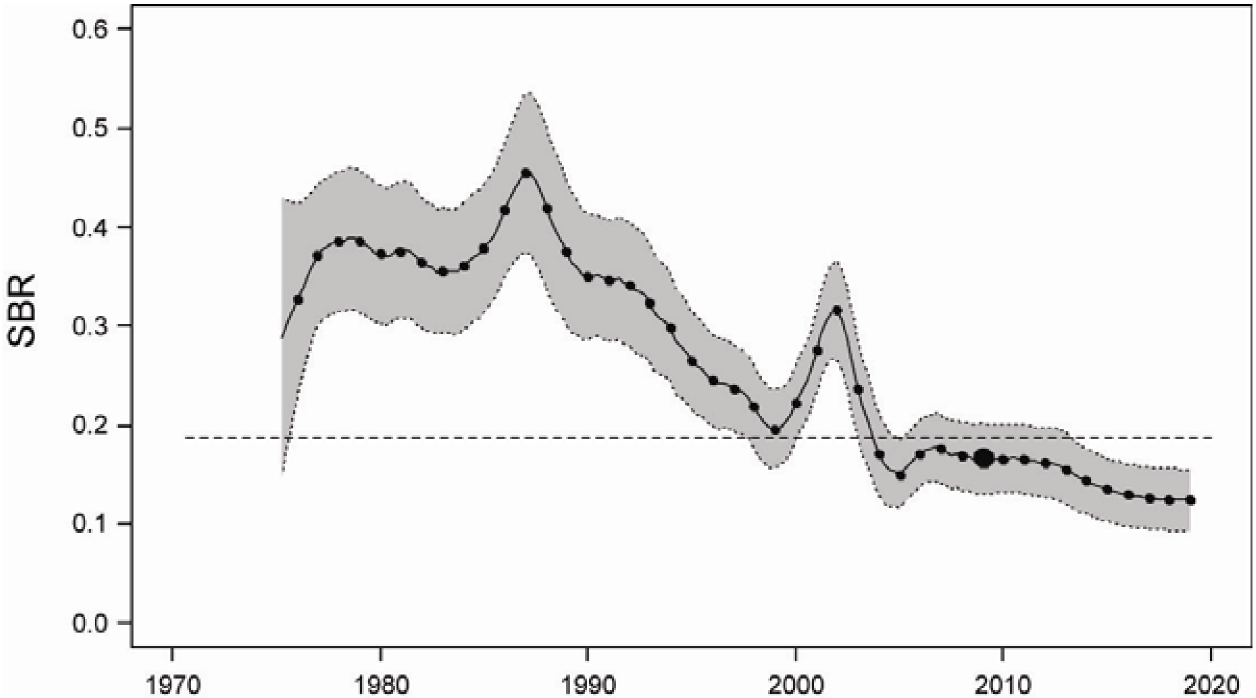


FIGURE D-6. Estimated spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.19) identifies the SBR at MSY. The solid curve illustrates the maximum likelihood estimates, and the estimates after 2009 (the large dot) indicate the SBR predicted to occur if fishing mortality rates continue at the average of that observed during 2006-2008. The dashed lines are the 95-percent confidence intervals around these estimates.

FIGURA D-6. Cocientes de biomasa reproductora (SBR) estimados del atún patudo en el OPO. La línea de trazos horizontal (en aproximadamente 0.19) identifica el SBR en RMS. La línea sólida ilustra las estimaciones de verosimilitud máxima, y las estimaciones a partir de 2009 (el punto grande) señalan el SBR predicho si las tasas de mortalidad por pesca continúan en el promedio observado durante 2006-2008. Las líneas de trazos representan los límites de confianza de 95% de las estimaciones.

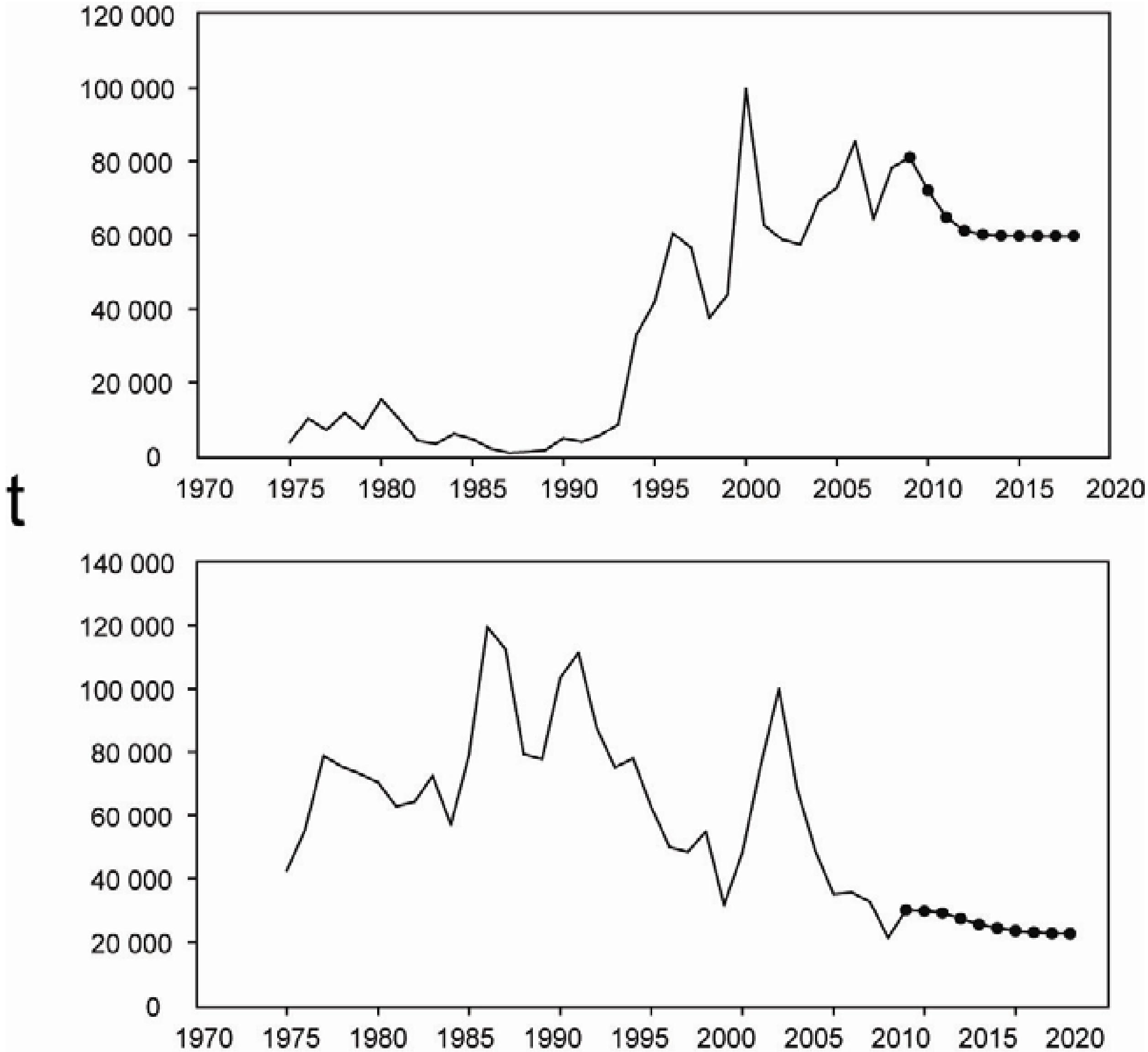
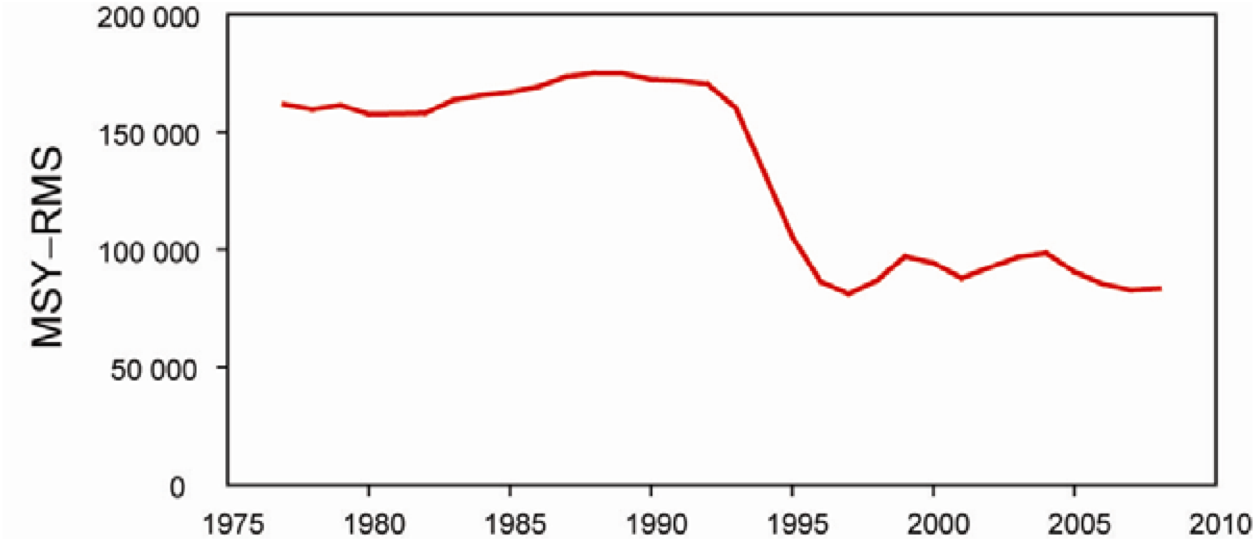


FIGURE D-7. Catches for 1975-2008, and predicted catches for 2009-2018, of bigeye tuna by the purse-seine and pole-and-line (upper panel) and longline (lower panel) fisheries. The predicted catches are based on average fishing mortality during 2006-2008.

FIGURA D-7. Capturas de atún patudo durante 1975-2008, y predichas para 2009-2018, por las pesquerías de cerco y de caña (recuadro superior) y de palangre (recuadro inferior). Las capturas predichas se basan en la mortalida por pesca promedio durante 2006-2008.



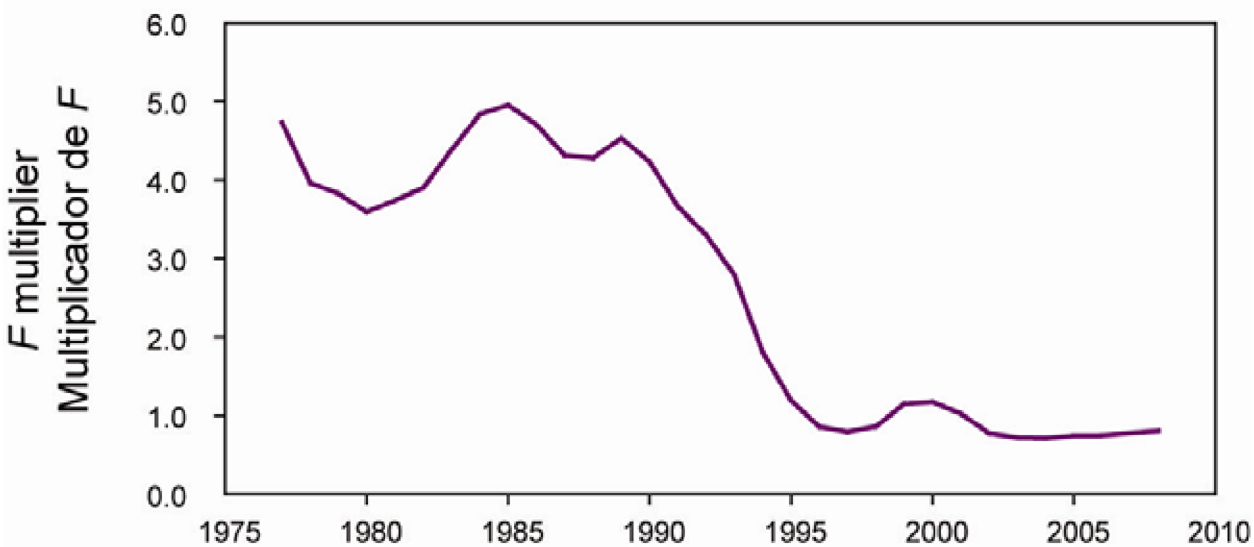


FIGURE D-8. MSY (upper panel), 1975-2008, and the change (increase or reduction) in the effort required to produce the MSY (lower panel) for bigeye tuna, estimated separately for each year, using the average age-specific fishing mortality for that year.

FIGURA D-8. RMS (recuadro superior), 1975-2008, y cambio (aumento o reducción) del esfuerzo necesario para producir el RMS (recuadro inferior), de atún patudo, estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

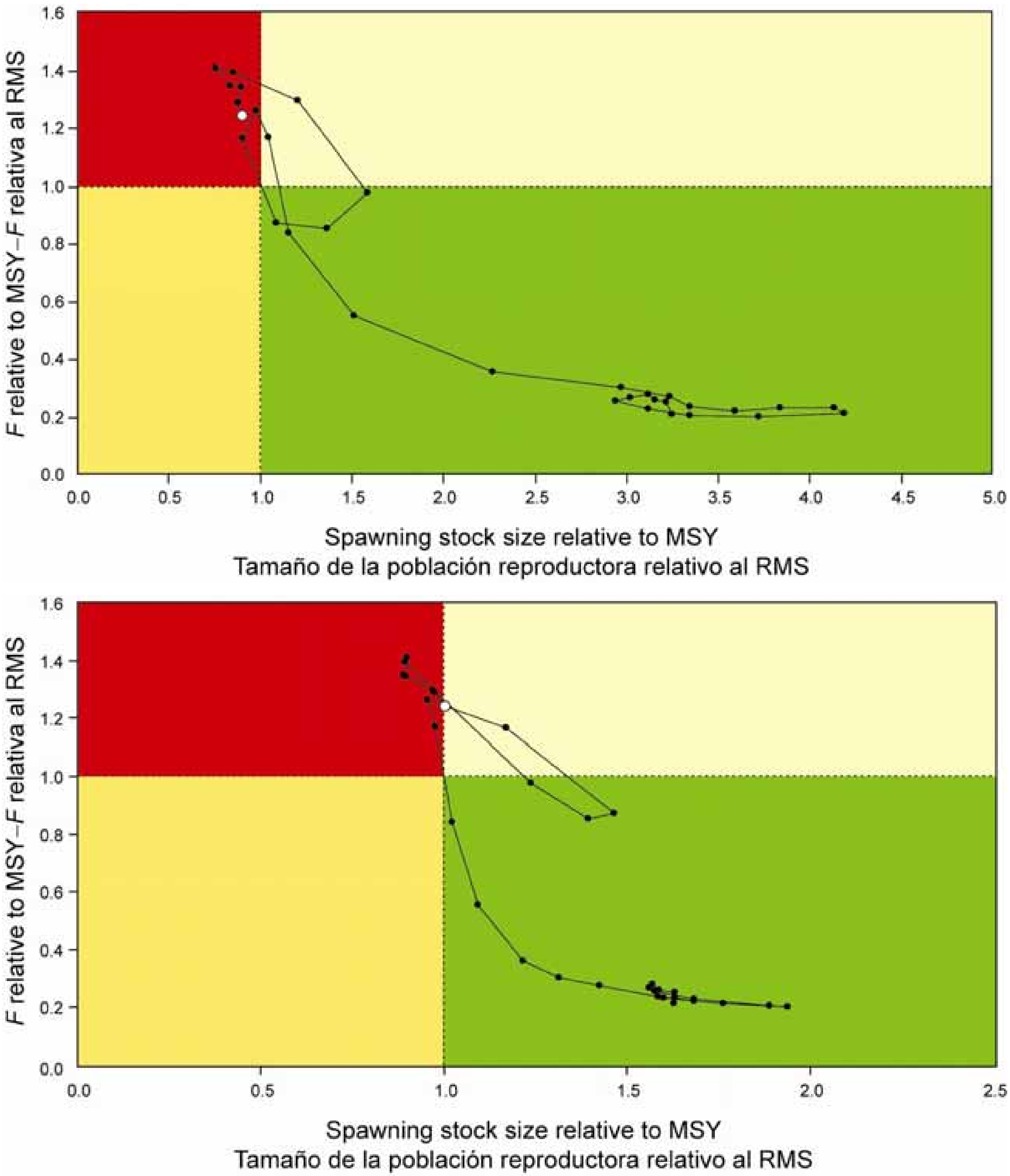


FIGURE D-9. Phase plot of the time series of estimates of stock size (top: spawning biomass, *S*; bottom: total biomass, *B*) and fishing mortality (*F*) of bigeye relative to their MSY reference points. Each dot is based on the average exploitation rate over three years; the large dot indicates the most recent estimate.

FIGURA D-9. Gráfica de fase de la serie de tiempo de las estimaciones del tamaño de la población (arriba: biomasa reproductora, *S*; abajo: biomasa total, *B*) y la mortalidad por pesca (*F*) de atún patudo en relación con sus puntos de referencia de RMS. Cada punto se basa en la tasa de explotación media de tres años. El punto grande indica la estimación más reciente.

TABLE D-1. Estimates of the MSY of bigeye tuna, and associated quantities for the base case assessment and the sensitivity analysis including a stock-recruitment relationship with steepness (*h*) of 0.75. All analyses are based on average fishing mortality for 2006-2008. B_{2009}, B_{MSY}, and B_0 are the biomass of bigeye 3+ quarters old at the start of 2009, at MSY, and without fishing, respectively, and S_{2009}, S_{MSY}, and S_0 are the spawning biomass at the start of 2009, at MSY, and without fishing, respectively. C_{2008} is the estimated total catch in 2008.

TABLA D-1. Estimaciones del RMS de atún patudo y valores asociados para la evaluación del caso base y el análisis de sensibilidad que incluye una relación población-reclutamiento con una inclinación (*h*) de 0.75. Todos los análisis se basan en la mortalidad por pesca media de 2006-2008. B_{2009}, B_{RMS}, y B_0 son la biomasa de patudo de edad 3+ trimestres al principio de 2009, en RMS, y sin pesca, respectivamente, y S_{2009}, S_{RMS}, y S_0 son la biomasa reproductora al principio de 2009, en RMS, y sin pesca, respectivamente. C_{2008} es la captura total estimada en 2008.

	Caso base **Basecase**	**Inclinación = 0.75** **Steepness = 0.75**
MSY—RMS	83,615	81,482
B_{MSY}—B_{RMS}	289,475	521,888
S_{MSY}—S_{RMS}	60,631	125,008
B_{MSY}/B_0—B_{RMS}/B_0	0.25	0.34
S_{MSY}/S_0—S_{RMS}/S_0	0.19	0.29
C_{2008}/MSY—C_{2008}/RMS	1.19	1.22
B_{2009}/B_{MSY}—B_{2009}/B_{RMS}	0.99	0.62
S_{2009}/S_{MSY}—S_{2009}/S_{RMS}	0.89	0.52
F multiplier—Multiplicador de *F*	0.81	0.54

E. PACIFIC BLUEFIN TUNA

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

Most of the catches of bluefin in the EPO are taken by purse seiners. Nearly all of the purse-seine catch have been made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 35°N. Ninety percent of the catch is estimated to have been between about 60 and 100 cm in length, representing mostly fish 1 to 3 years of age. Aquaculture facilities for bluefin were established in Mexico in 1999, and some Mexican purse seiners began to direct their effort toward bluefin during that year. During recent years, most of the catches have been transported to holding pens, where the fish are held for fattening and later sale to sashimi markets. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

Bluefin are exploited by various gears in the WCPO from Taiwan to Hokkaido. Age-0 fish about 15 to 30 cm in length are caught by trolling during July-October south of Shikoku Island and south of Shizuoka Prefecture. During November-April, age-0 fish about 35 to 60 cm in length are taken by trolling south and west of Kyushu Island. Age-1 and older fish are caught by purse seining, mostly during May-September, between about 30°-42°N and 140°-152°E. Bluefin of various sizes are also caught by traps, gillnets, and other gear, especially in the Sea of Japan. Small amounts of bluefin are caught near the southeastern coast of Japan by longlining. The Chinese Taipei small-scale longline fishery, which has expanded since 1996, takes bluefin tuna over 180 cm in length from late April to June, when they are aggregated for spawning in the waters east of the northern Philippines and Taiwan.

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

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

Bluefin more than about 50 cm in length are most often found in waters where the sea-surface temperatures (SSTs) are between 17° and 23°C. Fish 15 to 31 cm in length are found in the WCPO in waters where the SSTs are between 24° and 29°C. The survival of larval and early juvenile bluefin is undoubtedly strongly influenced by the environment. Conditions in the WCPO probably influence the portions of the juvenile fish there that migrate to the EPO, and also the timing of these migrations. Likewise, conditions in the EPO probably influence the timing of the return of the juvenile fish to the WCPO.

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

A preliminary stock assessment was carried out by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) in 2008, but the results were inconclusive, so another meeting of the group has been scheduled for mid-2009.

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.

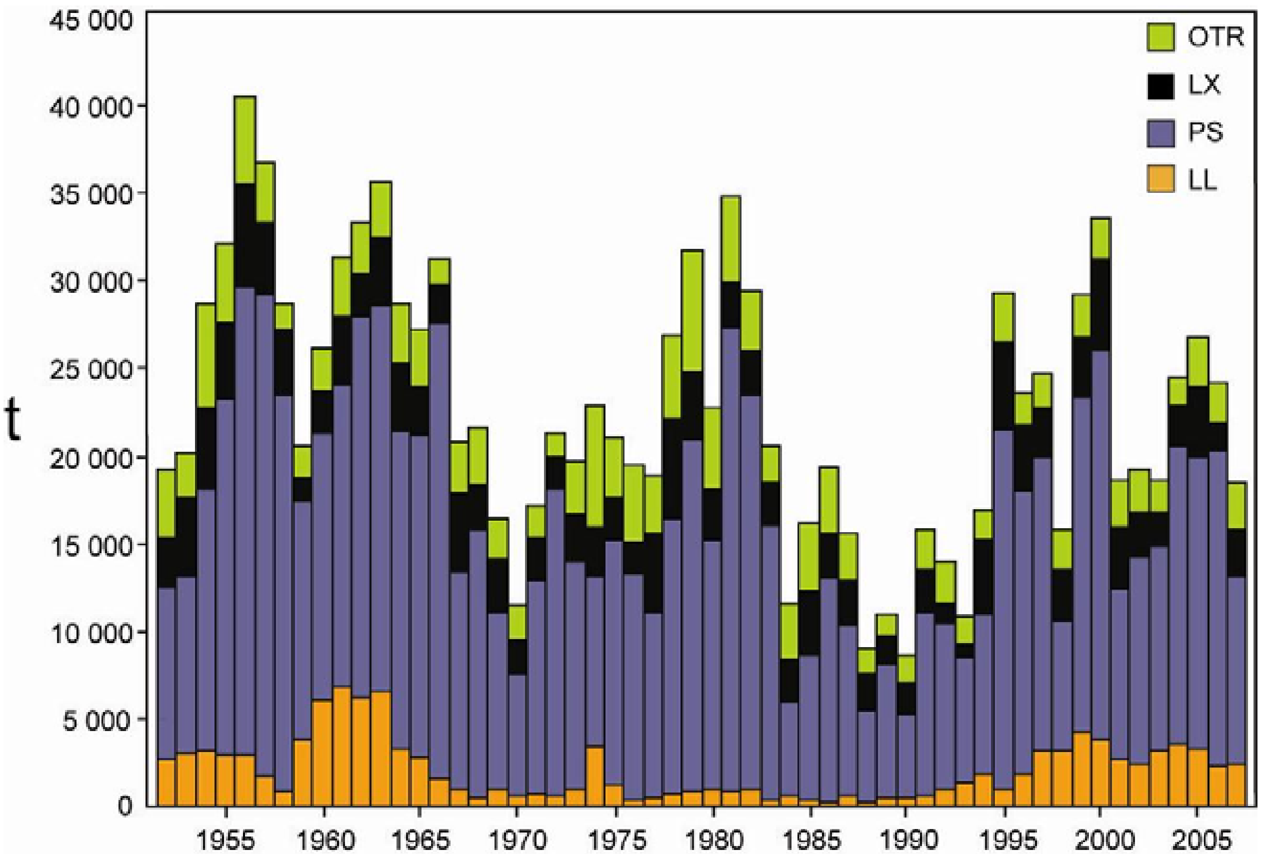


FIGURE E-1. Retained catches of Pacific bluefin, 1952-2007.
FIGURA E-1. Capturas retenidas de aleta azul del Pacífico, 1952-2007.

F. ALBACORE TUNA

There are two stocks of albacore in the Pacific Ocean, one occurring in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longline gear in most of the North and South Pacific, but not often between about 10°N and 5°S, by trolling gear in the eastern and central North and South Pacific, and by pole-and-line gear in the western North Pacific. In the North Pacific about 60% of the fish are taken in pole-and-line and troll fisheries that catch smaller, younger albacore, whereas about 90% of the albacore caught in the South Pacific are taken by longline. The total annual catches of North Pacific albacore peaked in 1976 at about 125,000 t, declined to about38,000 t in1991, and then increased to about 126,000 t in 1999 (Figure F-1a). The total annual catches of South Pacific albacore ranged from about 25,000 to 50,000 t during the 1980s and 1990s, but increased after that, ranging from about 55,000 to 70,000 t during 2001-2007 (Figure F-1b).

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

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

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

The most recent stock assessments for the South and North Pacific stocks of albacore were presented in 2008 and 2006, respectively.

The assessment of South Pacific albacore, which was carried out with MULTIFAN-CL by scientists of the Secretariat of the Pacific Community, incorporated catch and effort, length-frequency, tagging data, and information on biological parameters. Although uncertainties were found to exist, it appeared reasonably certain that the stock was above the level corresponding to the average maximum sustainable yield (MSY), that the effort during 2004-2006 was less than that corresponding to the MSY, and that the spawning biomass was greater than that corresponding to the MSY. There currently appears to be no need to restrict the fisheries for albacore in the South Pacific Ocean, but additional research to attempt to resolve the uncertainties in the data are recommended.

An assessment of North Pacific albacore was conducted at a workshop of the Albacore Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), held in November-December 2006.

The conclusions reached at that workshop were presented to the seventh plenary meeting of the ISC, held in July 2007. Among these were the following:

- The spawning stock biomass (SSB) in 2006 was estimated to be about 153 thousand t—53% above the long-term average (Figure F-2);

- Retrospective analysis revealed a tendency to overestimate the abundance of albacore;
- Recruitment had fluctuated about a long-term average of roughly 28 million fish during the 1990s and early 2000s;
- The current coefficient of fishing mortality (*F*), calculated as the geometric mean of the estimates for 2002-2004, was about 0.75, which is high relative to several biological reference points to which Working Group compared its estimate for albacore;
- The SSB was forecast to decline to an equilibrium level of about 92 thousand t by 2015;
- The substantial decline in total catch during recent years is cause for concern;
- In conclusion, the Working Group recommended that all nations participating in the fishery observe precautionary-based fishing practices.

Additional meetings of the Albacore Working Group took place in February-March 2008 and July 2008. These workshops were devoted mostly to discussion of data requirements and transition of assessments from Virtual Population Analysis to Stock Synthesis II. Another short meeting will take place in July 2009. An updated stock assessment will be produced at a meeting of the Albacore Working Group in March 2010.

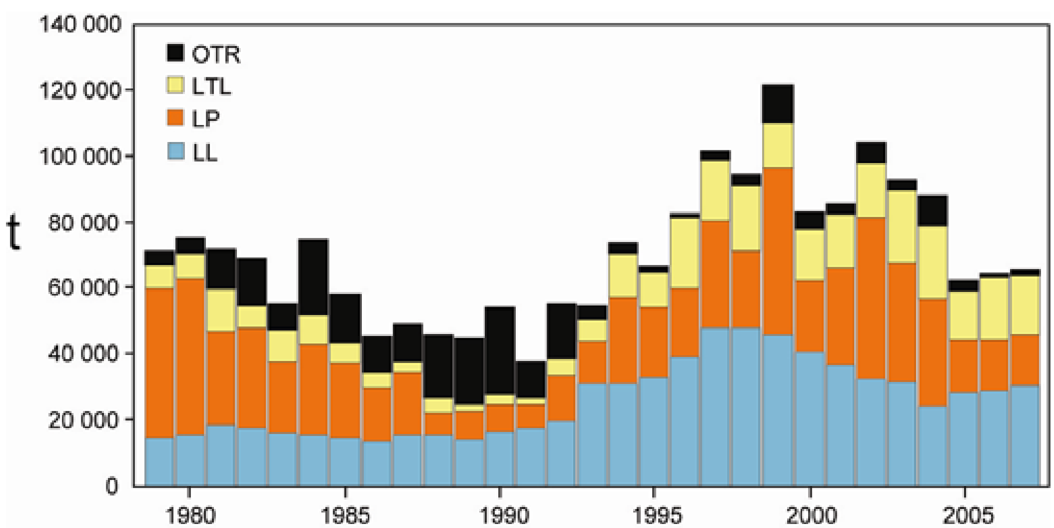


FIGURE F-1a. Retained catches of North Pacific albacore, 1978-2007.
FIGURA F-1a. Capturas retenidas de albacora del Pacífico norte, 1978-2007.

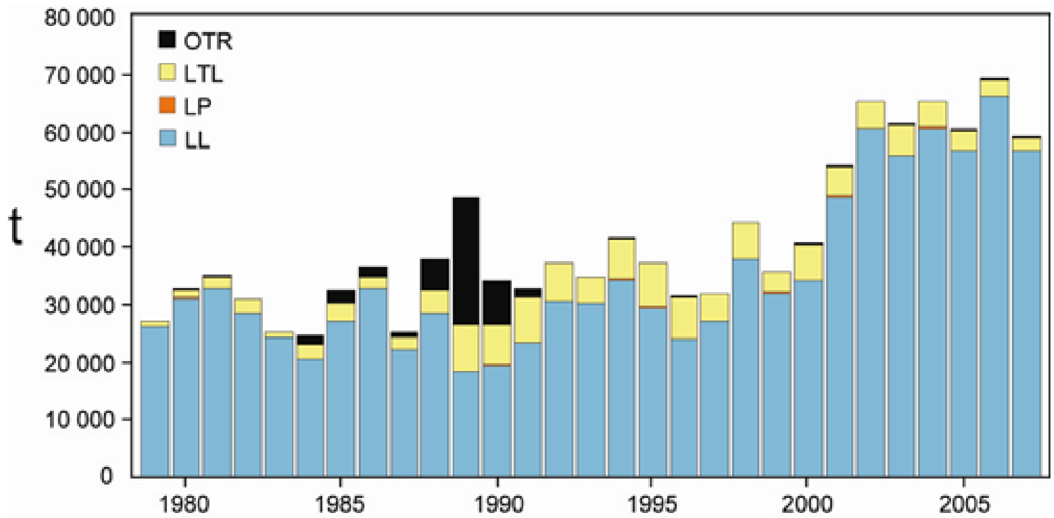


FIGURE F-1b. Retained catches of South Pacific albacore, 1978-2007.
FIGURA F-1b. Capturas retenidas de albacora del Pacífico sur, 1978-2007.

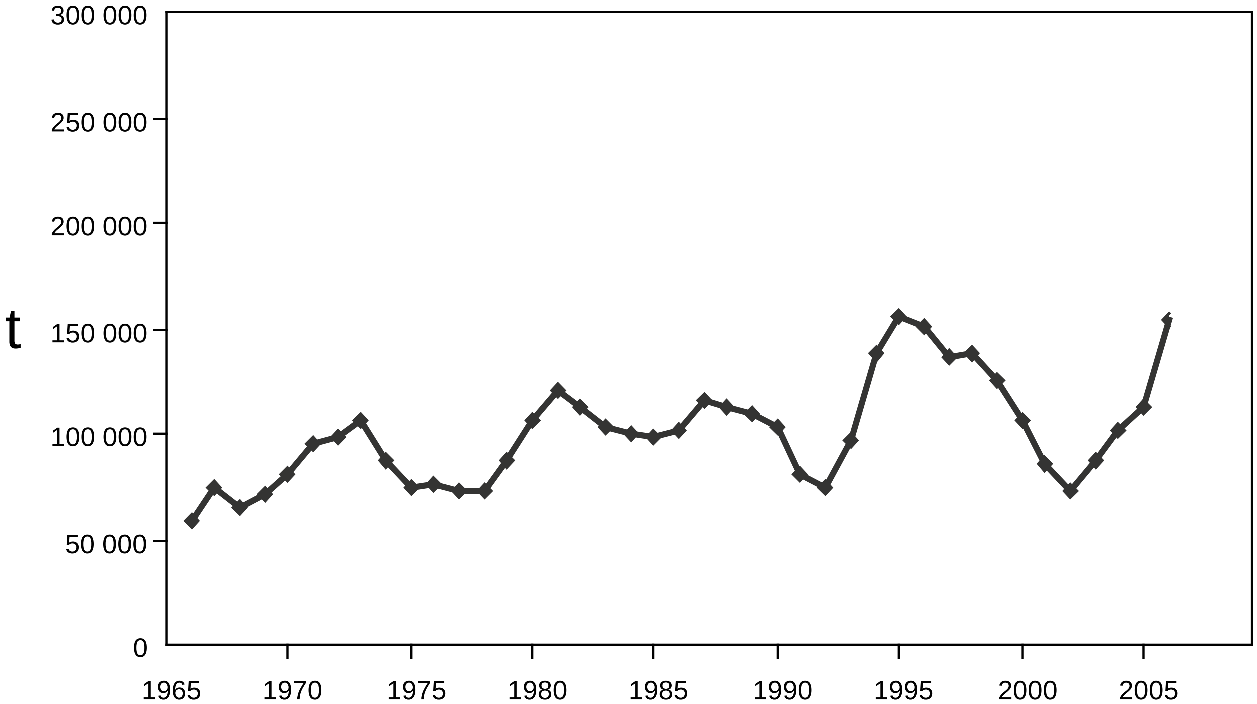


FIGURE F-2. Spawning stock biomass of North Pacific albacore tuna, from the North Pacific Albacore Workshop analysis of 2006

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

G. SWORDFISH

Swordfish occur throughout the Pacific Ocean between about 50°N and 50°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are taken by gillnet and harpoon fisheries. They are seldom caught by recreational fishermen. During the 2005-2007 period the greatest catches in the EPO have been taken by vessels of Spain, Chile, and Japan, which together harvest about 70% of the total swordfish catch taken in the region. All three have fisheries that target swordfish, though much of the swordfish taken in the Japanese fishery are incidental catches of a fishery that targets predominantly bigeye tuna. Other nations with fisheries known to target swordfish are Mexico and the United States.

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

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

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

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

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

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

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

The average annual catch from the this stock during 1993-2000 was about 7,000 t (range ~ 4,800-8,700 t). Since 2000, annual catches have averaged about 13,000 t, with catch in the most recent years on the order of 11,000-12,000 t (Figure G-1), which is about the estimated MSY catch. There have been indications of increasing efficiency at targeting of swordfish in the southern EPO, which has resulted in increased harvests of this stock. Some of the increased catch may have resulted from the above-average recruitment noted previously. It is not expected that further increases in the catch levels observed in recent years would be sustainable.

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

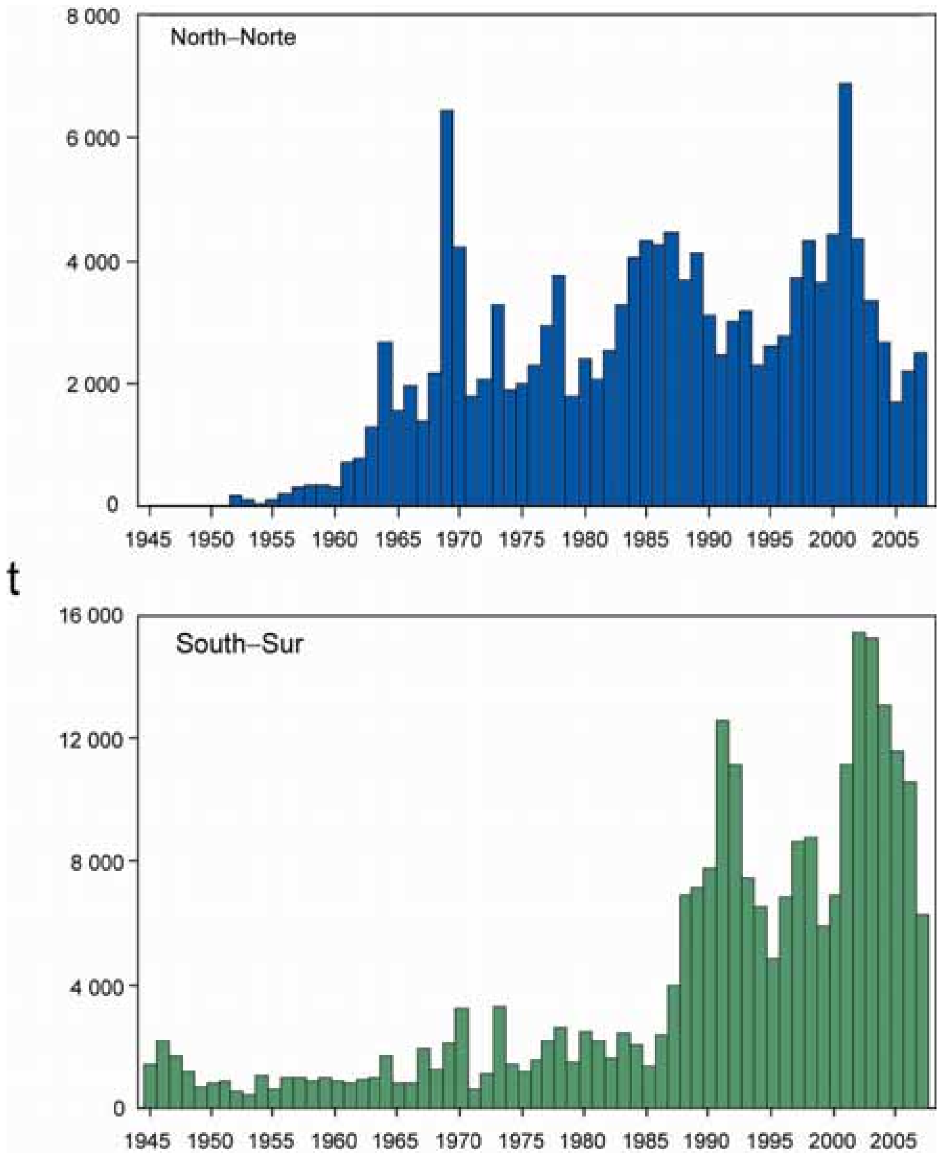


FIGURE G-1. Retained catches of swordfish in the eastern Pacific Ocean, 1945-2007 by stock (north and south).
FIGURA G-1. Capturas retenidas de pez espada en el Océano Pacífico oriental, 1945-2007 por población (norte y sur).

H. BLUE MARLIN

The best knowledge currently available indicates that blue marlin constitutes a single world-wide species, and that there is a single stock of blue marlin in the Pacific Ocean. For this reason, statistics on catches are compiled, and analyses of stock status are made, for the entire Pacific Ocean.

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

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

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

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

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

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

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

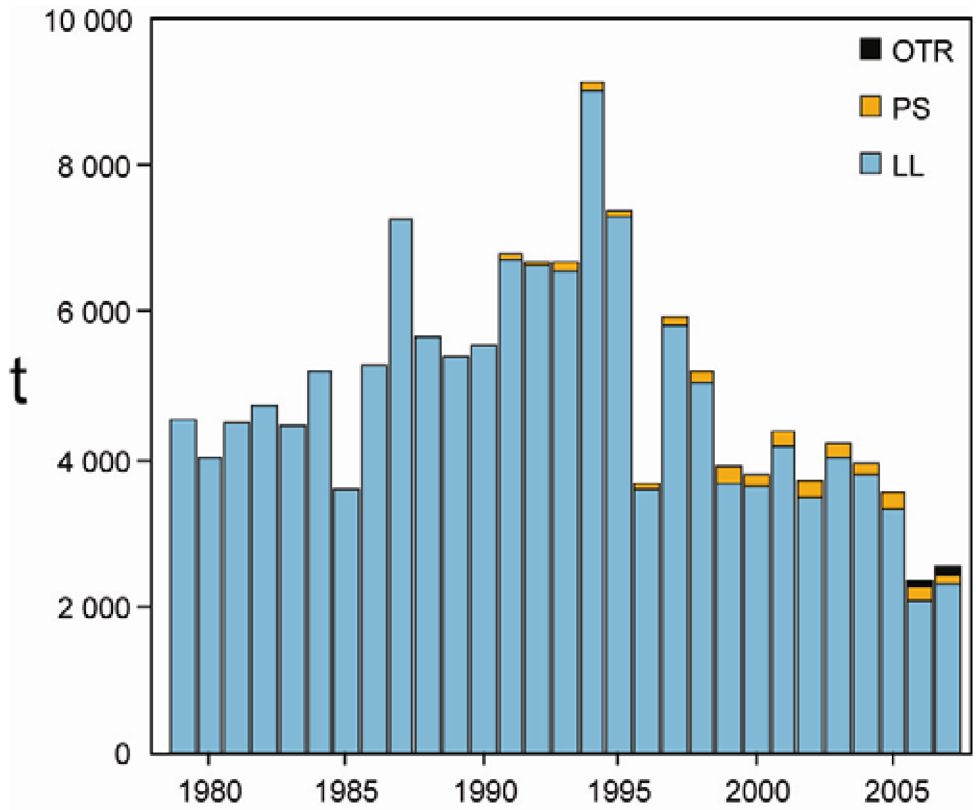


FIGURE H-1. Retained catches of blue marlin in the eastern Pacific Ocean, 1978-2007, by gear type.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1978-2007, por arte de pesca.

I. STRIPED MARLIN

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

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

Few tagging data are available on the movements of striped marlin. Tagged fish released off the tip of the Baja California peninsula generally have been recaptured in the same general area as where tagged, but some have been recaptured around the Revillagigedo Islands, a few around Hawaii, and one near Norfolk Island. Recently pop-up satellite tags have been placed on striped marlin in the Pacific (Domeier 2006), achieving times-at-liberty averaging about 2 to 3 months, with maximums of 4 to 9 months in each tagging region. These studies indicated that there was essentially no mixing of tagged fish among tagging areas, and that striped marlin maintained site fidelity.

The catch rates of striped marlin off California and Baja California tend to be greater when the sea-surface temperatures are higher and when the thermocline is shallow. The catch rates are greater on the shallower hooks of longlines, especially when the thermocline is shallow.

The stock structure of striped marlin is uncertain. Analyses of catch rates using generalized additive models (GAMs) suggest that in the north Pacific there appear to be at least two stocks, distributed principally east and west of about 145º-150ºW, with the distribution of the stock in the east extending as far south as 10°-15°S. Genetic studies provide a more detailed picture of stock structure. McDowell and Graves (2008) suggest that there are separate stocks in the northern, northeastern, and southeastern, and southwestern Pacific. Preliminary reports of more recent genetic studies (C. Purcell, University of Southern California, personal communication, May 2009) indicate that the striped marlin in the EPO off Mexico, Central America, and Ecuador are of a single stock and that there may be juveniles from an identified Hawaiian-stock present seasonally in regions of the northern EPO.

Analyses of stock status have been made using a number of population dynamics models. The results from these analyses indicated that striped marlin in the EPO were at or above the level expected to provide landings at the maximum sustainable yield (MSY), estimated at about 3300 to 3800 t, which is substantially greater than the annual catch in recent years and the new record low estimated catch of about 1,400 t in 2007. There is no indication of increasing fishing effort or catches in the EPO stock area. Based on the findings of Hinton and Maunder (2004), new information and recent observations of catch and fishing effort presented herein, it is considered that the striped marlin stocks in the EPO are in good condition, with current and near-term anticipated fishing effort less than F_{MSY}.

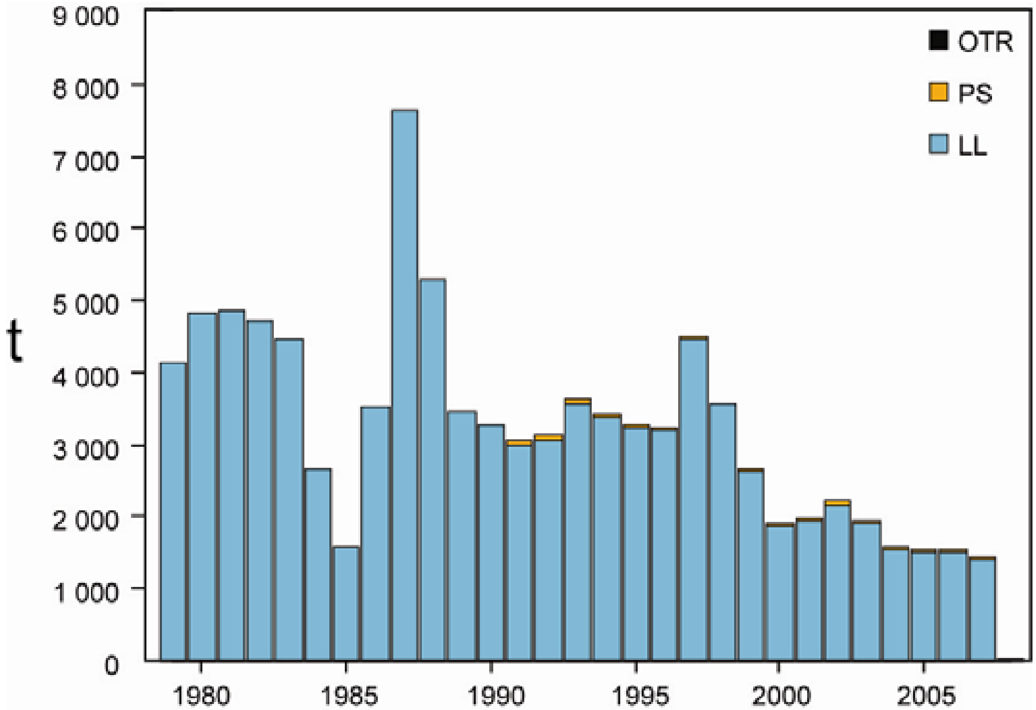


FIGURE I-1. Retained catches of striped marlin in the eastern Pacific Ocean, 1978-2007 by gear type.
FIGURA I-1. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1978-2007 por arte de pesca.

J. ECOSYSTEM CONSIDERATIONS

1. INTRODUCTION

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

The IATTC has taken account of ecosystem issues in many of its decisions, and this report on the offshore pelagic ecosystem of the tropical and subtropical Pacific Ocean, which is the habitat of tunas and billfishes, has been available since 2003 to assist in making its management decisions. This section provides a coherent view, summarizing what is known about the direct impact of the fisheries upon various species and species groups of the ecosystem, and reviews what is known about the environment and about other species that are not directly impacted by the fisheries.

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

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

In addition to reporting the catches of the principal species of tunas and billfishes, the staff has reported the bycatches of other species that are normally discarded. In this section, data on these bycatches are presented in the context of the effect of the fishery on the ecosystem. Unfortunately, while relatively good information is available for the tunas and billfishes, information for the entire fishery is not available. The information is comprehensive for large (carrying capacity greater than 363 metric tons) purse seiners that carry observers under the Agreement on the International Dolphin Conservation Program (AIDCP), and information on retained catches is also reported for other purse seiners, pole-and-line vessels, and much of the longline fleet. Some information is available on sharks that are retained by parts of the longline fleet. Information on bycatches and discards is also available for large purse-seiners, and for some smaller ones. There is little information available on the bycatches and discards for other fishing vessels.

2. IMPACT OF CATCHES

2.1. Single-species assessments

This section provides a summary of current information on the effects of the tuna fisheries on the stocks of individual species in the eastern Pacific Ocean (EPO). It focuses on the current biomass of each stock considered, compared to what it might have been in the absence of a fishery. The intention is to show how the fishery may have altered the components of the ecosystem, rather than the detailed assessments, which can be found in other sections of this report and in other IATTC documents. The section below frequently refers to comparisons with the estimated unexploited stock size. There are no direct measurements of the stock size before the fishery began, and, in any case, the stocks would have varied from year to year. In addition, the unexploited stock size may be influenced by predator and prey abundance, which is not included in the single-species analyses.

2.2. Tunas

2.2.1. Yellowfin

The yellowfin stock changed into a higher recruitment regime in about 1983, but may have recently moved back into an intermediate recruitment regime. During 2005-2007, the yellowfin stock has been below the level corresponding to the maximum sustainable yield (27% of its unexploited size), but has increased to above that level in 2008. One estimate of the effect of this reduced stock size is that the predation by adult yellowfin on other parts of the ecosystem is reduced to about 35% of what it was in the absence of a fishery.

2.2.2. Skipjack

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

2.2.3. Bigeye

Up to 1993, bigeye were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 32% of its unexploited size. After 1993, purse seining for tunas associated with fish-aggregating devices (FADs) took significant quantities of small and medium-sized bigeye. In 2005, after several years of poor recruitment and excessive levels of fishing mortality, the stock size was estimated to be at about 14% of its unexploited size. Due to recent spikes in recruitment, the current level has slightly increased and stabilized at about 17%.

2.2.4. Pacific bluefin

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

2.2.5. Albacore

It is generally considered that there are two stocks of albacore in the Pacific Ocean, one in the North Pacific and the other in the South Pacific. An assessment for South Pacific albacore, done by the Secretariat of the Pacific Community in 2003, showed that the South Pacific stock was at about 60% of its unexploited size. An assessment by the ISC North Pacific Albacore Working Group in 2006 indicated that the biomass of the North Pacific spawning stock in 2006 was about 53% above its time series average.

2.3. Billfishes

2.3.1. Swordfish

The northeastern and southeastern Pacific Ocean stocks of swordfish are distinctly identifiable by genetics and fisheries analyses. Preliminary analyses of the status of the southeastern Pacific Ocean stock of swordfish indicate that the spawning biomass declined over the 1945-2003 period, and is now at about twice the level (~0.26) that will support the maximum sustainable yield (MSY) of 13,000-14,000 metric tons (t). Catches have been decreasing since about 2002. Recent harvests are on the order of 11,000 to 13,000 t annually.

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

2.3.2. Blue marlin

There appears to be a single stock of blue marlin in the Pacific Ocean. The most recent stock assessments of blue marlin suggest that the current stock size is between 50 and 90% of the unexploited stock size.

2.3.3. Striped marlin

Recent genetics analyses suggest that there are three stocks of striped marlin in the north and eastern Pacific Ocean. Spawning areas have been identified (by presence of larvae) off Japan/Chinese Taipei, Hawaii, and Mexico, and no significant genetic differences have been found among individuals ranging from Mexico to Ecuador. There was an indication that juvenile striped marlin from stocks off Hawaii may be present seasonally in the northern EPO off California, but not off the coast of Mexico. The most recent assessments (2004) by the IATTC staff suggested that the then current size of the EPO (Mexico/Ecuador) stock was about 50 to 70% of the unexploited stock size. Catches from the EPO have been declining since about 1997, with a new low annual catch of about 1,400 t in 2007 and an average annual catch of about 1,500 t since 2004, well below the estimated MSY of the stock. Fishing effort and catches have continued the decline noted in previous assessments, and it is considered that the striped marlin stock in the EPO is in good condition, with current and near-term anticipated fishing effort less than F_{MSY}.

An analysis by the ISC in 2007 of the status of an hypothesized single stock of striped marlin spanning the north Pacific from Japan to 140ºW, utilizing catch-rate series, indicated a decline to 10-45% of the initial biomass.

2.3.4. Black marlin, sailfish, and shortbill spearfish

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

2.4. Summary

Preliminary estimates of the catches (including purse-seine discards), in metric tons, of tunas during 2008 and billfishes during 2007 in the EPO are as follows.

	PS			LP	LL	OTR	Total
	OBJ	NOA	DEL				
Yellowfin tuna	38,587	32,043	116,181	812	2	172	187,797
Skipjack tuna	161,721	134,171	8,854	499	0	278	305,524
Bigeye tuna	76,226	1,794	5	0	19,305	0	97,330
Pacific bluefin	0	4,406	0	15	0	0	4,421
Albacore tuna	0	10	0	0	73	0	1,266
Swordfish	<1	3	<1	0	4,353	4,377	8,734
Blue marlin	117	11	9	0	2,295	106	2,538
Striped marlin	19	9	8	0	1,400	6	1,442
Black marlin	62	10	11	0	37	0	120
Sailfish	2	20	28	0	790	32	871
Shortbill spearfish	<1	<1	<1	0	252	0	263

2.5. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis*), are frequently found associated with yellowfin tuna in the size range of about 10 to 40 kg in the EPO. Purse-seine fishermen have found that their catches of yellowfin in the EPO can be maximized by setting their nets around herds of dolphins and the associated schools of tunas, and then releasing the dolphins while retaining the tunas. The incidental mortality of dolphins in this operation was high during the early years of the fishery, and the populations of dolphins were reduced from their unexploited levels during the 1960s and 1970s. After the late 1980s the incidental mortality decreased precipitously, and there is now evidence that the populations are recovering. Preliminary mortality estimates of dolphins in the fishery in 2008 are as follows:

Species and stock	**Incidental mortality**	
	Number	**Metric tons**
Offshore spotted dolphin		
Northeastern	179	12
Western-southern	165	11
Spinner dolphin		
Eastern	349	15
Whitebelly	170	10
Common dolphin		
Northern	107	8
Central	14	1
Southern	138	10
Other dolphins[4]	49	3
Total	**1,171**	**70**

Studies of the association of tunas with dolphins have been an important component of the staff's long-term approach to understanding key interactions in the ecosystem. The extent to which yellowfin tuna and dolphins compete for resources, or whether either or both of them benefits from the interaction, remain critical pieces of information, given the large biomasses of both groups and their high rates of prey consumption. Diet and stable isotope analyses of yellowfin tuna and spotted and spinner dolphins caught in multispecies aggregations by purse-seine vessels in the EPO demonstrate significant differences in food habits and trophic position of the three species, suggesting that the tuna-dolphin association is probably not maintained by feeding advantages. This conclusion is supported by radio tracking studies of spotted dolphins outfitted with time-depth recorders, which indicate that the dolphins feed primarily at night on organisms associated with the deep scattering layer, while food habits studies of yellowfin tuna show primarily daytime feeding.

During August-December 2006, scientists of the U.S. National Marine Fisheries Service (NMFS) conducted the latest in a series of research cruises under the *Stenella* Abundance Research (STAR) project. The primary objective of the multi-year study is to investigate trends in population size of the dolphins that have been taken as incidental catch by the purse-seine fishery in the EPO. Data on cetacean distribution, herd size, and herd composition were collected from the large-scale line-transect surveys to estimate dolphin abundance. The 2006 survey covered the same areas and used the same methods as past surveys. Data from the 2006 survey produced new abundance estimates, and previous data were re-analyzed to produce revised estimates for 10 dolphin species and/or stocks in the EPO between 1986 and 2006. The 2006 estimates for northeastern offshore spotted dolphins were somewhat greater, and for eastern spinner dolphins substantially greater, than the estimates for 1998-2000. Estimates of population

[4] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: Central American spinner dolphins (*Stenella longirostris centroamericana*) 9 (0.4 t); striped dolphins 24 (1.6 t); coastal spotted dolphins 4 (0.3 t); bottlenose dolphins 4 (0.4 t), unidentified dolphins 8 (0.4 t).

growth for these two depleted stocks and the depleted coastal spotted dolphin stock may indicate they are recovering, but the western-southern offshore spotted dolphin stock may be declining. The abundance estimates for coastal spotted, whitebelly spinner, and rough-toothed (*Steno bredanensis*) dolphins showed an increasing trend, while those for the striped (*S. coeruleoalba*), short-beaked common (*Delphinus delphis*), bottlenose (*Tursiops truncatus*), and Risso's (*Grampus griseus*) dolphins were generally similar to previous estimates obtained with the same methods.

Scientists of the NMFS have made estimates of the abundances of several other species of marine mammals based on data from research cruises made between 1986 and 2000 in the EPO. The STAR 2003 and 2006 cruises will provide further estimates of abundance of these mammals. Of the species not significantly affected by the tuna fishery, short-finned pilot whales (*Globicephala macrorhynchus*) and three stocks of common dolphins showed increasing trends in abundance during that 15-year period. The apparent increased abundance of these mammals may have caused a decrease in the carrying capacity of the EPO for other predators that overlap in diet, including spotted dolphins. Bryde's whales (*Balaenoptera edeni*) also increased in estimated abundance, but there is very little diet overlap between these baleen whales and the upper-level predators impacted by the fisheries. Striped dolphins (*Stenella coeruleoalba*) showed no clear trend in estimated abundance over time, and the estimates of abundance of sperm whales (*Physeter macrocephalus*) have tended to decrease in recent years.

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

2.6. Sea turtles

Sea turtles are caught on longlines when they take the bait on hooks, are snagged accidentally by hooks, or are entangled in the lines. Estimates of incidental mortality of turtles due to longline and gillnet fishing are few. At the 4th meeting of the IATTC Working Group on Bycatch in January 2004, it was reported that 166 leatherback (*Dermochelys coriacea*) and 6,000 other turtle species, mostly olive Ridley (*Lepidochelys olivacea*), were incidentally caught by Japan's longline fishery in the EPO during 2000, and that, of these, 25 and 3,000, respectively, were dead. At the 6th meeting of the Working Group in February 2007, it was reported that the Spanish longline fleet targeting swordfish in the EPO averaged 65 interactions and 8 mortalities per million hooks during 1990-2005. The mortality rates due to longlining in the EPO are likely to be similar for other fleets targeting bigeye tuna, and possibly greater for those that set their lines at shallower depths for albacore and swordfish. About 23 million of the 200 million hooks set each year in the EPO by distant-water longline vessels target swordfish with shallow longlines.

In addition, there is a sizeable fleet of artisanal longline vessels that fish for tunas, billfishes, sharks, and dorado (*Coryphaena* spp.) in the EPO. Since 2005, staff members of the IATTC and some other organizations, together with the governments of several coastal Latin American nations, have been engaged in a program to reduce the hooking rates and mortalities of sea turtles in these fisheries. Additional information on this program can be found in Section 8.2.

Sea turtles are occasionally caught in purse seines in the EPO tuna fishery. Most interactions occur when the turtles associate with floating objects, and are captured when the object is encircled. In other cases, nets set around unassociated schools of tunas or schools associated with dolphins may capture sea turtles that happen to be at those locations. The olive Ridley turtle is, by far, the species of sea turtle taken most often by purse seiners. It is followed by green sea turtles (*Chelonia mydas*), and, very occasionally, by loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles. Only one mortality of a leatherback turtle has been recorded during the 10 years that IATTC observers have been recording this information. Some of the turtles are unidentified because they were too far from the vessel or it was too dark for the observer to identify them. Sea turtles, at times, become entangled in the webbing under fish-aggregating devices (FADs) and drown. In some cases, they are entangled by the fishing gear and may be injured or killed. Preliminary estimates of the mortalities (in numbers) of turtles caused by large purse-seine vessels during 2008 are as follows:

	Set type			Total
	OBJ	NOA	DEL	
Olive Ridley	1.5	0.0	0.0	1.5
Eastern Pacific green	0.0	0.0	0.0	0.0
Loggerhead	0.0	0.0	0.0	0.0
Hawksbill	0.0	0.0	0.0	0.0
Leatherback	0.0	0.0	0.0	0.0
Unidentified	1.5	0.0	0.0	1.5
Total	3.0	0.0	0.0	3.0

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, green, and loggerhead turtles are designated as endangered, and those of hawksbill and leatherback turtles as critically endangered, by the International Union for the Conservation of Nature.

2.7. Sharks and other large fishes

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

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

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

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

Preliminary estimates of the discards (in metric tons) of sharks and other large fishes in the EPO during 2008, other than those discussed above, by large purse-seine vessels are as follows. Complete data are not available for small purse-seine, longline, and other types of vessels.

	Set type			
	OBJ	NOA	DEL	Total
Sharks	231	36	27	294
Rays (Mobulidae and Dasyatidae)	4	33	11	48
Dorado (*Coryphaena* spp.)	1,143	21	2	1,166
Wahoo (*Acanthocybium solandri)*	242	1	<1	243
Rainbow runner (*Elagatis bipinnulata*) and yellowtail (*Seriola lalandi*)	75	36	<1	111
Black skipjack	2,283	172	106	2,561
Bonito	52	13	0	65
Unidentified tunas	9,151	3,040	363	12,554
Unidentified billfishes	11	3	5	19
Other large fishes	17	7	3	27

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

The catch rates of species other than tunas in the purse-seine fishery are different for each type of set. With a few exceptions, the bycatch rates are greatest in sets on floating objects, followed by unassociated sets and, at a much lower level, dolphin sets. Dolphin bycatch rates are greatest for dolphin sets, followed by unassociated sets and, at a much lower level, floating-object sets. The bycatch rates of sailfish (*Istiophorus platypterus*), manta rays (Mobulidae), and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets, and lowest in floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch figures. The estimated numbers of purse-seine sets of each type in the EPO during 1993-2008 are shown in Table A-7.

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

3. OTHER ECOSYSTEM COMPONENTS

3.1. Seabirds

There are approximately 100 species of seabirds in the tropical EPO. Some seabirds associate with epipelagic predators near the sea surface, such as fishes (especially tunas) and marine mammals. Subsurface predators often drive prey to the surface to trap them against the air-water interface, where the prey become available to the birds. Most species of seabirds take prey within a half meter of the sea surface or in the air (flyingfishes (Exocoetidae) and squids (Ommastrephidae)). In addition to driving the prey to the surface, subsurface predators make prey available to the birds by injuring or disorienting the prey, and by leaving scraps after feeding on large prey. Feeding opportunities for some seabird species are dependent on the presence of tuna schools feeding near the surface.

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

According to the *Report of the Scientific Research Program under the U.S. International Dolphin Conservation Program Act*, prepared by the NMFS in September 2002, there were no significant temporal trends in abundance estimates over the 1986-2000 period for any species of seabird, except for a downward trend for the Tahiti petrel (*Pseudobulweria rostrata*), in the tropical EPO. Population status and trends are currently under review for waved (*Phoebastria irrorata*), black-footed (*P. nigripes*), and Laysan (*P. immutabilis*) albatrosses.

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

3.2. Forage

The forage taxa occupying the middle trophic levels in the EPO are obviously important components of the ecosystem, providing a link between primary production at the base of the food web and the upper-trophic-level predators, such as tunas and billfishes. Indirect effects on those predators caused by environmental variability are transmitted to the upper trophic levels through the forage taxa. Little is known, however, about fluctuations in abundance of the large variety of prey species in the EPO. Scientists from the NMFS have recorded data on the distributions and abundances of common prey groups, including lantern fishes (Myctophidae), 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. The estimates were low again in 1998, and then increased through 2000. Their interpretation of this pattern was that El Niño events in 1986-1987 and 1997-1998 had negative effects on these prey populations. More data on these taxa were collected during the NMFS STAR 2003 and 2006 cruises, and are currently being analyzed.

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

Some small fishes, many of which are forage for the larger predators, are incidentally caught by purse-seine vessels in the EPO. Frigate and bullet tunas (*Auxis* spp.), for example, are a common prey of many of the animals that occupy the upper trophic levels in the tropical EPO. In the tropical EPO ecosystem model (Section 7), frigate and bullet tunas comprise 10% or more of the diet of eight predator categories. Small quantities of frigate and bullet tunas are captured by purse-seine vessels on the high seas and by artisanal fisheries in some coastal regions of Central and South America. The vast majority of frigate and bullet tunas captured by tuna purse-seine vessels is discarded at sea. Preliminary estimates of the discards, in metric tons, of small fishes by large purse-seine vessels with observers aboard in the EPO during 2008 are as follows:

	Set type			
	OBJ	**NOA**	**DEL**	**Total**
Triggerfishes (Balistidae) and filefishes (Monacanthidae)	124	7	<1	132
Other small fishes	91	<1	<1	91
Frigate and bullet tunas (*Auxis* spp.)	1,085	941	<1	2,026

3.3. Larval fishes and plankton

Larval fishes have been collected by manta (surface) net tows in the EPO for many years by personnel of the NMFS Southwest Fisheries Science Center. Of the 314 taxonomic categories identified, 17 were found to be most likely to show the effects of environmental change. The occurrence, abundance, and distribution of these key taxa revealed no consistent temporal trends. Recent research has shown a longitudinal gradient in community structure of the ichthyoplankton assemblages in the eastern Pacific warm pool, with abundance, species richness, and species diversity high in the east (where the thermocline is shallow and primary productivity is high) and low in the west (where the thermocline is deep and primary productivity is low).

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

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

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

4. TROPHIC INTERACTIONS

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

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

While diet studies have yielded many insights, stable isotope analysis is a useful complement to stomach contents for delineating the complex structure of marine food webs. Stomach contents represent a sample of only the most-recent several hours of feeding at the time of day an animal is captured, and under the conditions required for its capture. Stable carbon and nitrogen isotopes, however, integrate information on all components of the diet into the animal's tissues, providing a recent history of trophic interactions and information on the structure and dynamics of ecological communities. More insight is provided by compound-specific isotope analysis (CSIA) of amino acids. In samples of consumer tissues, "source" amino acids (*e.g.* phenyalanine, glycine) retained the isotopic values at the base of the food web, and "trophic" amino acids (*e.g.* glutamic acid) became enriched in ^{15}N by about 7‰ relative to the baseline. In CSIA, predator tissues alone are adequate for trophic-position estimates, and separate analysis of the isotopic composition of the base of the food web is not necessary. A recent analysis of the spatial distribution of stable isotope values of yellowfin tuna in relation to those of omnivorous copepods showed that the trophic position of yellowfin tuna increased from inshore to offshore in the EPO, a characteristic of the food web never detected in diet data. The diet data for the same yellowfin samples analyzed for isotope content showed comparable variability in the trophic position of yellowfin, but did not show an inshore-offshore gradient in trophic position.

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

Interannual differences in predation on other diet components were small. *Auxis* spp. were eaten in significantly greater quantities ($p<0.05$) in 2005 and 2006 compared to 2003 and 2004, and significantly more Pacific flatiron herring (*Harengula thrissina*) and chub mackerel (*Scomber japonicus*) were eaten in 2006 than in the previous three years. Overall, there is no convincing evidence of substantial changes in the trophic structure having taken place during 2003-2006, based on the food habits of yellowfin tuna caught in association with dolphins.

5. PHYSICAL ENVIRONMENT[5]

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

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

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

The IATTC reports monthly average oceanographic and meteorological data for the EPO, including a summary of current ENSO conditions, on a quarterly basis. In 2007, oceanographic and meteorological data indicated that La Niña conditions intensified during the second, third, and fourth quarters. In 2008, somewhat weaker La Niña conditions prevailed during the first quarter, followed by near neutral conditions during the second and third quarters. Mild La Niña conditions developed during the fourth quarter of 2008.

Variability on a decadal scale (*i.e.* 10 to 30 years) also affects the EPO. During the late 1970s there was a major shift in physical and biological states in the North Pacific Ocean. This climate shift was also detected in the tropical EPO by small increases in SSTs, weakening of the trade winds, and a moderate change in surface chlorophyll levels. Some researchers have reported another major shift in the North

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

Pacific in 1989. Climate-induced variability in the ocean has often been described in terms of "regimes," characterized by relatively stable means and patterns in the physical and biological variables. Analyses by the IATTC staff have indicated that yellowfin tuna in the EPO have experienced regimes of lower (1975-1982) and higher (1983-2001) recruitment, and possibly intermediate (2002-2006) recruitment. The increased recruitment during 1983-2001 is thought to be due to a shift to a higher productivity regime in the Pacific Ocean. Decadal fluctuations in upwelling and water transport are simultaneous to the higher-frequency ENSO pattern, and have basin-wide effects on the SSTs and thermocline slope that are similar to those caused by ENSO, but on longer time scales.

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

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

6. AGGREGATE INDICATORS

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

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

Ecologically-based approaches to fisheries management place renewed emphasis on achieving accurate depictions of trophic links and biomass flows through the food web in exploited systems. The structure of the food web and the interactions among its components have a demonstrable role in determining the dynamics and productivity of ecosystems. Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms, to facilitate estimates of energy or mass flow through communities, and for elucidating trophodynamics aspects of ecosystem functioning. A simplified food-web diagram, with approximate TLs, of the pelagic tropical EPO, is shown in Figure J-1. Toothed whales (Odontoceti, average TL 5.2), large squid predators (large bigeye tuna and swordfish, average TL 5.2), and sharks (average TL 5.0) are top-level predators. Other tunas, large piscivores, dolphins (average TL 4.8), and seabirds (average TL 4.5) occupy slightly lower TLs. Smaller epipelagic fishes (*e.g. Auxis* spp. and flyingfishes, average TL 3.2), cephalopods (average TL 4.4), and mesopelagic fishes (average TL 3.4) are the principal forage of many of the upper-level predators in the ecosystem. Small fishes and crustaceans prey on two zooplankton groups, and the herbivorous micro-zooplankton (TL 2) feed on the producers, phytoplankton and bacteria (TL 1).

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

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

7. ECOSYSTEM MODELING

It is clear that the different components of an ecosystem interact. Ecosystem-based fisheries management is facilitated through the development of multi-species, ecosystem models that represent ecological interactions among species or guilds. Our understanding of the complex maze of connections in open-ocean ecosystems is at an early stage, and, consequently, the current ecosystem models are most useful as descriptive devices for exploring the effects of a mix of hypotheses and established connections among the ecosystem components. Ecosystem models must be compromises between simplistic representations on the one hand and unmanageable complexity on the other.

The IATTC staff has developed a model of the pelagic ecosystem in the tropical EPO (IATTC Bulletin, Vol. 22, No. 3) to explore how fishing and climate variation might affect the animals at middle and upper trophic levels. The ecosystem model has 38 components, including the principal exploited species (*e.g.* tunas), functional groups (*e.g.* sharks and 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, and purse-seine sets on tunas associated with dolphins, with floating objects, and in unassociated schools. The model focuses on the pelagic regions; localized, coastal ecosystems are not adequately described by the model.

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

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

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

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

8.1. Dolphins

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

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

8.2. Sea turtles

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

b. In June 2003 the IATTC adopted a Recommendation on Sea Turtles, which contemplates "the development of a three-year program that could include mitigation of sea turtle bycatch, biological research on sea turtles, improvement of fishing gears, industry education and other techniques to improve sea turtle conservation." In January 2004, the Working Group on Bycatch drew up a detailed program that includes all these elements, and urges all nations with vessels fishing for tunas in the EPO to provide the IATTC with information on interactions with sea turtles in the EPO, including both incidental and direct catches and other impacts on sea turtle populations. Resolution C-04-07 on a three-year program to mitigate the impact of tuna fishing on sea turtles was adopted by the IATTC in June 2004; it includes requirements for data collection, mitigation measures, industry education, capacity building, and reporting.

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

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

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

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

8.3. Seabirds

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

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

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

8.4. Other species

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

b. Resolution C-04-05, adopted by the IATTC in June 2006, instructs the Director to seek funds for reduction of incidental mortality of juvenile tunas, for developing techniques and equipment to facilitate release of billfishes, sharks, and rays from the deck or the net, and to carry out experiments to estimate the survival rates of released billfishes, sharks, and rays.

8.5. All species

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

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

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

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

9. FUTURE DEVELOPMENTS

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

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

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

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

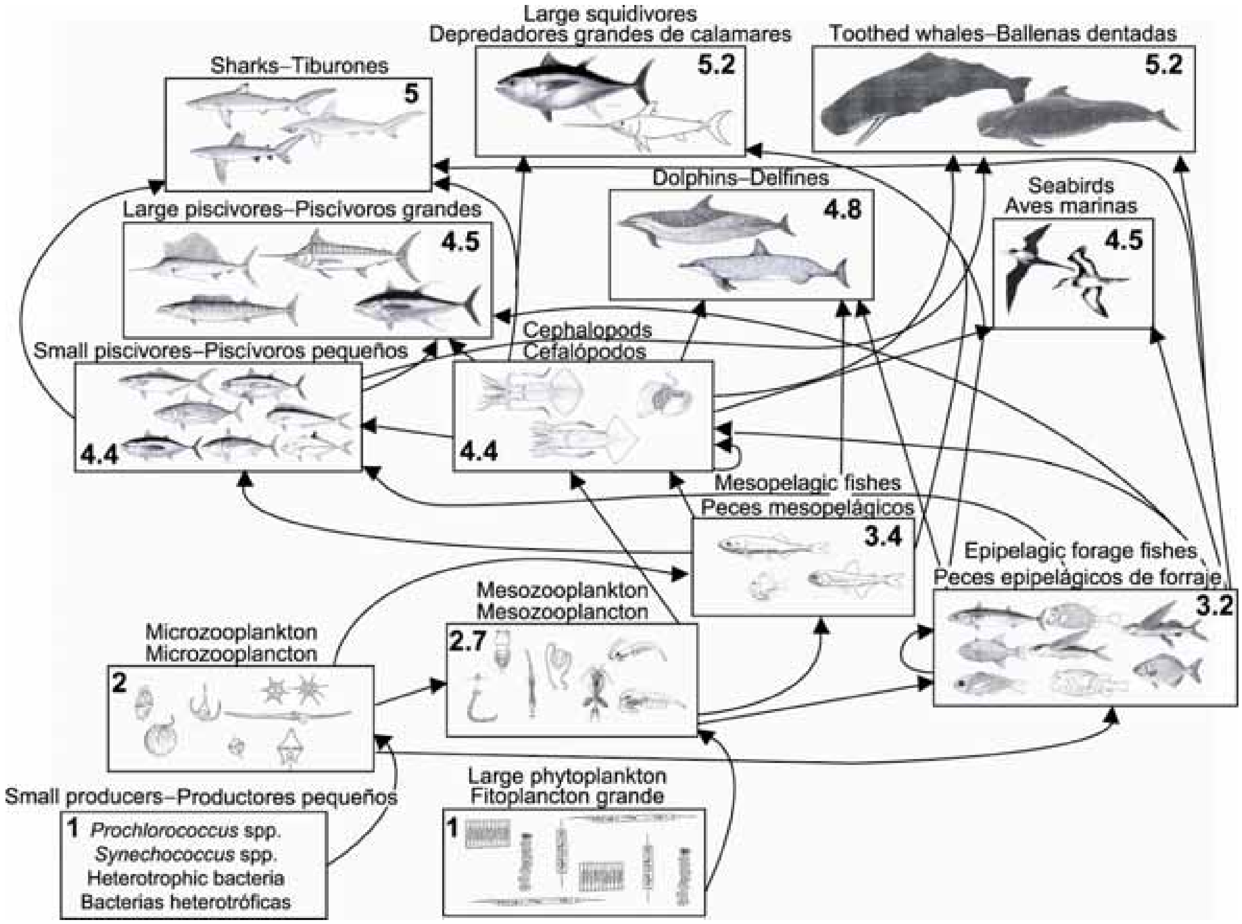


FIGURE J-1. Simplified food-web diagram of the pelagic ecosystem in the tropical EPO. The numbers inside the boxes indicate the approximate trophic levels of each group.

FIGURA J-1. Diagrama simplificado de la red trófica del ecosistema pelágico en el OPO tropical. Los números en los recuadros indican el nivel trófico aproximado de cada grupo.

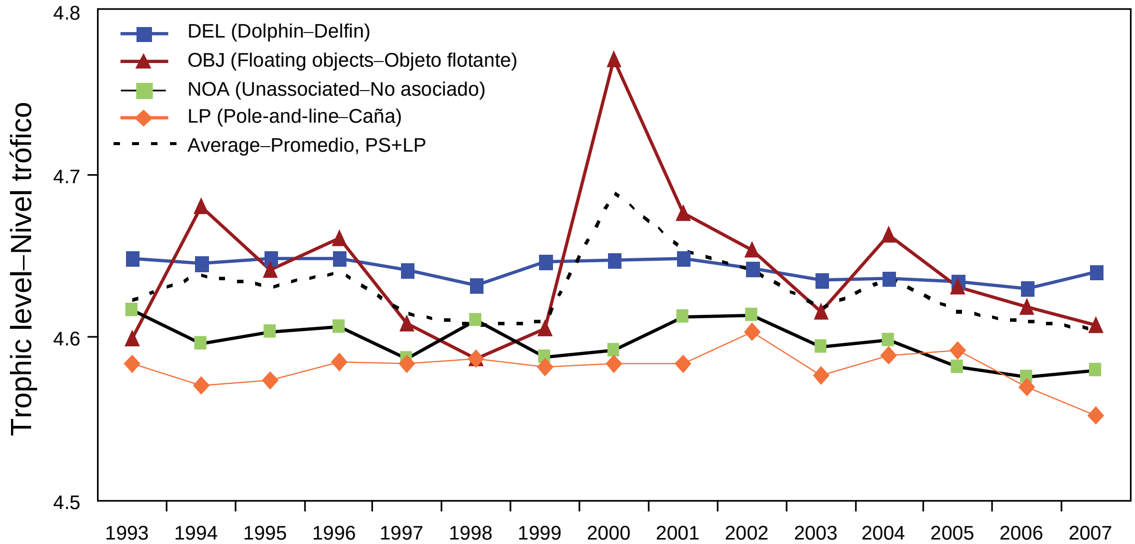


FIGURE J-2. Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine and pole-and-line fisheries in the tropical EPO, 1993-2007.
FIGURA J-2. Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de las pesquerías cerquera y cañera en el OPO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

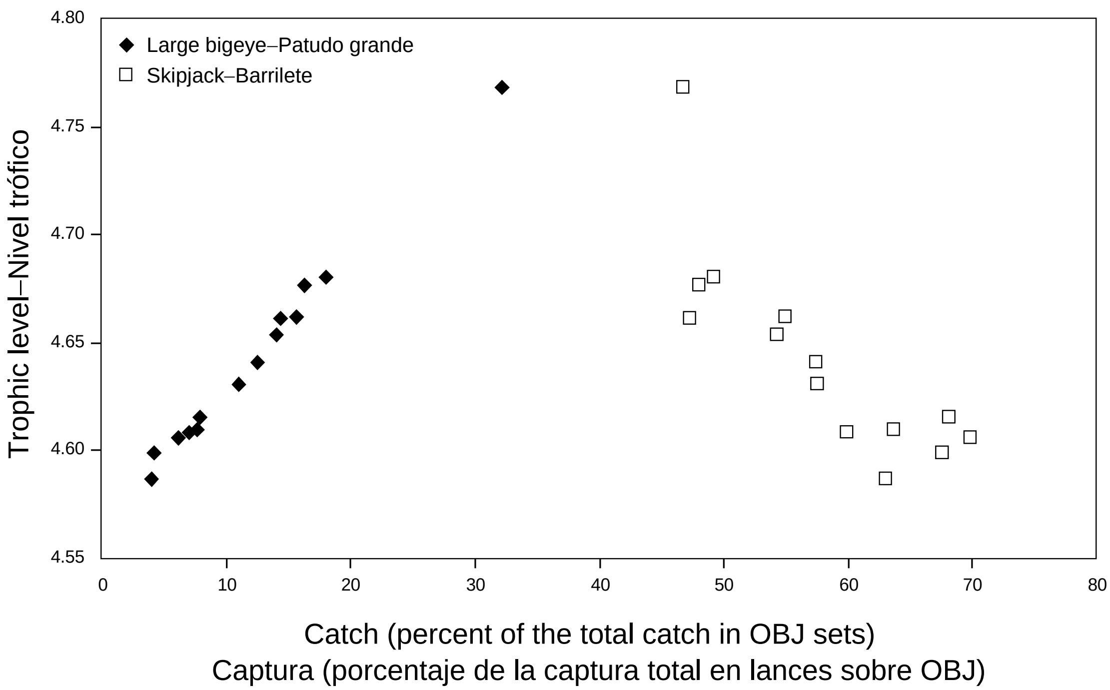


FIGURE J-3. Estimates of the trophic levels of the retained catches of large bigeye and of skipjack in floating-object sets (OBJ) in the tropical EPO, 1993-2006, versus the catches of large bigeye and of skipjack calculated as percentages of the total catches in floating-object sets each year.
FIGURA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

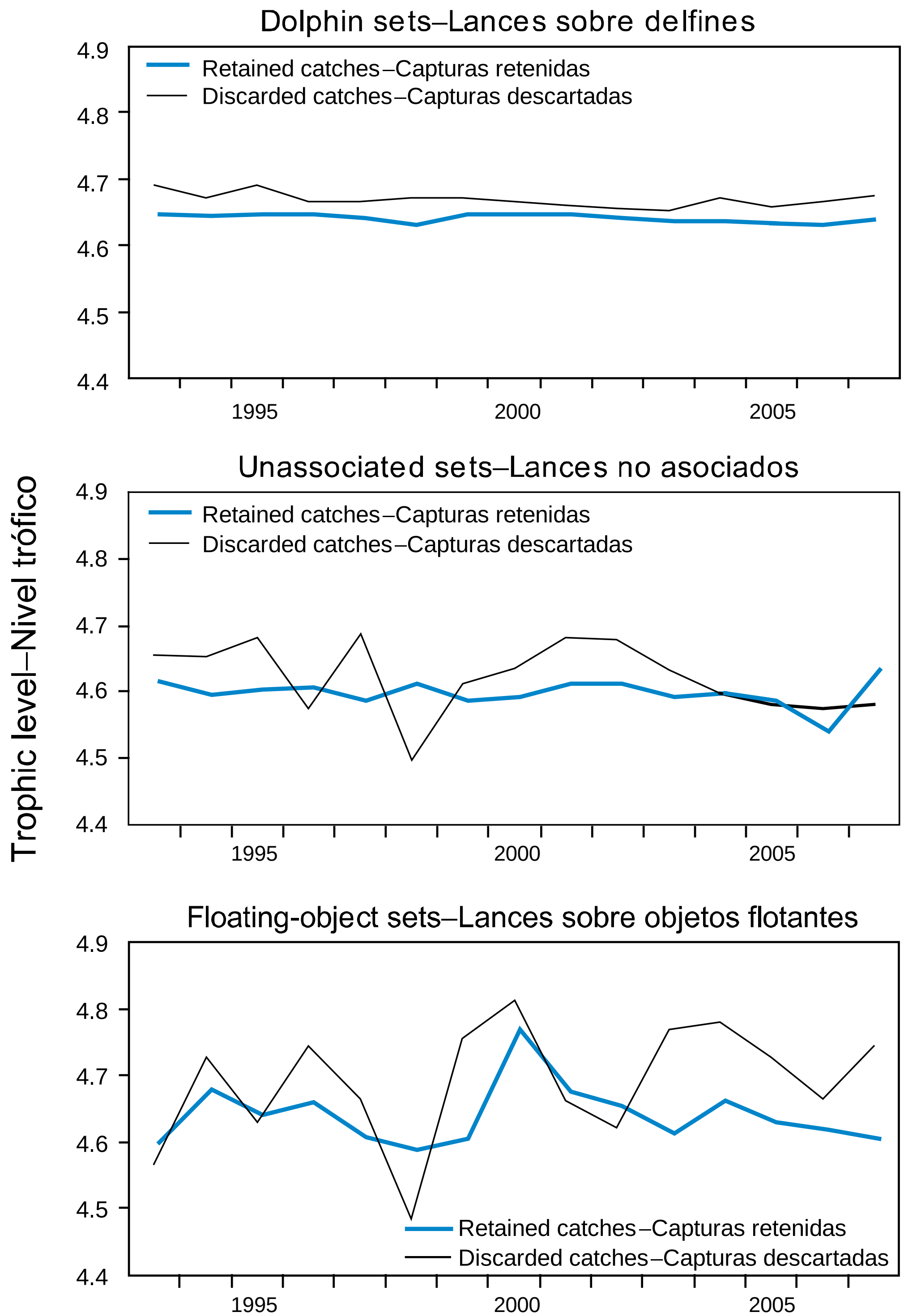


FIGURE J-4. Trophic level estimates of the retained catches and discarded catches by purse-seine fishing modes in the tropical EPO, 1993-2007.

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