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FISHERY STATUS REPORT 4

TUNAS AND BILLFISHES IN THE EASTERN PACIFIC OCEAN IN 2005

A. The fishery for tunas and billfishes in the eastern Pacific Ocean 4
B. Yellowfin tuna 53
C. Skipjack tuna 62
D. Bigeye tuna 66
E. Pacific bluefin tuna 76
F. Albacore tuna 78
G. Swordfish 81
H. Blue marlin 83
I. Striped marlin 85
J. Ecosystem considerations 87

INTRODUCTION

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

The report is based on data available to the IATTC staff in June 2006. The sections on bluefin and albacore tunas (E, F), and the three sections on billfishes (G, H, I) are essentially the same as the corresponding sections of IATTC Fishery Status Report 3, published in 2005, 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 <1 metric ton; blank means no data collected; * means data missing or not available. The following abbreviations are used:

Species:

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

Set types:

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

[1] not elsewhere included

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
URY	Uruguay
USA	United States of America
VEN	Venezuela
VUT	Vanuatu

Fishing gears:

FPN	Trap
GN	Gillnet
HAR	Harpoon
LL	Longline
LP	Pole-and-line
LTL	Troll
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:

AMSY	Average maximum sustainable yield
B	Biomass
C	Catch
CPUE	Catch per unit of effort
F	Coefficient of fishing mortality
SBR	Spawning biomass ratio
SSB	Spawning stock biomass

[2] Used to group known gear types

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

1. Catches and landings of tunas, billfishes, and associated species 4
1.1. Catches by species 5
1.2. Distributions of the catches of tunas 8
1.3. Size compositions of the catches of tunas 8
1.4. Catches of tunas and bonitos, by flag and gear 10
1.5. Landings of tunas and bonitos by purse-seine and pole-and-line vessels 10
1.6. Purse-seine catches per cubic meter of well volume 11
2. Effort 11
2.1. Purse seine 11
2.2. Longline 11
3. The fleets 12
3.1. The purse-seine and pole-and-line fleets 12
3.2. Other fleets of the EPO 13

This section summarizes the fisheries for species covered by the IATTC Convention (tunas and other fish caught by tuna-fishing vessels) in the eastern Pacific Ocean (EPO). The most important of these are the scombrids (Family Scombridae), which include tunas, bonitos, 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 less complete.

The IATTC Regional Vessel Register contains details of vessels authorized to fish for tunas in the EPO. The IATTC has detailed records of most of 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 large (>24 m) longline vessels of some nations that fish in the EPO and in other areas.

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

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

The data in this report are derived from 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 published reports.

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 often incomplete. Data for fish discarded at sea by Class-6 purse-seine vessels have been collected by observers since 1993. This information allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the retained catch) are based principally on data from unloadings. Beginning with the 2004 report, the unloading data for purse-seine and pole-and-line vessels have been adjusted, based on the species composition estimates for yellowfin, skipjack, and bigeye tunas. The current species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-2005 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 2005 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 longlines and other gears for 2004 and 2005 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 1976-2005 are shown in Table A-2. The catches of tunas and bonitos by all gears during 2001-2005, by gear and flag, are shown in Tables A-3a-e, and the purse-seine and pole-and-line catches and the recreational landings of tunas and bonitos during 2004-2005 are summarized by flag in Tables A-4a-b. 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 1998-2005. 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 1976-2005 are shown in Table A-1 and Figure B-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 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. In the WCPO, the catches of yellowfin reached 354 thousand metric tons (t) in 1990, peaked at 463 thousand t in 1998, and remained high through 2004 (2005 data for the WCPO are not yet available). The catches throughout the Pacific Ocean were high during 2001-2003. In the EPO, the catch of yellowfin in 2002, 443 thousand t, was the greatest on record, but in 2004 and

2005 it decreased substantially.

The annual retained catches of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1976-2005 are shown in Table A-2a. The average annual retained catch during 1990-2004 was 275 thousand t (range: 212 to 413 thousand t). The preliminary estimate of the retained catch in 2005, 270 thousand t, was 1% less than in 2004, and also 1% less than the average for 1990-2004. The average amount of yellowfin discarded at sea during 1993-2005 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 1976-2005 are shown in Table A-2a. During 1990-2004 they remained relatively stable, averaging about 22 thousand t (range: 11 to 35 thousand t), or about 7% of the total retained catches of yellowfin. Yellowfin are also caught by recreational vessels, as incidental catch in gillnets, and by artisanal fisheries. Estimates of these catches are shown in Table A-2a, under “Other gears” (OTR); during 1990-2004 they averaged about 2 thousand t.

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

1.1.2. Skipjack tuna

The annual catches of skipjack during 1976-2005 are shown in Table A-1 and Figure C-1. Most of the skipjack catch in the Pacific is taken in the WCPO. The greatest reported catch in the WCPO, about 1.4 million t, occurred in 2004, while the greatest reported catch in the EPO,302 thousand t, occurred in 2003.

The annual retained catches of skipjack in the EPO by purse-seine and pole-and-line vessels during 1976-2005 are shown in Table A-2a. During 1990-2004 the annual retained catch averaged 144 thousand t (range 64 to 276 thousand t). The preliminary estimate of the retained catch in 2005, 261 thousand t, is 83% greater than the average for 1990-2004, but 6% less than the record-high catch of 2003. The average amount of skipjack discarded at sea during 1993-2005 was about 11% of the total catch of skipjack (range: 7 to 19%) (Table A-2a).

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

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

1.1.3. Bigeye tuna

The annual catches of bigeye during 1976-2005 are shown in Table A-1 and Figure D-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 reported 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 118 thousand t. The greatest reported catch of bigeye in the WCPO, about 122 thousand t, occurred in 2002.

Prior to 1994, the average annual retained catch of bigeye taken by purse-seine vessels in the EPO was about 9 thousand t (range 1 to 22 thousand t) (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 45 to 64 thousand t during 1995-1999, to a record high of 94 thousand t in 2000. A preliminary estimate of the retained catch in the EPO in 2005 is 70 thousand t. The average amount of bigeye discarded at sea during 1993-2005 was about 5% of the purse-seine catch of bigeye (range: 2 to 9%). Small amounts of bigeye have been caught by pole-and-line vessels, as shown in Table A-2a.

During 1975-1993, prior to the increased use of FADs and the resulting greater catches of bigeye by purse-seine vessels, the longline fisheries accounted for about 88%, on average, of the retained catches of this species from the EPO. During 1994-2004 the annual retained catches of bigeye by the longline fisheries ranged from about 36 to 75 thousand t (average: 55 thousand t), or an average of 45% of the total catch of bigeye in the EPO (Table A-2a). The preliminary estimate of the catch in the EPO in 2005 is 38 thousand t (Table A-2a).

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

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

1.1.4. Bluefin tuna

The catches of Pacific bluefin in the entire Pacific Ocean, by flag and gear, are shown in Table A-5 and Figure E-1. 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 1976-2005, by gear, are shown in Table A-2. During 1990-2004 the annual retained catch of bluefin from the EPO by purse-seine and pole-and-line vessels averaged 3 thousand t (range 400 t to 9 thousand t). The preliminary estimate of the retained catch of bluefin in 2005, 5 thousand t, is 2 thousand t greater than the average for 1990-2004. Small amounts of bluefin are discarded at sea by purse-seine vessels (Table A-2a).

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

1.1.5. Albacore tuna

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 and in Figures F-1a-b. 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.

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

1.1.6. Other tunas and tuna-like species

While yellowfin, skipjack, and bigeye tunas comprise the most significant portion of the retained catches of the purse-seine and pole-and-line 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 1976-2005 are presented in Table A-2a. The catches reported in the unidentified tunas category (TUN) in Table A-2a contain some catches reported by species (frigate or bullet tunas, wahoo) along with the unidentified tunas. The total retained catch of these other species by these fisheries was about 2 thousand t in 2005, which is less than the 1990-2004 annual average retained catch of about 3 thousand t (range: 500 t to 15 thousand t).

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

1.1.7. Billfishes

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

Swordfish are 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 1990-2004 was 10 thousand t, but during 2001-2004 was about 16 thousand t. It is not clear whether this is due to increasing effort directed toward swordfish.

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 1990-2004 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 discarded, although some may be landed but not reported. These data are also included in Table A-2b.

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

1.1.8. Other species

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 1990-2004 (1994-2004 for bigeye), are shown in Figures A-1a, A-2a, and A-3a, and preliminary estimates for 2005 are shown in Figures A-1b, A-2b, and A-3b. The catches of yellowfin were low in the Northern areas off Mexico and Central America in 2005, as in 2004; they were greater in the South between 10° and 20°S in the first half of the year. The distribution of the skipjack catches in 2005 were similar to those of 1990-2004, although, as was the case in 2004, the catches in the Inshore areas off Mexico were greater, possibly due to changes in fishing strategy due to poor yellowfin fishing. There were also increased catches of skipjack in the Inshore areas off South America. Bigeye are not often caught north of about 7°N. The catches of bigeye were reduced in the Inshore areas off South America in 2004 and 2005. With the development of the fishery for tunas associated with FADs, described above, the relative importance of the Inshore areas has decreased, while that of the Offshore areas has increased.

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 the Japanese longline fleet during 2000-2004 are shown in Figure A-4. Data for the Japanese longline fishery in the EPO during 1956-1997 is 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 all of its Annual Reports since that for 1954, and in its Stock Assessment Reports.

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

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

Data for fish caught during the 2000-2005 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 2005, and the second shows the combined data for each year of the 2000–2005 period. For bluefin, the histograms show the 2000-2005 catches by commercial and recreational gear combined. For black skipjack, the histograms show the 2000-2005 catches by commercial gear. Only a small amount of catch was taken by pole-and-line vessels in 2005, and only four 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 school) and one pole-and-line fishery are defined (Figure A-5). The last fishery includes all 13 sampling areas. Of the 789 wells sampled, 603 contained yellowfin. The estimated size compositions of the fish caught during 2005 are shown in Figure A-6a. The majority of the yellowfin catch was taken by sets on schools associated with dolphins. The larger yellowfin (>100 cm) were caught during the first half of 2005 in the Southern dolphin fishery, and in the second through fourth quarters in the Northern dolphin fishery. Larger fish were also caught in the Inshore dolphin fishery, mostly in the third quarter. A mode of smaller yellowfin (60 cm) was evident in both the Northern and Southern unassociated fisheries during the first half of the year. Small amounts of yellowfin were caught in the floating-object fisheries throughout the year. The catches by pole-and-line vessels were negligible.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2000-2005 are shown in Figure A-6b. The average weights of the yellowfin caught in 2005 were the lowest since 1999.

For stock assessments of skipjack, seven purse-seine fisheries (four associated with floating objects, two unassociated school, 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 789 wells sampled, 627 contained skipjack. The estimated size compositions of the fish caught during 2005 are shown in Figure A-7a. The majority of the skipjack catch during the first quarter of 2005 was taken in unassociated sets in the Southern area. During the second quarter large catches of skipjack continued in unassociated sets in the Southern area, and catches also increased significantly in floating-object sets in all areas. Skipjack catches in unassociated sets during the third quarter increased in the North, but decreased in the South. Significant skipjack catches continued on floating object sets except in the Southern area, where the catches declined during the third quarter. Skipjack catches during the fourth quarter declined in the North on unassociated sets, while catches increased in the Southern area in both floating-object and unassociated sets. The skipjack caught in the fishery for schools associated with dolphins were taken mostly during the second quarter. Negligible amounts of skipjack were caught by pole-and-line vessels.

The estimated size compositions of the skipjack caught by all fisheries combined during 2000-2005 are shown in Figure A-7b. The smaller fish (40 to 50 cm) were caught primarily during the first and fourth quarters of 2004, and the larger ones (>55 cm) primarily during the second quarter that year.

For stock assessments of bigeye, six purse-seine fisheries (four associated with floating objects, one unassociated school, 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 789 wells sampled, 209 contained bigeye. The estimated size compositions of the fish caught during 2005 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 2005, as in 2004, nearly equal amounts of bigeye were taken in the Northern, Equatorial, and Southern floating-object fisheries. Small amounts of bigeye were caught in sets on unassociated schools, in floating-object sets in the Inshore area, and in sets on schools associated with dolphins. There were no recorded catches of bigeye by pole-and-line vessels.

The estimated size compositions of the bigeye caught by all fisheries combined during 2000-2005 are shown in Figure A-8b. The average weight of the fish was greatest in 2000, when the greatest catch of bigeye was taken. Since 2002 the average weights of bigeye have been fairly constant. The smaller bigeye (40-60 cm) were caught in floating-object sets throughout the year, while most of the larger fish were caught during the fourth quarter in floating-object sets in the Equatorial and Southern areas.

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 2005 bluefin were caught between 26°N and 31°N from May through August. The majority of the catches of bluefin by both commercial and recreational vessels were taken during July and August. In the past, commercial and recreational catches have been reported separately. In 2004 and 2005, however, small sample sizes make it infeasible to estimate the catches and size compositions separately. Therefore, the commercial and recreational catches of bluefin were combined for each year of the 2000-2005 period. The estimated size compositions are shown in Figure A-9. The commercial catch of bluefin far exceeded the recreational catch, but the estimate for the latter is very preliminary.

Black skipjack are caught incidentally by fishermen who direct their effort toward yellowfin, skipjack, and bigeye tuna. The demand for this species is low, so most of the catch is discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. Fifteen samples of black skipjack were taken in 2005; the estimated size compositions are shown in Figure A-10.

1.3.2. Longline fishery

The estimated size compositions of the catches of yellowfin and bigeye by the Japanese longline fishery in the EPO during 2000-2004 are shown in Figures A-11 and A-12. The average weights of both yellowfin and bigeye taken by that fishery have remained about the same throughout its existence. Information on the size compositions of fish caught by the Japanese longline fishery in the EPO during 1958-1997 is available in IATTC Bulletins describing that fishery.

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

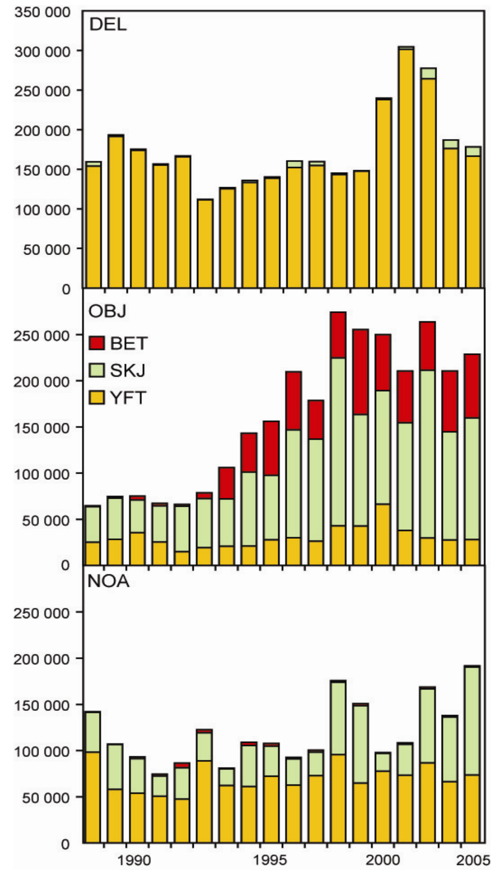
The annual retained catches of tunas and bonitos in the EPO during 2001-2005, by flag and gear, are shown in Tables A-3a-e. These tables include all of the known catches of tunas and bonitos compiled from records gathered from governments, fish-processing companies, logbooks, and import-export records. 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 website. The purse-seine,pole-and-line and recreational catches of tunas and bonitos in 2004 and 2005, by flag, are summarized in Tables A-4a-b (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 2004 and 2005 (Tables A-4a-b, lower panels) indicate that, of the 608 thousand t of tunas and bonitos landed in 2005, 52% was landed in Ecuador and 24% in Mexico. Other countries with significant landings of tunas and bonitos caught in the EPO included Colombia (7%), and Costa Rica and Venezuela (3%). It is important to note that, when final information is available, the landings currently assigned to various countries may change due to exports from storage facilities to processors in other nations.

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

The total retained catch per cubic meter of well volume (C/m^3) for the purse-seine vessels that fish for tunas in the EPO are presented in Table A-7 for the EPO, by vessel size group and species, for 2000-2005. To provide more detail in this index than would be available if the IATTC's historical six classes of vessel capacity classification were used, the vessels are assigned to eight size groups. Yellowfin, skipjack, and bigeye contribute the most to the C/m^3 for the larger vessels, while other species of tuna, such as black skipjack, make up an important part of the C/m^3 of the smaller vessels in many years.



Purse-seine catches of tunas, by species and set type, 1987-2005

2. EFFORT

2.1. Purse seine

Tunas are caught by purse-seine vessels in three types of schools, those associated with dolphins, those associated with floating objects, such as flotsam or FADs, and those associated only with other fish (unassociated schools). Estimates of the numbers of purse-seine sets of each type in the EPO during the 1988-2005 period, and the retained catches of these sets, are shown in Table A-8 and in the figure on this page. The estimates for Class-1 to -5 vessels were calculated from logbook data in the IATTC statistical data base, and those for Class-6 vessels were calculated from the observer data bases of the IATTC, Ecuador, the European Union, Mexico, the United States, and Venezuela. The greatest numbers of sets on schools associated with floating objects and on unassociated schools of tuna were made from the mid-1970s to the early 1980s. Despite opposition to fishing for tunas associated with dolphins and the refusal of U.S. canners to accept tunas caught during trips during which sets were made on dolphin-associated fish, the numbers of sets made on fish associated with dolphins decreased only moderately during the mid-1990s, and in 2003 were the greatest recorded.

There are two types of floating objects, flotsam and FADs. The occurrence of the former is unplanned from the point of view of the fishermen, whereas the latter are constructed by fishermen specifically for the purpose of attracting fish. FADs have been widely used for about 12 years, and their relative importance has increased during this period, while that of flotsam has decreased, as shown by the data in Table A-9.

2.2. Longline

The reported annual effort, in total number of hooks, regardless of the target species, and the catches of the predominant tuna species by longline vessels in the EPO are shown in Table A-10. The data for China, Chinese Taipei, French Polynesia, Japan, the Republic of Korea (1987-2004 only), and the United States are representative of total catch and effort, whereas those of Mexico, Panama, the Republic of Korea (1975-1986), and Vanuatu, which were compiled from logbook data, do not represent the totals.

3. THE FLEETS

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

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

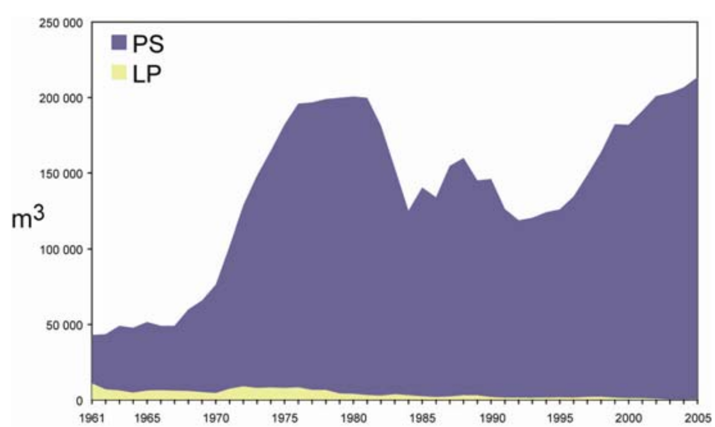
Historically the owner's or builder's estimates of carrying capacities of individual vessels, in tons of fish, were used until landing records indicated that revision of these estimates was required. The vessels were grouped, by carrying capacity, originally in short tons and later in metric tons, into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

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.

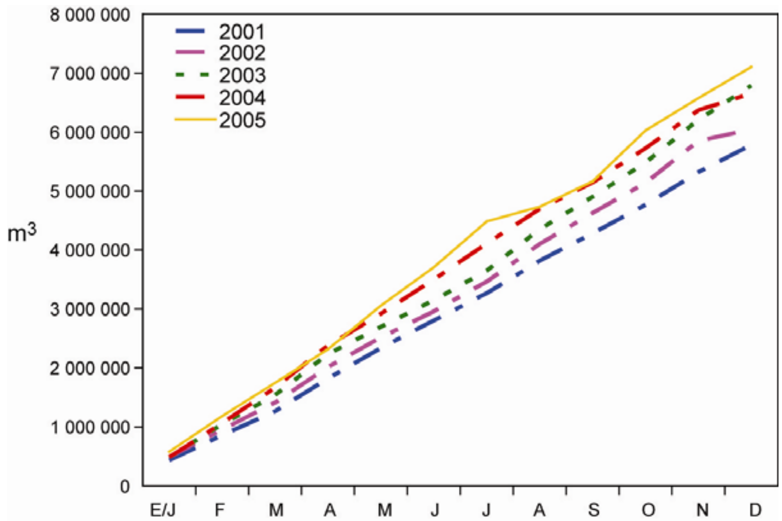
Until about 1960 fishing for tunas in the EPO was dominated by pole-and-line vessels operating in coastal regions and in the vicinity of offshore islands and banks. During the late 1950s and early 1960s most of the larger pole-and-line vessels were converted to purse seiners, and by 1961 the EPO fishery was dominated by these vessels. From 1961 to 2005 the number of pole-and-line vessels decreased from 93 to 4, and their total well volume from about 11 thousand to about 500 m^3. During the same period the number of purse-seine vessels increased from 125 to 219, and their total well volume from about 32 thousand to about 213 thousand m^3, an average of about 973 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 691 m^3 per vessel (Table A-11; figure on this page).

The catch rates in the EPO were low during 1978-1981, due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 125 thousand m^3. In early 1990 the U.S. tuna-canning industry adopted a policy of not purchasing tunas caught during trips during which sets on tunas associated with dolphins were made. This caused many U.S.-flag vessels to leave the EPO, with a consequent reduction in the fleet to about 119 thousand m^3 in 1992. With increases in participation of vessels of other nations in the fishery, the total well volume has increased steadily since 1992, and in 2005 was 213 thousand m^3.



Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2005

The 2004 and preliminary 2005 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-12a-b. The fleet was dominated by vessels operating under the Mexican and Ecuadorian flags during 2005. The Ecuadorian and Mexican fleets each had about 26% of the total well volume during 2005, Venezuela about 16%, Panama about 15%, Colombia about 7 %, Nicaragua about 4%, and Spain and El Salvador about 3% each.



Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2001-2005

Class-6 vessels made up about 91% of the total well volume of the purse-seine fleet operating in the EPO during 2005. The cumulative capacity at sea during 2005 is compared to those of the previous four years in the figure on this page.

The monthly average, minimum, and maximum total well volumes at sea (VAS), in thousands of cubic meters, of purse-seine and pole-and-line vessels that fished for tunas in the EPO during 1995-2004, and the 2005 values, are shown in Table A-13. The monthly values are averages of the VAS estimated at weekly intervals by the IATTC staff. The fishery was regulated during some or all of the last four months of 1998-2005, so the VAS values for September-December 2005 are not comparable to the average VAS values for those months of 1995-2004. The average VAS values for 1995-2004 and 2005 were 102 thousand m^3 (59% of total capacity) and 136 thousand m^3 (64% of total capacity), respectively.

3.2. Other fleets of the EPO

Information on other types of vessels that fish for tunas in the EPO is available on the IATTC's Regional Vessel Register, on the IATTC web site. The Register is incomplete for small vessels. It contains records for large (>24 m) longline vessels of some nations that fish in the EPO and in other areas.

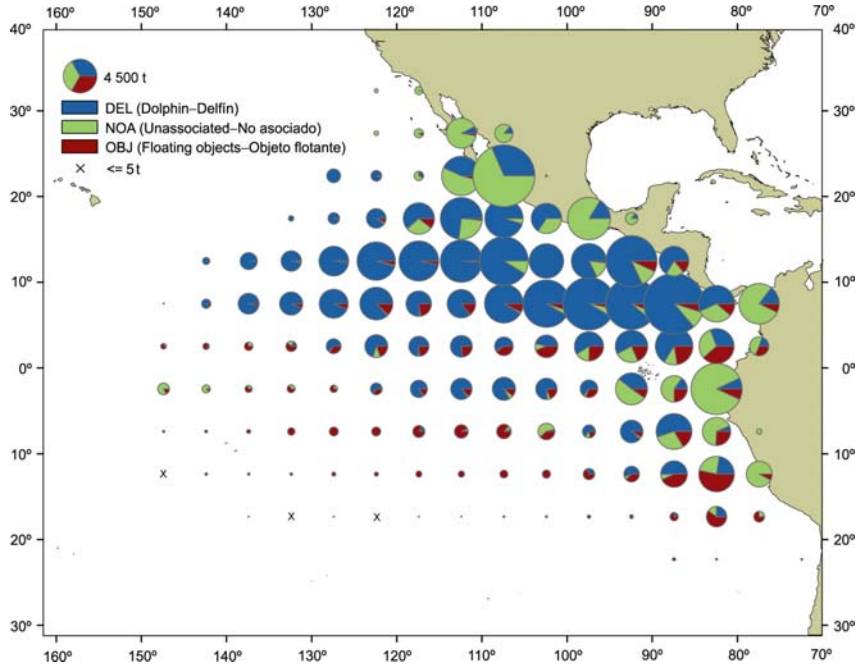


FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 1990-2004. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 1990-2004. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

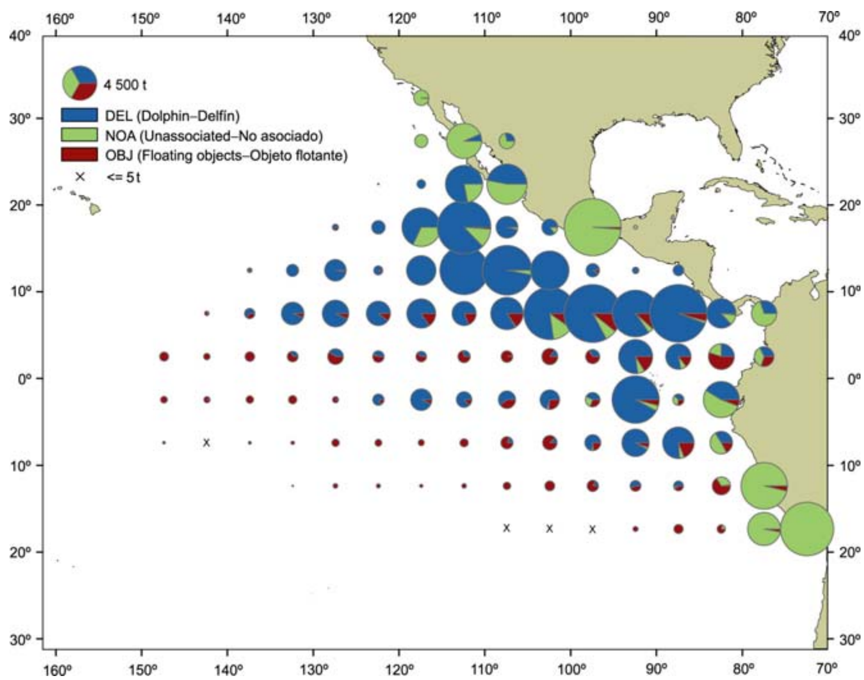


FIGURE A-1b. Average annual distributions of the purse-seine catches of yellowfin, by set type, 2005. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2005. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

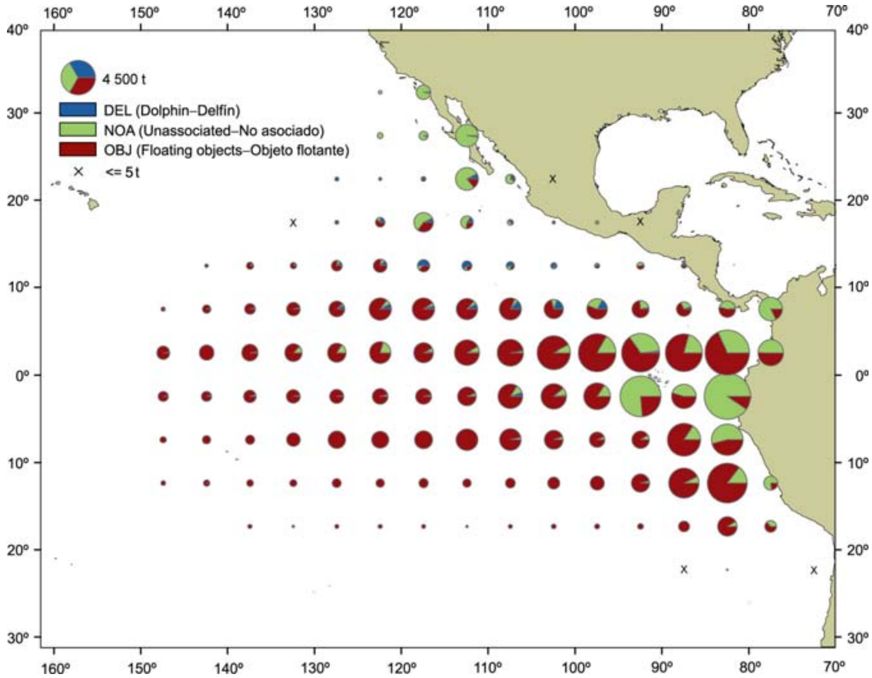


FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 1990-2004. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 1990-2004. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

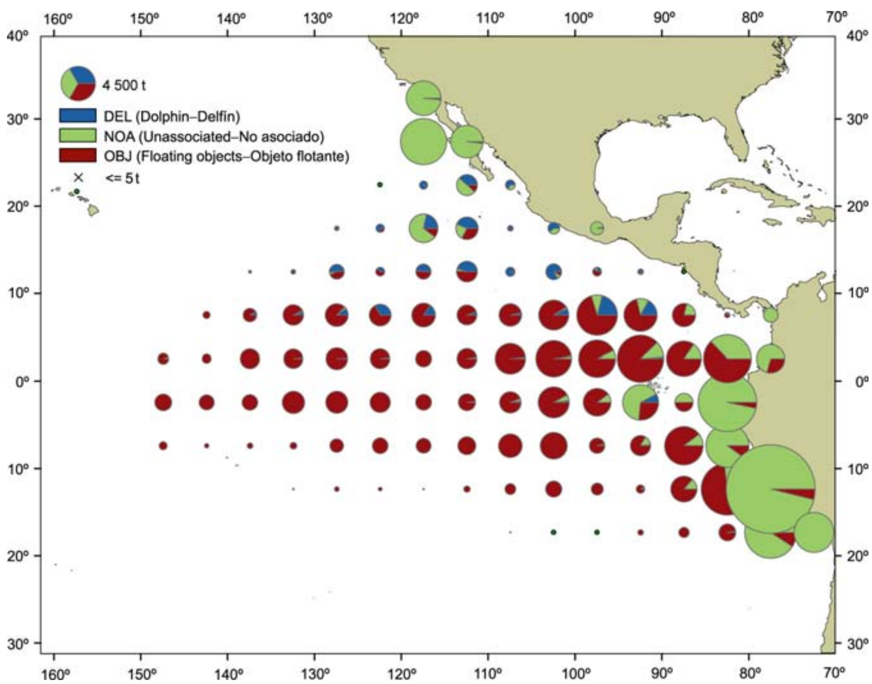


FIGURE A-2b. Average annual distributions of the purse-seine catches of skipjack, by set type, 2005. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2b. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 2005. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

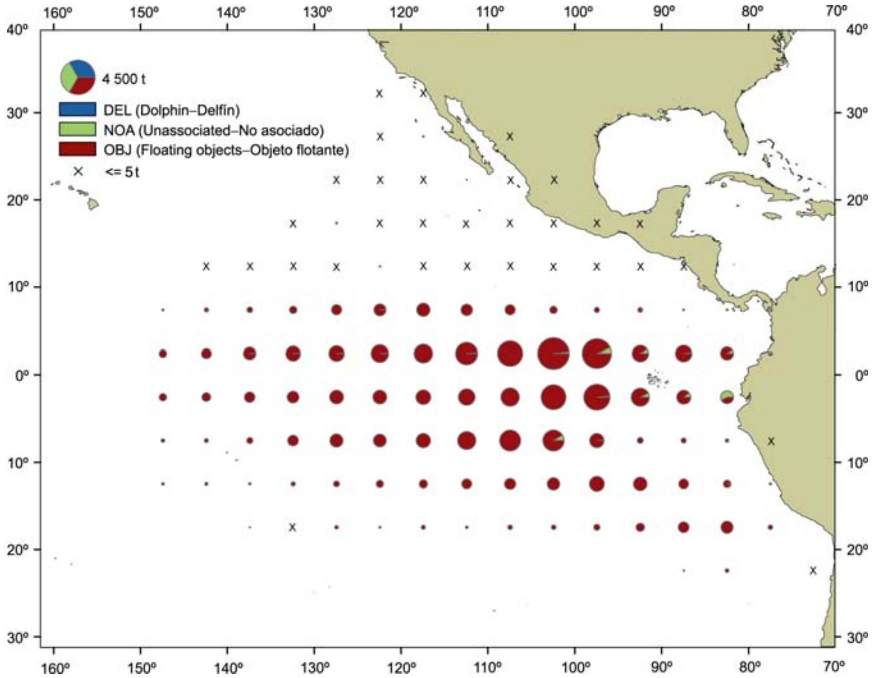


FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 1994-2004. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 1994-2004. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

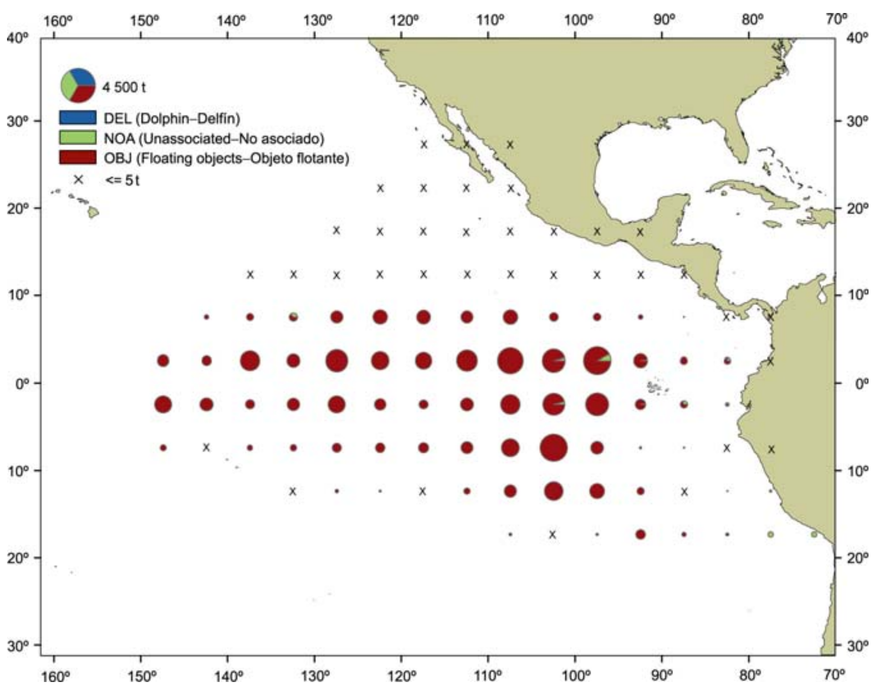


FIGURE A-3b. Average annual distributions of the purse-seine catches of bigeye, by set type, 2005. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3b. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 2005. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

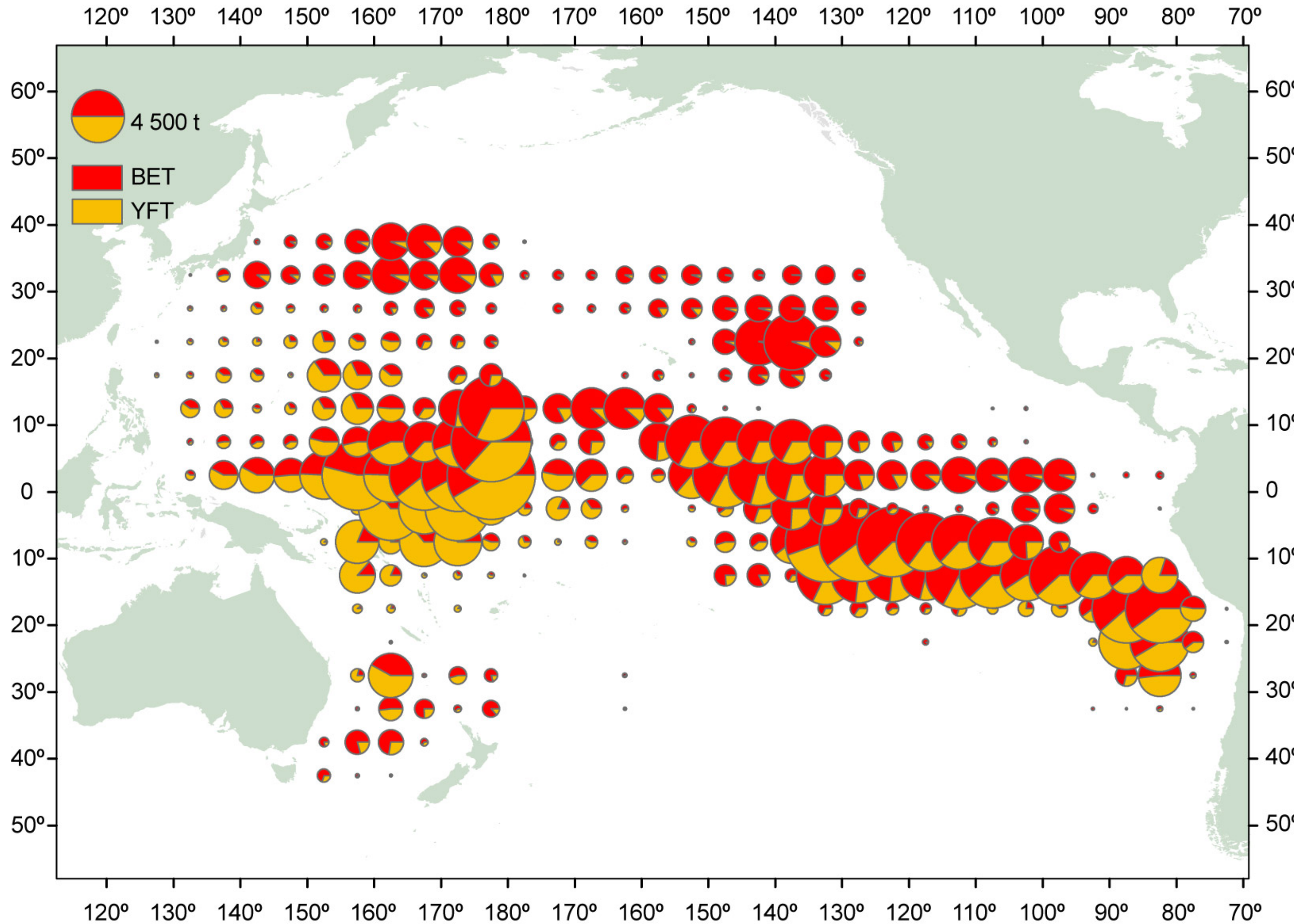


FIGURE A-4. Distributions of the catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by the Japanese longline fleet, 2000-2004. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.
FIGURA A-4. Distribución de las capturas de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por la flota palangrera japonesa , 2000–2004. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

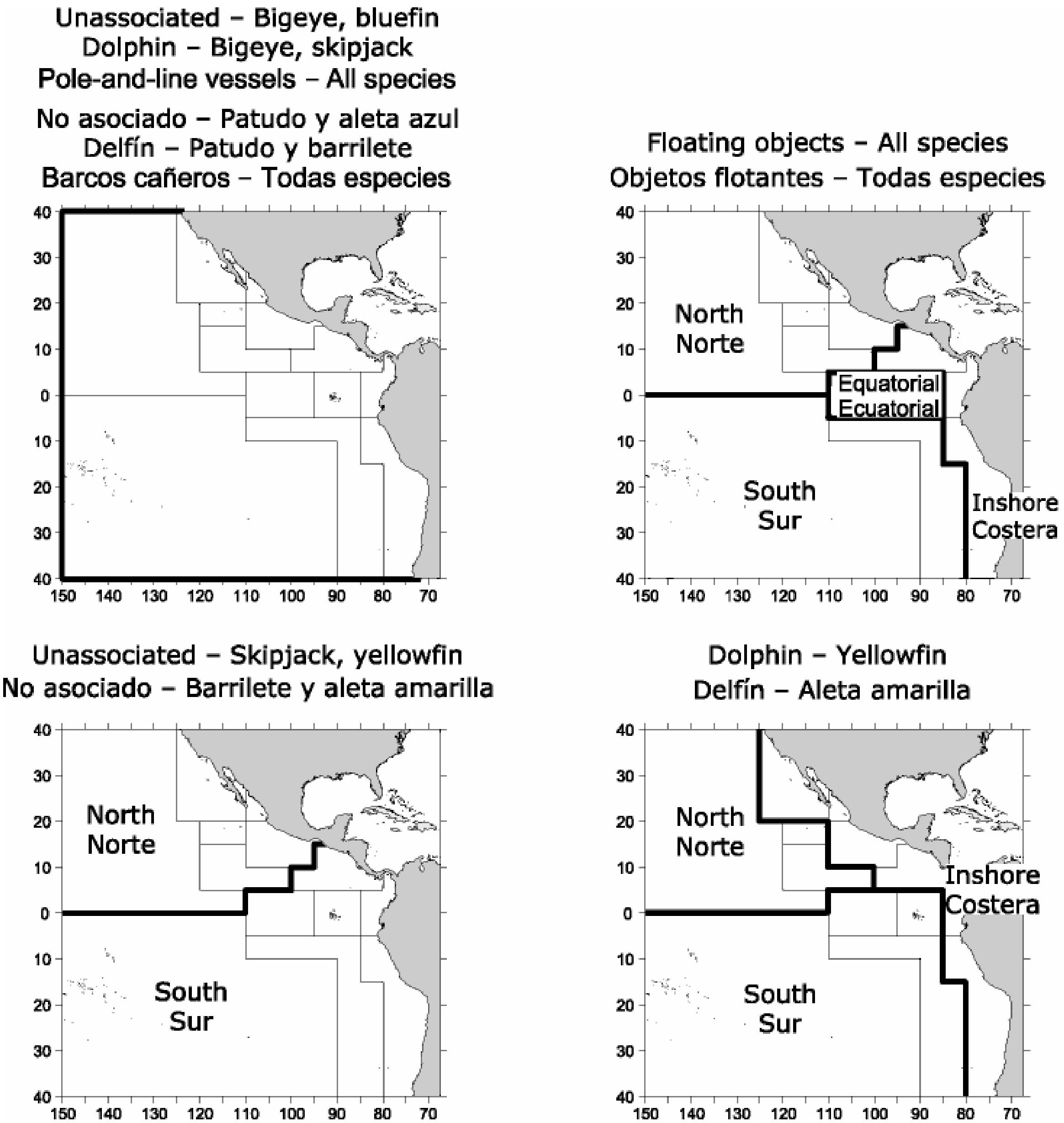


FIGURE A-5. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

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.

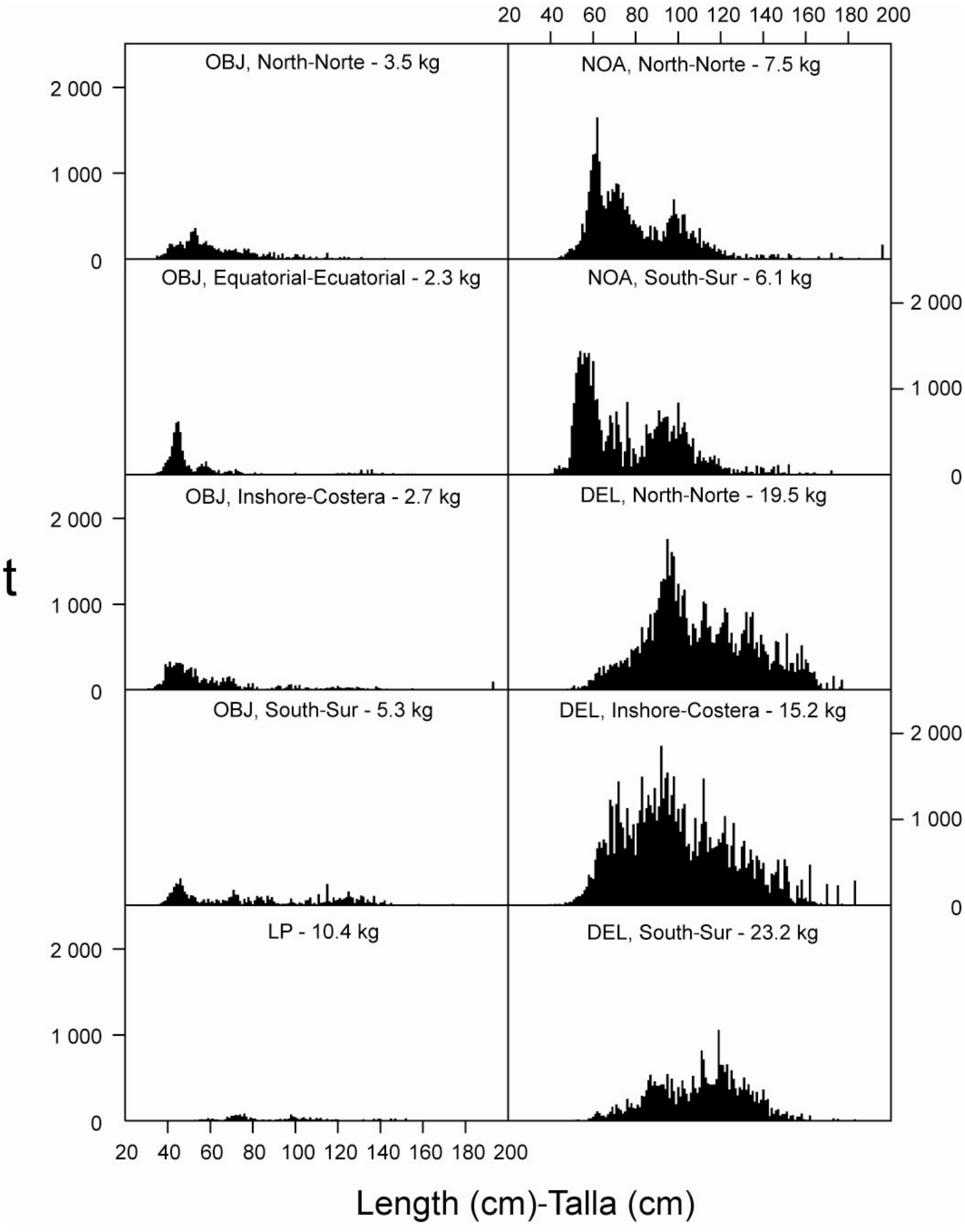


FIGURE A-6a. Estimated size compositions of the yellowfin caught in each fishery of the EPO during 2005. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en cada pesquería del OPO en 2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

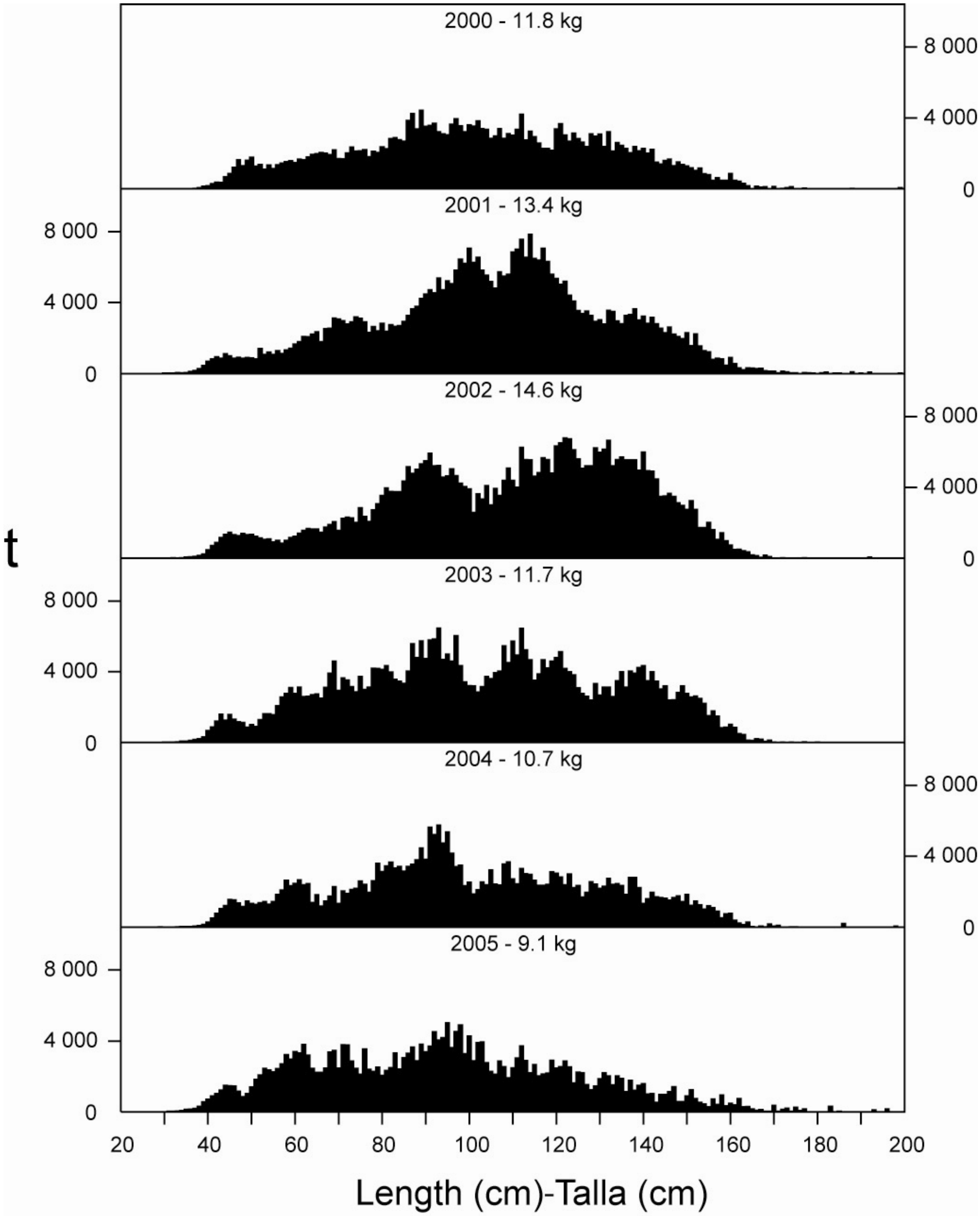


FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2000-2005. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2000-2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

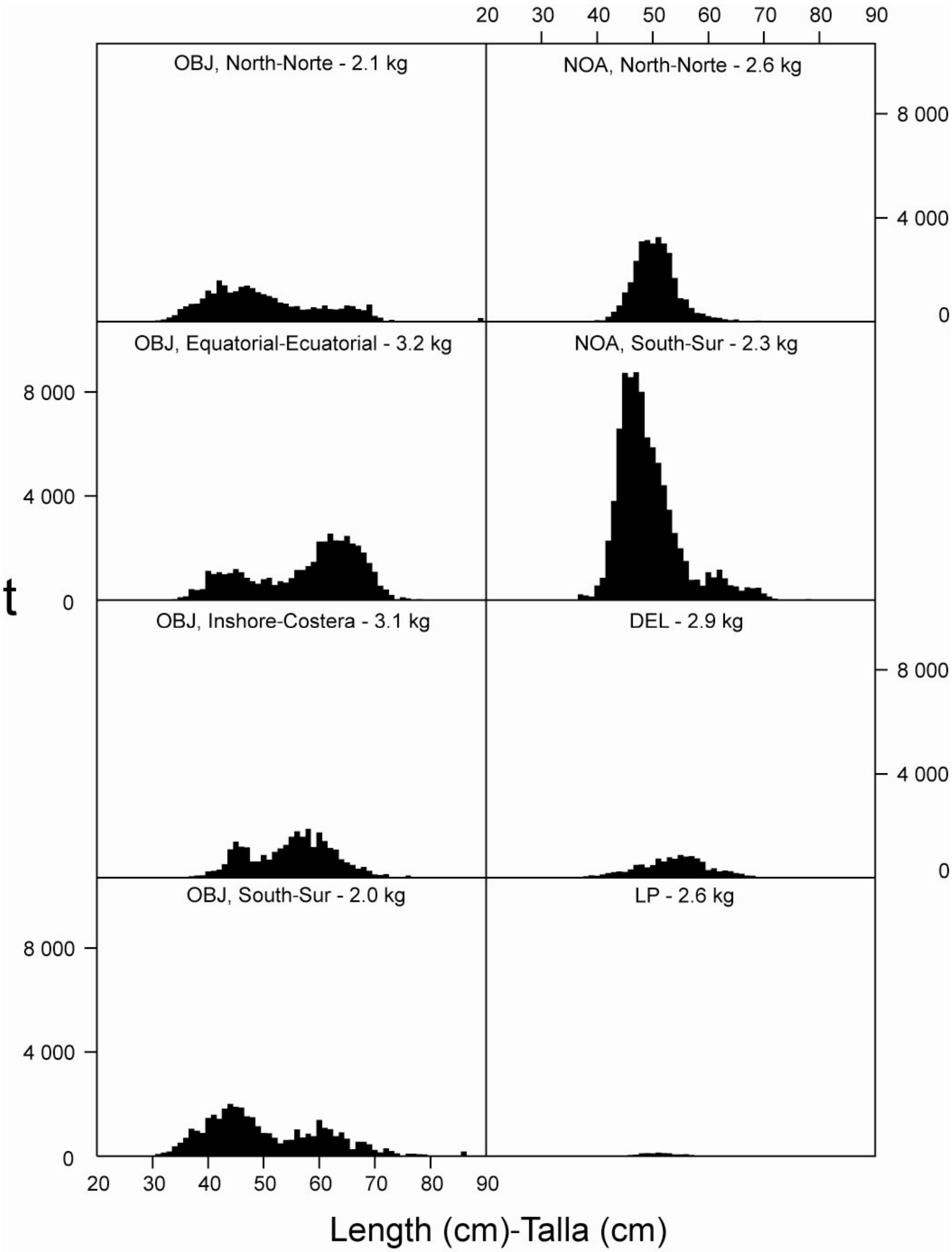


FIGURE A-7a. Estimated size compositions of the skipjack caught in each fishery of the EPO during 2005. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7a. Composición por tallas estimada del barrilete capturado en cada pesquería del OPO en 2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

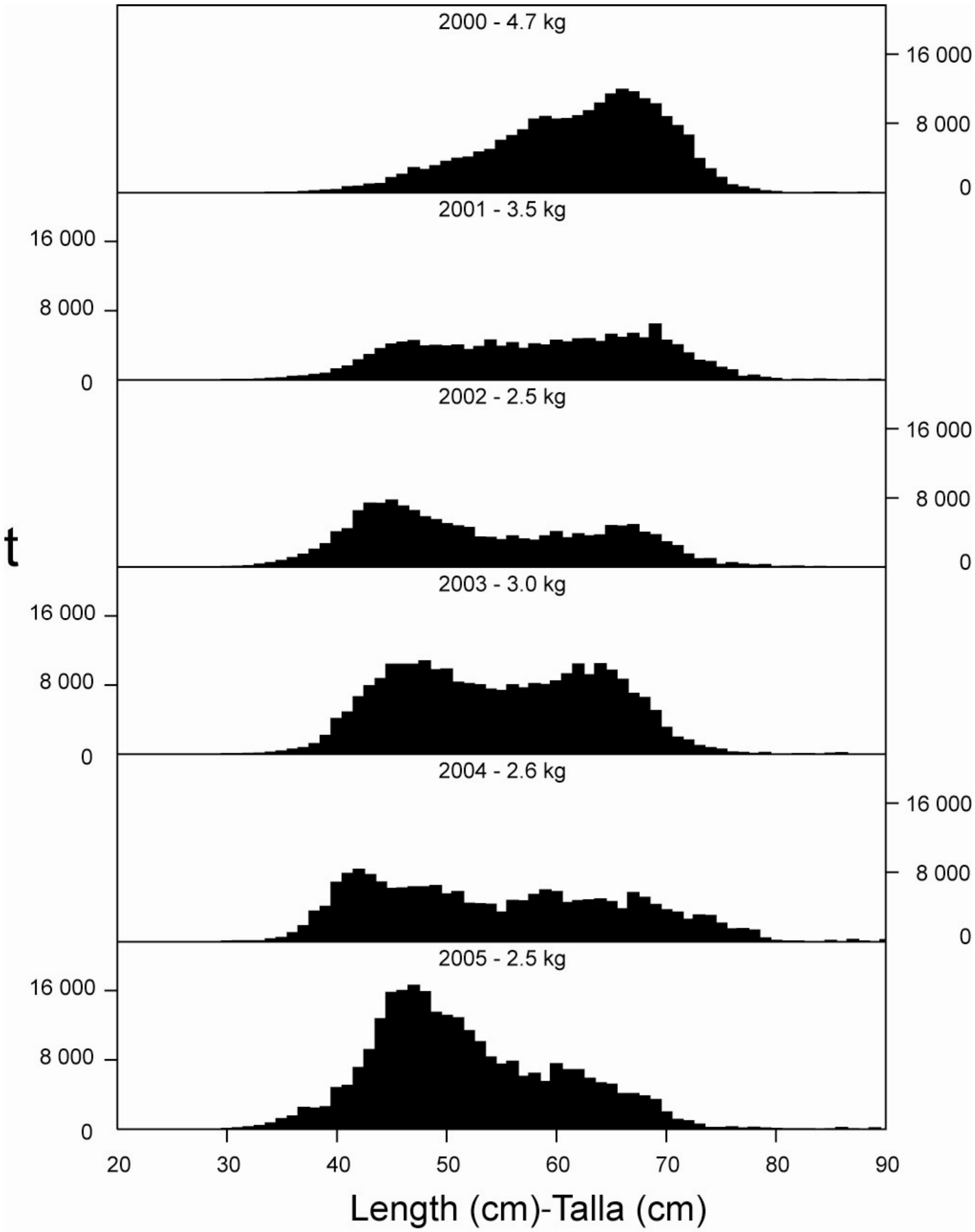


FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2000-2005. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2000-2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

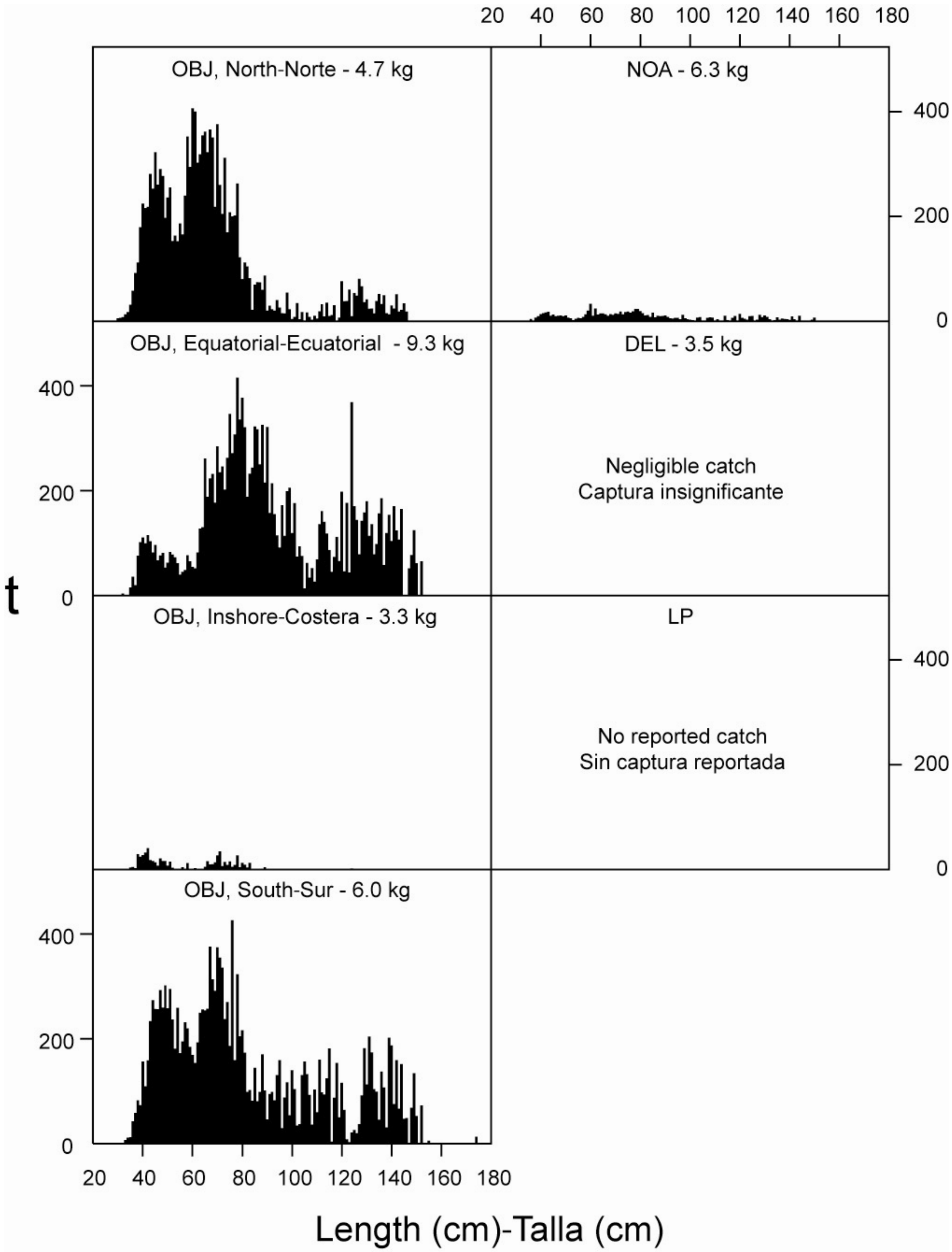


FIGURE A-8a. Estimated size compositions of the bigeye caught in each fishery of the EPO during 2005. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-8a. Composición por tallas estimada del patudo capturado en cada pesquería del OPO en 2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

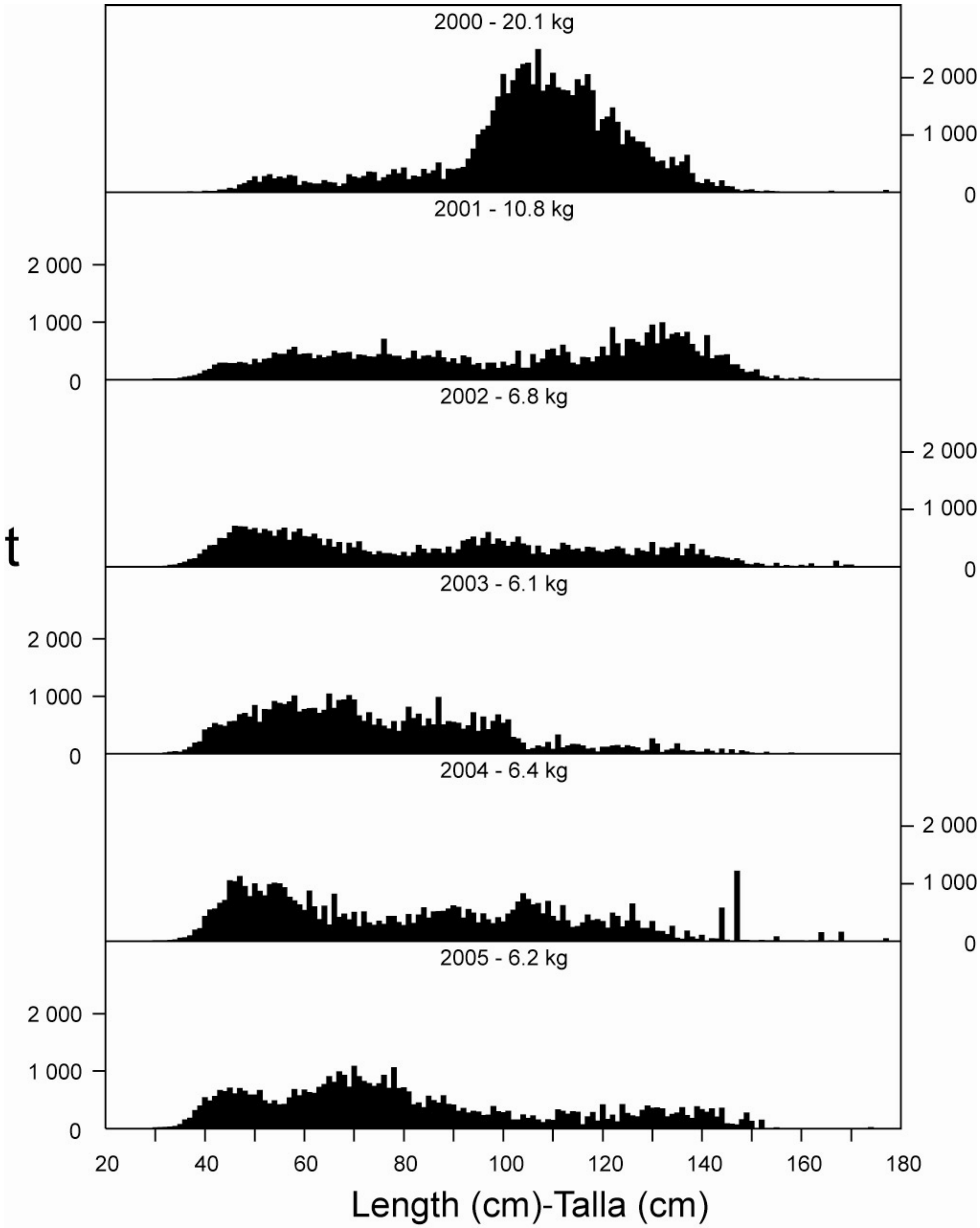


FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2000-2005. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2000-2005. En cada recuadro se detalla el peso promedio de los peces en las muestras.

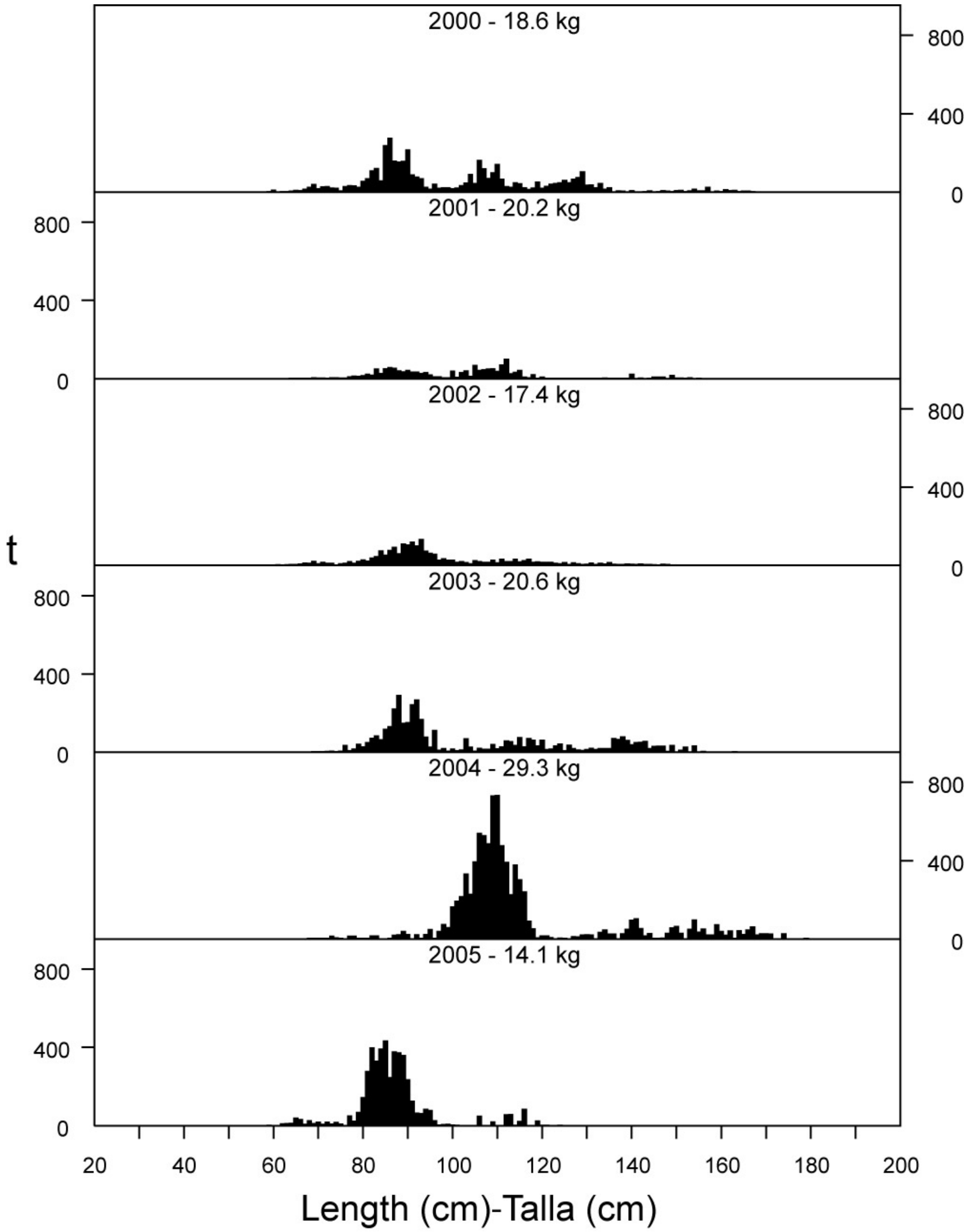


FIGURE A-9. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 2000-2005. The values at the tops of the panels are the average weights.

FIGURA A-9. Captura estimada de aleta azul del Pacífico por buques cerqueros y deportivos en el OPO durante 2000-2005. El valor en cada recuadro representa el peso promedio.

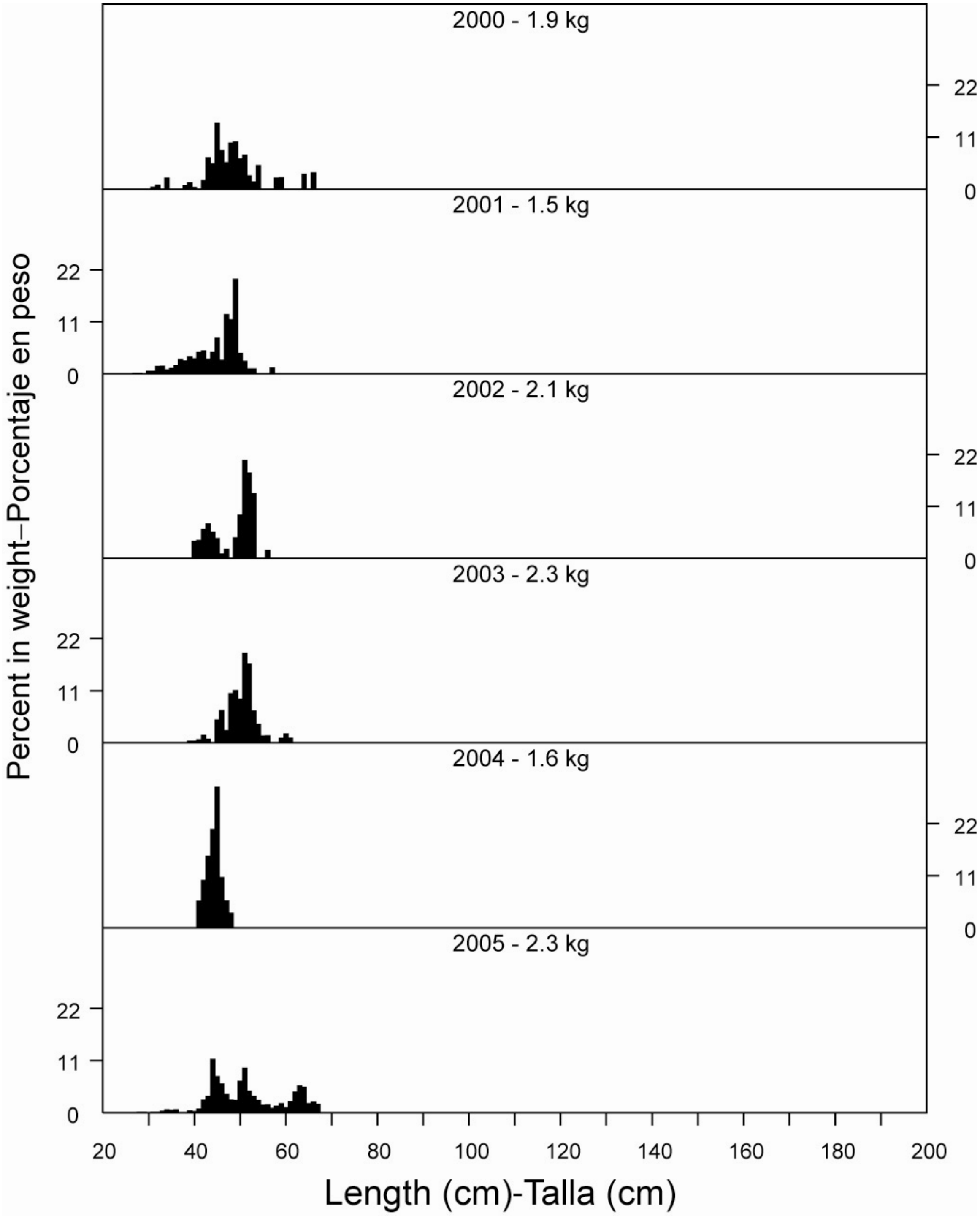


FIGURE A-10. Estimated size compositions of the catches of black skipjack by purse-seine vessels in the EPO during 2000-2005. The values at the tops of the panels are the average weights.
FIGURA A-10. Composición por tallas estimada del barrilete negro capturado por buques cerqueros en el OPO durante 2000-2005. El valor en cada recuadro representa el peso promedio.

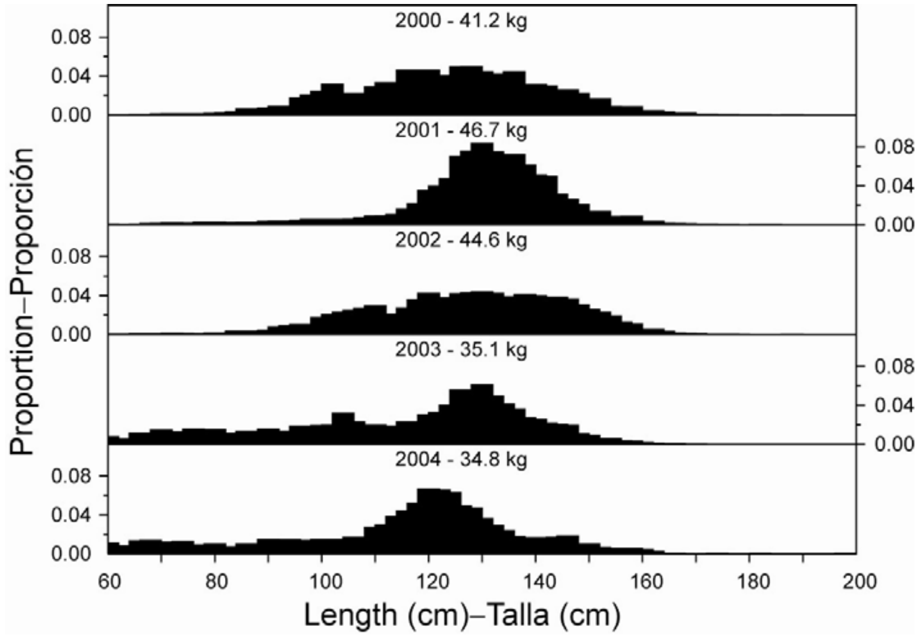


FIGURE A-11. Estimated size compositions of the catches of yellowfin tuna by the Japanese longline fishery in the EPO, 2000-2004.
FIGURA A-11. Composición por tallas estimada de las capturas de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 2000-2004.

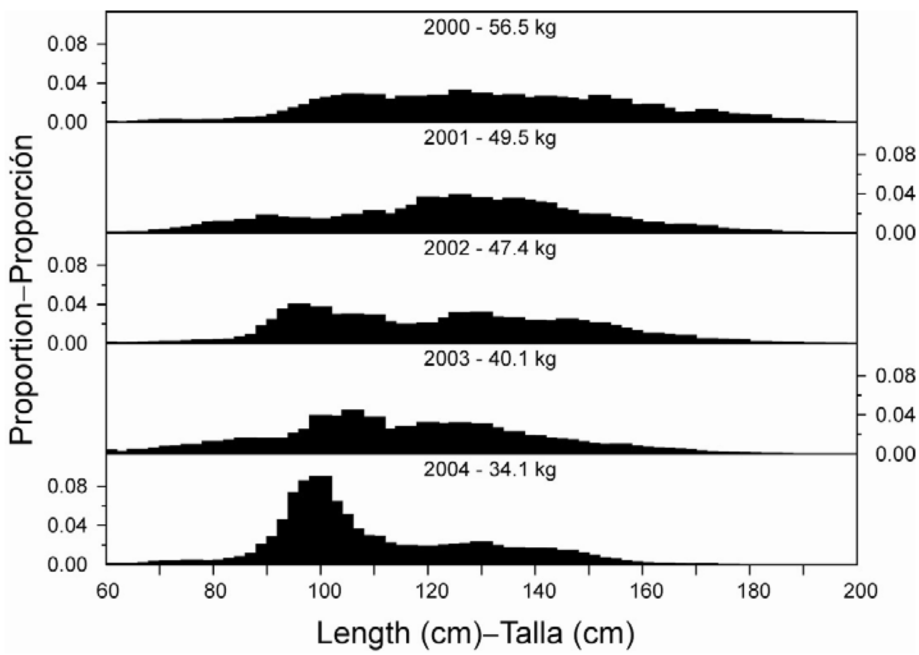


FIGURE A-12. Estimated size compositions of the catches of bigeye tuna by the Japanese longline fishery in the EPO, 2000-2004.
FIGURA A-12. Composición por tallas estimada de las capturas de atún patudo por la pesquería palangrera japonesa en el OPO, 2000-2004.

TABLE A-1. Annual catches of yellowfin, skipjack, and bigeye, by all types of gear combined, in the Pacific Ocean, 1976-2005. The EPO totals for 1993-2005 include discards from the purse-seine fishery.
TABLA A-1. Capturas anuales de aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico, 1976-2005. Los totales del OPO de 1993-2005 incluyen descartes de la pesquería de cerco.

	YFT			SKJ			BET			Total		
	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total
1976	234,375	150,420	384,795	136,927	351,305	488,232	71,584	77,131	148,715	442,886	578,856	1,021,742
1977	199,380	180,986	380,366	94,108	397,122	491,230	85,249	76,600	161,849	378,737	654,708	1,033,445
1978	173,996	173,400	347,396	179,676	441,081	620,757	89,198	58,562	147,760	442,870	673,043	1,115,913
1979	187,137	193,011	380,148	141,504	405,334	546,838	67,533	66,072	133,605	396,174	664,417	1,060,591
1980	158,850	211,867	370,717	138,108	450,964	589,072	86,403	64,986	151,389	383,361	727,817	1,111,178
1981	178,514	224,983	403,497	126,001	430,566	556,567	68,339	53,402	121,741	372,854	708,951	1,081,805
1982	127,537	220,833	348,370	104,670	478,530	583,200	60,346	58,778	119,124	292,553	758,141	1,050,694
1983	100,013	256,285	356,298	62,150	669,530	731,680	64,755	59,502	124,257	226,918	985,317	1,212,235
1984	149,478	252,381	401,859	63,613	741,721	805,334	55,273	63,591	118,864	268,364	1,057,693	1,326,057
1985	226,036	258,320	484,356	52,000	595,188	647,188	72,404	68,466	140,870	350,440	921,974	1,272,414
1986	286,149	249,934	536,083	67,748	739,330	807,078	105,120	63,586	168,706	459,017	1,052,850	1,511,867
1987	286,359	303,342	589,701	66,464	675,087	741,551	101,314	77,796	179,110	454,137	1,056,225	1,510,362
1988	296,635	262,310	558,945	92,125	830,499	922,624	74,304	66,201	140,505	463,064	1,159,010	1,622,074
1989	299,739	313,545	613,284	98,930	808,975	907,905	72,993	74,954	147,947	471,662	1,197,474	1,669,136
1990	302,284	354,236	656,520	77,117	871,736	948,853	104,807	88,941	193,748	484,208	1,314,913	1,799,121
1991	266,091	396,979	663,070	65,895	1,097,666	1,163,561	109,116	69,841	178,957	441,102	1,564,486	2,005,588
1992	253,714	419,746	673,460	87,354	1,029,426	1,116,780	91,999	86,380	178,379	433,067	1,535,552	1,968,619
1993	256,675	387,185	643,860	100,521	904,890	1,005,411	82,834	77,113	159,947	440,030	1,369,188	1,809,218
1994	248,248	393,841	642,089	84,641	1,007,795	1,092,436	109,326	85,240	194,566	442,215	1,486,876	1,929,091
1995	244,601	374,355	618,956	150,670	1,043,816	1,194,486	108,209	76,662	184,871	503,479	1,494,833	1,998,312
1996	266,463	309,396	575,859	132,929	1,020,470	1,153,399	114,703	78,367	193,070	514,095	1,408,233	1,922,328
1997	278,264	430,729	708,993	188,530	967,161	1,155,691	122,348	104,334	226,682	589,142	1,502,224	2,091,366
1998	280,140	462,991	743,131	165,673	1,295,914	1,461,587	93,946	109,025	202,971	539,759	1,867,930	2,407,689
1999	304,939	416,024	720,963	292,070	1,151,145	1,443,215	93,300	118,087	211,387	690,309	1,685,256	2,375,565
2000	288,960	428,978	717,938	231,911	1,220,529	1,452,440	147,611	106,907	254,518	668,483	1,756,414	2,424,897
2001	423,561	419,700	843,261	159,433	1,131,183	1,290,616	131,472	106,383	237,855	714,467	1,657,266	2,371,733
2002	443,030	406,002	849,032	167,274	1,275,783	1,443,057	132,933	122,345	255,278	743,237	1,804,130	2,547,367
2003	411,746	443,001	854,747	302,399	1,290,767	1,593,166	116,716	112,788	229,504	830,861	1,846,556	2,677,417
2004	291,187	407,509	698,696	216,690	1,369,838	1,586,528	109,684	116,259	225,943	617,561	1,893,606	2,511,167
2005	280,879	*	280,879	282,152	*	282,152	110,593		110,593	673,624	*	673,624

TABLE A-2a. Estimated retained catches, by gear type, and estimated discards (purse-seine only), of tunas and bonitos, in metric tons, in the EPO, 1976-2005 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 2004-2005 are preliminary.

TABLA A-2a. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes (red de cerco únicamente), de atunes y bonitos, en toneladas métricas, en el OPO, 1976-2005. 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. Los datos de 2004-2005 son preliminares.

	Yellowfin—Aleta amarilla (YFT)						Skipjack—Barrilete (SKJ)						Bigeye—Patudo (BET)					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1976	215,108		3,280	15,632	355	234,375	124,957		11,256	131	583	136,927	17,212		75	54,290	7	71,584
1977	184,922		1,841	12,355	262	199,380	84,603		7,522	112	1,871	94,108	11,161		2	74,086	0	85,249
1978	158,801		3,888	10,188	1,119	173,996	172,294		6,047	61	1,274	179,676	18,539			70,659	0	89,198
1979	170,650		4,789	11,473	225	187,137	133,695		6,346	33	1,430	141,504	12,097			55,435	1	67,533
1980	143,042		1,481	13,477	850	158,850	130,912		5,225	26	1,945	138,108	21,938			64,335	130	86,403
1981	168,234		1,477	7,999	804	178,514	119,165		5,906	20	910	126,001	14,921			53,416	2	68,339
1982	114,755		1,538	10,961	283	127,537	100,499		3,760	28	383	104,670	6,939		42	53,365	0	60,346
1983	83,929		4,007	10,895	1,182	100,013	56,851		4,387	28	884	62,150	4,575		39	60,043	98	64,755
1984	135,785		2,991	10,345	357	149,478	59,859		2,884	32	838	63,613	8,861		2	46,394	16	55,273
1985	211,459		1,070	13,198	309	226,036	50,829		946	44	181	52,000	6,056		2	66,325	21	72,404
1986	260,512		2,537	22,808	292	286,149	65,634		1,921	58	135	67,748	2,686			102,425	9	105,120
1987	262,008		5,107	18,911	333	286,359	64,019		2,233	37	175	66,464	1,177			100,121	16	101,314
1988	277,293		3,723	14,660	959	296,635	87,113		4,325	26	661	92,125	1,535		5	72,758	6	74,304
1989	277,996		4,145	17,032	566	299,739	94,934		2,940	28	1,028	98,930	2,030			70,963	0	72,993
1990	263,253		2,676	34,633	1,722	302,284	74,369		823	41	1,884	77,117	5,921			98,871	15	104,807
1991	231,257		2,856	30,730	1,248	266,091	62,228		1,717	33	1,917	65,895	4,870		31	104,194	21	109,116
1992	228,121		3,789	18,527	3,277	253,714	84,283		1,957	24	1,090	87,354	7,179			84,799	21	91,999
1993	219,492	4,722	4,951	23,809	3,701	256,675	83,830	10,588	3,772	61	2,270	100,521	9,657	645		72,473	59	82,834
1994	208,408	4,691	3,625	29,545	1,979	248,248	70,126	10,472	3,240	73	730	84,641	34,899	2,261		71,359	807	109,326
1995	215,434	5,275	1,268	20,054	2,570	244,601	127,047	16,378	5,253	77	1,915	150,670	45,321	3,251		58,256	1,381	108,209
1996	238,607	6,314	3,762	16,425	1,355	266,463	103,973	24,837	2,555	52	1,512	132,929	61,311	5,689		46,957	746	114,703
1997	244,878	5,516	4,418	21,448	2,004	278,264	153,456	31,558	3,260	135	121	188,530	64,272	5,482		52,571	23	122,348
1998	253,959	4,718	5,085	14,212	2,166	280,140	140,631	22,856	1,684	294	208	165,673	44,129	2,853		46,347	617	93,946
1999	281,920	6,638	1,783	10,651	3,947	304,939	261,565	26,851	2,044	201	1,409	292,070	51,158	5,176		36,425	541	93,300
2000	254,928	6,796	2,431	22,771	2,034	288,960	205,130	26,415	231	68	67	231,911	94,115	5,649		47,578	269	147,611
2001	382,023	7,808	3,916	28,476	1,338	423,561	144,059	13,233	448	1,214	479	159,433	61,404	1,294		68,727	47	131,472
2002	412,389	4,019	950	23,873	1,799	443,030	153,394	12,625	616	251	388	167,274	57,457	937		74,508	31	132,933
2003	380,582	5,338	470	22,462	2,894	411,746	275,042	23,302	638	600	2,817	302,399	54,137	2,260		60,280	39	116,716
2004	269,918	2,853	1,884	13,379	3,153	291,187	198,067	16,420	528	559	1,116	216,690	67,179	1,612		40,683	210	109,684
2005	268,156	3,101	2,067	3,853	3,702	280,879	260,268	18,946	1,039	125	1,774	282,152	70,294	1,894		38,383	22	110,593

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

	Pacific bluefin—Aleta azul del Pacífico (PBF)						Albacore—Albacore (ALB)						Black skipjack—Barrilete negro (BKJ)					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1976	10,621		22	13	3	10,659	272		3,456	2,506	16,975	23,209	1,499		28			1,527
1977	5,449		10	11	34	5,504	15		1,960	10,578	11,471	24,024	1,445		11		1	1,457
1978	5,389		4	9	8	5,410	156		1,577	11,939	17,436	31,108	2,165		3			2,168
1979	6,102		5	6	19	6,132	148		179	5,583	5,043	10,953	1,334		30			1,364
1980	2,909			0	31	2,940	194		407	5,319	5,649	11,569	3,653		30			3,683
1981	1,085			4	9	1,098	99		608	7,275	12,301	20,283	1,907		3			1,910
1982	3,145			7	12	3,164	355		198	8,407	3,562	12,522	1,337					1,337
1983	835			2	34	871	7		449	7,433	7,840	15,729	1,222		0		13	1,235
1984	840		0	3	65	908	3,910		1,441	6,712	9,794	21,857	662				3	665
1985	3,996			1	111	4,108	42		877	7,268	6,654	14,841	288		0		7	295
1986	5,040			1	66	5,107	47		86	6,450	4,701	11,284	568				18	586
1987	980			3	54	1,037	1		320	9,994	2,662	12,977	570				1	571
1988	1,380			2	49	1,431	17		271	9,934	5,549	15,771	957				311	1,268
1989	1,102		5	4	124	1,235	1		21	6,784	2,695	9,501	802		0			802
1990	1,430		61	12	90	1,593	39		170	6,536	4,105	10,850	784				4	788
1991	420			5	94	519			834	7,893	2,754	11,481	422				25	447
1992	1,928			21	116	2,065			255	17,080	5,740	23,075	104				3	107
1993	579	0		11	329	919		0	1	11,194	4,410	15,605	103	4,116			31	4,250
1994	969	0		12	121	1,102		0	85	10,390	10,154	20,629	188	834			40	1,062
1995	629	0		25	264	918		0	465	6,185	7,427	14,077	203	1,448			0	1,651
1996	8,223	0		19	80	8,322	11	0	72	7,631	8,398	16,112	706	2,304			12	3,022
1997	2,608	3	2	14	256	2,883	1	0	59	9,678	7,540	17,278	100	2,512			11	2,623
1998	1,772	0	0	94	504	2,370	42	0	81	12,635	13,158	25,916	488	1,876	39		0	2,403
1999	2,553	54	5.0	152	552	3,316	47	0.0	227	11,633	14,510	26,417	170	3,424			0	3,594
2000	3,712	0	61	46	374	4,193	71	0	86	9,663	13,453	23,273	294	1,877			0	2,171
2001	891	3	1	148	389	1,432	3	0	156	19,410	13,727	33,296	2,260	1,253			0	3,513
2002	1,709	6	3	71	358	2,147	31	0	381	15,283	14,433	30,128	1,458	2,207	8			3,673
2003	3,233	0	3	88	751	4,075	33	0	59	24,855	20,397	45,344	433	1,606	6	13	117	2,175
2004	8,880	19		16	63	8,978	105	0.0	126	18,241	22,011	40,483	883	351		27	862	2,123
2005	4,743	14			100	4,857	2	0	66	5,983	15,678	21,729	1,446	1,909			5	3,360

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

	Bonito (BZX)						Unidentified tunas—Atunes no identificados (TUN)						Scombrids—Escómbridos TOTAL					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1976	4,312		44		299	4,655	97				4,981	5,078	374,078		18,161	72,572	23,203	488,014
1977	10,983		292		2,875	14,150	21				5,782	5,803	298,599		11,638	97,142	22,296	429,675
1978	4,801		35		2,419	7,255	188				6,677	6,865	362,333		11,554	92,856	28,933	495,676
1979	1,801		3		2,658	4,462	558				3,016	3,574	326,385		11,352	72,530	12,392	422,659
1980	6,089		36		2,727	8,852	442				836	1,278	309,179		7,179	83,157	12,168	411,683
1981	5,690		27		4,609	10,326	214		3		1,109	1,326	311,315		8,024	68,714	19,744	407,797
1982	2,122				6,776	8,898	52				382	434	229,204		5,538	72,768	11,398	318,908
1983	3,827		2		7,291	11,120	82				4,711	4,793	151,328		8,884	78,401	22,053	260,666
1984	3,514				7,291	10,805	7				2,524	2,531	213,438		7,318	63,486	20,888	305,130
1985	3,599		5		7,869	11,473	18				678	696	276,287		2,900	86,836	15,830	381,853
1986	232		258		1,889	2,379	177		4		986	1,167	334,896		4,806	131,742	8,096	479,540
1987	3,195		121		1,782	5,098	479				2,043	2,522	332,429		7,781	129,066	7,066	476,342
1988	8,811		739		947	10,497	258				2,939	3,197	377,364		9,063	97,380	11,421	495,228
1989	11,278		818		465	12,561	469		0		621	1,090	388,612		7,929	94,811	5,499	496,851
1990	13,641		215		371	14,227	373		0		692	1,065	359,810		3,945	140,093	8,883	512,731
1991	1,207		82		242	1,531	4			0	192	196	300,408		5,520	142,855	6,493	455,276
1992	977				318	1,295	120			2	1,071	1,193	322,712		6,001	120,453	11,636	460,802
1993	599	12	1		436	1,048	12	2,288		2	4,082	6,384	314,272	22,370	8,725	107,550	15,318	468,235
1994	8,331	147	362		185	9,025	9	1,279		0	464	1,752	322,930	19,683	7,312	111,379	14,480	475,784
1995	7,929	55	81		54	8,119	12	1,394		1	1,004	2,411	396,575	27,800	7,067	84,598	14,615	530,655
1996	647	1	7		16	671	36	1,756		1	1,038	2,831	413,514	40,900	6,396	71,085	13,157	545,052
1997	1,097	4	8		34	1,143	75	4,580		1	1,437	6,093	466,487	49,655	7,747	83,847	11,426	619,162
1998	1,330	4	7		588	1,929	15	2,294		3	18,158	20,470	442,366	34,601	6,896	73,585	35,399	592,847
1999	1,719	0		24	369	2,112	29	3,470		2,107	4,279	9,885	599,161	45,614	4,059	61,193	25,607	735,634
2000	637	0.0		75	56	768	190	2,191		1,987	1,468	5,836	559,077	42,929	2,809	82,188	17,721	704,724
2001	18	0	0	34	19	71	206	2,806		2,322	55	5,389	590,864	26,398	4,521	120,331	16,054	758,168
2002		0		42	1	43	577	3,408		2,791	1,422	8,198	627,015	23,202	1,958	116,819	18,432	787,426
2003		0	1		25	26	81	2,537		172	750	3,540	713,541	35,044	1,177	108,470	27,790	886,022
2004	14	47	1	8	3	73	256	2,783		3,259	258	6,556	545,302	24,086	2,539	76,172	27,676	675,775
2005	313	18				331	180	4,014		2,191	414	6,799	605,402	29,896	3,172	50,535	21,695	710,700

TABLE A-2b. Estimated retained catches, by gear type, and estimated purse-seine discards, of billfishes, in metric tons, in the EPO, 1976-2005. Data for 2004-2005 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 (red de cerco únicamente), de peces picudos, en toneladas métricas, en el OPO, 1976-2005. Los datos de 2004-2005 son preliminares. PS dis. = descartes por buques cerqueros.

	Swordfish—Pez espada (SWO)				Blue marlin—Marlín azul (BUM)				Black marlin—Marlín negro (BLM)				Striped marlin—Marlín rayado (MLS)			
	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total	PS dis.	LL	OTR	Total
1976		3,489	363	3,852		3,240		3,240		253		253		6,432	0	6,432
1977		4,298	788	5,086		3,016		3,016		621		621		3,145	0	3,145
1978		4,103	2,205	6,308		3,570		3,570		417		417		2,495	0	2,495
1979		2,658	614	3,272		4,528		4,528		332		332		4,137	0	4,137
1980		3,746	1,107	4,853		4,016		4,016		335		335		4,827	0	4,827
1981		3,070	1,134	4,204		4,476		4,476		247		247		4,876	0	4,876
1982		2,604	1,551	4,155		4,745		4,745		213		213		4,711	0	4,711
1983		3,341	2,338	5,679		4,459		4,459		240		240		4,472	0	4,472
1984		2,752	3,336	6,088		5,197		5,197		248		248		2,662	0	2,662
1985		1,885	3,768	5,653		3,588		3,588		180		180		1,599	0	1,599
1986		3,286	3,294	6,580		5,278		5,278		297		297		3,540	0	3,540
1987		4,676	3,740	8,416		7,282		7,282		358		358		7,647	0	7,647
1988		4,916	5,642	10,558		5,662		5,662		288		288		5,283	0	5,283
1989		5,202	6,072	11,274		5,392		5,392		193		193		3,473	0	3,473
1990		5,807	5,066	10,873		5,540		5,540		223		223		3,260	0	3,260
1991	17	10,564	4,414	14,995	69	6,462	257	6,788	58	246		304	76	2,805	188	3,069
1992	4	9,793	4,294	14,091	52	6,426	201	6,679	95	228		323	69	2,907	147	3,123
1993	6	6,167	4,434	10,607	56	6,279	292	6,627	64	217		281	35	3,332	243	3,610
1994	4	4,963	3,849	8,816	73	8,609	418	9,100	118	256		374	35	3,126	270	3,431
1995	6	4,466	3,003	7,475	83	6,944	344	7,371	82	158		240	21	2,943	306	3,270
1996	2	6,756	2,801	9,559	84	3,396	200	3,680	90	99		189	22	2,981	237	3,240
1997	6	9,508	2,853	12,367	134	5,468	340	5,942	124	153		277	25	4,201	272	4,498
1998	2	9,381	3,665	13,048	137	4,477	580	5,194	113	168		281	18	3,277	281	3,576
1999	3	7,470	2,064	9,537	188	3,010	680	3,878	138	94		232	31	2,287	334	2,652
2000	3	8,523	2,790	11,316	134	3,028	606	3,768	104	105		209	17	1,747	190	1,954
2001	5	15,354	2,617	17,976	163	3,554	643	4,360	138	123		261	20	1,693	274	1,987
2002	1	16,968	2,757	19,726	208	2,825	662	3,695	143	78		221	73	1,948	214	2,235
2003	6	17,881	640	18,527	187	3,213	876	4,276	160	71		231	31	1,787	139	1,957
2004	3	14,854	488	15,345	149	3,188	416	3,753	75	36		111	20	1,289	234	1,543
2005	3	1,895	479	2,377	423	1,092	805	2,320	100	110		210	32	492	303	827

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

	Shortbill spearfish—Marlín trompa corta (SSP)				Sailfish—Pez vela (SFA)				Unidentified Istiophorid billfishes—Picudos Istiofóridos no identificados (BIL)				Billfishes—Peces picudos TOTAL			
	PS dis.	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**	**PS dis.**	**LL**	**OTR**	**Total**
1976						494		494		0				13,908	363	14,271
1977						753		753		15		15		11,848	788	12,636
1978						878		878		3		3		11,466	2,205	13,671
1979						251		251		6		6		11,912	614	12,526
1980						244		244		0		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		0		0		192		192		51		51		14,503	6,072	20,575
1990						6		6		123		123		14,959	5,066	20,025
1991	0	1		1	40	10	707	757		112		112	260	20,200	5,566	26,026
1992	1	1		2	41	741	610	1,392		1,120		1,120	262	21,216	5,252	26,730
1993	0	1		1	36	1,145	1,121	2,302	24	1,650		1,674	221	18,791	6,090	25,102
1994	0	144		144	27	878	804	1,709	13	1,028		1,041	270	19,004	5,341	24,615
1995	0	155		155	31	237	1,114	1,382	8	232		240	231	15,135	4,767	20,133
1996	0	126		126	24	197	541	762	10	308	1	319	232	13,863	3,780	17,875
1997	1	141		142	28	799	418	1,245	4	1,324		1,328	322	21,594	3,883	25,799
1998	0	200		200	50	394	988	1,432	9	575	52	636	329	18,472	5,566	24,367
1999	1	278		279	42	107	1,109	1,258	9	1,135		1,144	412	14,381	4,187	18,980
2000	1	285		286	58	108	1,239	1,405	3	865	136	1,004	320	14,661	4,961	19,942
2001	0	304		304	37	134	1,614	1,785	6	1,298	204	1,508	369	22,460	5,352	28,181
2002	0	265		265	44	391	1,416	1,851	5	2,083	14	2,102	474	24,558	5,063	30,095
2003	1	289		290	105	145	1,012	1,262	4	1,249		1,253	494	24,635	2,667	27,796
2004	0	187		187	39	132	1,261	1,432	4	1,132		1,136	290	20,818	2,399	23,507
2005	1	11		12	45	20	644	709	8	614		622	612	4,234	2,231	7,077

TABLE A-2c. Estimated retained catches, by gear type, and estimated purse-seine discards, of other species, in metric tons, in the EPO, 1976-2005. Data for 2004-2005 are preliminary.
TABLA A-2c. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes (red de cerco únicamente), de otras especies, en toneladas métricas, en el OPO, 1976-2005. Los datos de 2004-2005 son preliminares.

	Unidentified carangids—Carángidos no identificados (CGX)						Dorado (*Coryphaena* spp.) (DOX)						Unidentified elasmobranchs—Elasmobranquios no identificados (SKX)						Unidentified fishes—Peces no identificados (MZZ)					
	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total	PS		LP	LL	OTR	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1976	483					483	124		9		963	1,096	307		10		141	458	292		3			295
1977	1,099					1,099	167		0		827	994	233				34	267	427					427
1978	238		1			239	87				738	825	145				390	535	148					148
1979	81		0			81	124				927	1,051	7			17	1,290	1,314	478			7		485
1980	224		2			226	124		0		1,001	1,125	16			7	858	881	301					301
1981	111		17			128	410				628	1,038	49			120	1,211	1,380	201		3	51		255
1982	122					122	274				980	1,254	22		30	215	864	1,131	284			59		343
1983	1,240					1,240	88				3,374	3,462	34			85	695	814	267		1			268
1984	414					414	103				202	305	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	141			360		501
1989	60		2			62	210				1,680	1,890	29			66	1,025	1,120	237			152		389
1990	234		0		1	235	63				1,491	1,554	0			1	1,095	1,096	240			260	13	513
1991	116				0	116	57			7	613	677	1		6	73	1,346	1,426	462		1	457		920
1992	116				0	116	69			37	708	814				311	1,190	1,501	445			182		627
1993	17	73			2	92	36	909		17	724	1,686	24	1,458		218	916	2,616	223	459	2	182		866
1994	7	47			16	70	279	1,571		46	3,459	5,355	113	1,166		893	1,314	3,486	10	362		251		623
1995	11	58			9	78	110	1,592		39	2,127	3,868	20	1,213		554	1,075	2,862		588		209		797
1996	55	230			57	342	119	1,902		43	183	2,247	3	1,176		521	2,151	3,851	5	358		455		818
1997	2	179			39	220	36	1,899		564	9,411	11,910	22	1,615		532	2,360	4,529	14	449		847		1,310
1998	57	214			4	275	15	1,293		39	11,656	13,003	6	1,649		686	4,484	6,825	65	1,032		1,338		2,435
1999	35	260	1			296	75	1,758		2,333	5,111	9,277		1,144		4,286	2,144	7,574	86	884		973		1,943
2000	57	160		4	4	225	109	2,164		3,537	1,041	6,851	3	1,027		6,732	405	8,167	1	284		1,362		1,647
2001		222		18	26	266	148	3,053		4,720	14,046	21,967		1,058		9,677	117	10,852		233		1,591	1	1,825
2002		180		15	20	215	45	2,690		3,918	11,969	18,622		1,069		8,025	3,752	12,846		198		1,745		1,943
2003		199		54		253	23	1,692		622	4,262	6,599		1,264		5,805	4,902	11,971		232		4,391		4,623
2004		213				213	99	2,274		1,394	6,965	10,732		992	9	5,171	2,190	8,362	14	312		335		661
2005	61	197				258	111	2,559		489	6,789	9,948		884	4	4,945	936	6,769	189	226		205		620

TABLE A-3a. Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2001. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition 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, 2001. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

2001		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	1,833	1,080	1,987	131	4,854				9,885
CAN	LTL					4,600				4,600
CHL	NK	66		5		5		19		95
CHN	LL	942		2,639		1,581				5,162
COK	LTL					48				48
COL	PS	21,474	2,638	240	0	0	79	0	0	24,431
CRI	NK	1,133		28			0			1,161
ECU	NK			14					1	15
	PS	55,161	66,210	24,476	0	0	2,101	0	203	148,151
ESP	PS	9,439	22,733	9,439	0	0	0	0	0	41,611
JPN	LL	14,808	28	38,048	2	1,889				54,775
KOR	LL	5,230	29	12,576	10	355				18,200
MEX	LL	29		1					0	30
	LP	3,916	448			17		0		4,381
	PS	130,327	7,905	19	863	0	0	18		139,132
PAN	LL	732	26	80		28				866
	PS	10,422	6,178	3,329	0	0	0	0	0	19,929
PER	NK	13	11						54	78
PYF	LL	846	14	684		3,542				5,086
TWN	LL	3,928	36	9,285		6,811				20,060
USA	GN	5	1		34			0	0	40
	LL	29	1	147	5	56			1	239
	LP	0	0	0	1	139	0	0	0	140
	LTL					7,439				7,439
	NK	45								45
	PS	4,773	4,363	3,325	28	3	60	0	0	12,552
	RG	76	467		355	1,635				2,533
VEN	PS	111,038	1,162	0	0	0	2	0	0	112,202
VUT	LL	13		3,277		294				3,584
	PS	9,499	8,205	5,624	0	0	0	0	0	23,328
OTR[1]	LL[2]	86		3				34	2,321	2,444
	PS[3]	29,890	24,665	14,952	0	0	18	0	3	69,528

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

2 Includes El Salvador, Guatemala, Honduras, and Nicaragua—Incluye El Salvador, Honduras, Guatemala y Nicaragua.

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

TABLE A-3b. Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2002. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition 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, 2002. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a las estimaciones de composición por especie, y son preliminares.

2002		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	1,447		1,459	67	438				3,411
CAN	LTL					4,753				4,753
CHL	NK	15		7		40		0		62
CHN	LL	1,457		7,614		1,327				10,398
COK	LTL					27				27
COL	PS	30,578	2,530	290	0	0	0	0	284	33,682
CRI	NK	1,563		19						1,582
ECU	NK			5						5
	PS	29,594	81,203	27,914	0	0	876	0	85	139,672
ESP	PS	5,165	19,761	7,849	0	0	0	0	0	32,775
JPN	LL	8,530	66	34,300	2	2,630				45,528
KOR	LL	3,626	44	10,358	1	341				14,370
MEX	GN	1								1
	LL	4			1					5
	LP	950	616	0	1	0	8	0	0	1,575
	PS	151,556	7,919	10	1,709	28	358	0	0	161,580
PAN	LL	761	49	2		4				816
	PS	20,767	6,882	2,386	0	0	5	0	0	30,040
PER	NK	195	109						1,422	1,726
PYF	LL	278	27	388		2,545				3,238
SLV	PS	3,220	5,778	6,624	0	0	0	0	0	15,622
TWN	LL	7,360	64	17,253		7,096				31,773
USA	GN	1			7			1	0	9
	LL	5	1	132		0			1	139
	LP				2	381				383
	LTL					7,256				7,256
	PS	8,738	3,276	2,535	0	3	214		194	14,960
	RG	24	279		351	2,357				3,011
VEN	PS	121,800	2,627		0	0	0	0	0	124,427
VUT	LL	290		2,995		902				4,187
	PS	5,687	6,085	2,769	0	0	0	0	0	14,541
OTR[1]	LL[2]	115		7				42	2,790	2,954
	PS[3]	35,284	17,333	7,080	0	0	5	0	14	59,716

[1] This category is used to avoid revealing the operations of individual vessels or companies—Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatemala, Honduras, and Nicaragua—Incluye El Salvador, Guatemala, Honduras, y Nicaragua.
[3] Includes Belize, Bolivia, Guatemala, Honduras, Nicaragua, Peru, and Unknown—Incluye Belice, Bolivia, Guatemala, Honduras, Nicaragua, Perú, 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, 2003 .The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.

TABLA A-3c. Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2003. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a las estimaciones de composición por especie, y son preliminares.

2003		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	353		604	42	600				1,599
CAN	LTL					6,295				6,295
CHL	LL						13			13
	NK	73		14		1		24		112
CHN	LL	2,739		10,066		1,743				14,548
COK	LTL					251				251
COL	PS	19,351	5,872	250	0	0	0	0	0	25,473
CRI	NK	1,418		18						1,436
ECU	LL	148	293							441
	NK		93							93
	PS	31,174	139,814	25,606	0	0	62	0	38	196,694
ESP	LL			58						58
	PS	4,162	26,881	7,655	0	0	0	0	0	38,698
JPN	LL	9,266	49	25,428	3	2,116				36,862
KOR	LL	4,911	25	10,272		343				15,551
MEX	LL	365			43				0	408
	LP	468	637	0	0	0	6	0	0	1,111
	PS	169,664	10,841	369	3,211	28	192	0	0	184,305
PAN	PS	27,420	12,658	4,481	0	0	3	0	10	44,572
PER	NK	806	2,575				117		750	4,248
PYF	LL	462	60	346		3,233			144	4,245
TWN	LL	3,477	172	12,016		12,663				28,328
USA	GN		9	6	14	16		1		46
	LL	5	1	232		24			4	266
	LP	2	1	0	3	59	0	1	0	66
	LTL					11,622				11,622
	PS	1,012	7,695	2,694	22	3	163	0	25	11,614
	RG	597	140	1	737	2,212				3,687
VEN	PS	90,705	12,782	26	0	0	0	0	0	103,513
VUT	LL	699		1,258		4,133				6,090
	PS	3,258	19,786	6,313	0	0	13	0	0	29,370
OTR[1]	LL[2]	37							24	61
	PS[3]	33,836	38,713	6,743	0	2	0	0	8	79,302

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

[2] Includes Honduras, Nicaragua, and Panama—Incluye Honduras, Nicaragua, y Panamá.

[3] Includes Belize, Bolivia, El Salvador, Guatemala, Honduras, Peru, and Unknown—Incluye Belice, Bolivia, El Salvador, Guatemala, Honduras, Perú, y Desconocido.

TABLE A-3d. Preliminary 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-3d. Estimaciones preliminares 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 las estimaciones 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
COK	LTL					99				99
CRI	NK	1,701		21						1,722
ECU	LL			312						312
	NK			185						185
	PS	36,973	86,283	32,356	0	0	97	7	8	155,724
ESP	LL			5						5
HND	PS	1,073	3,798	1,763	0	0	0	0	1	6,635
JPN	LL	6,450	91	18,509	2	2,204				27,256
KOR	LL	2,997	31	10,729		783				14,540
MEX	LL	32			14					46
	LP	1,882	528	0	0	0	0	0	0	2,410
	PS	92,899	22,701		8,880	104	417	7	54	125,062
NIC	LL	43								43
PAN	LL								3,084	3,084
	PS	31,758	21,284	10,853	0	0	25	0	2	63,922
PER	NK	291	1,098				862		258	2,509
PYF	LL	767	56	405		1,802			143	3,173
TWN	LL	1,824	339	7,384		9,988				19,535
USA	GN	1			10	12		3		26
	LL	6	3	149		8			1	167
	LP	2	0	0	0	126	0	1	0	129
	LTL	1				12,718				12,719
	PS	2,565	5,347	3,555	0	1	296	0	178	11,942
	RG	1,159	18	4	53	1,506				2,740
VEN	PS	54,999	13,647	1,001	0	0	47	0	1	69,695
VUT	LL	171		407		2,554				3,132
	PS	1,648	8,766	4,911	0	0	0	0	0	15,325
OTR	LL	15	13	9		8			31	76
[1]	PS[2]	48,003	36,241	12,740	0	0	1	0	12	96,997

[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, Nicarargua, Spain, and Unknown—Incluye Bolivia, Colombia, El Salvador, España, Guatemala, Nicaragua, y Desconocido.

TABLE A-3e. Preliminary 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-3e. Estimaciones preliminares 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 las estimaciones de composición por especie, y son preliminares.

2005		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	127	16	56		42				241
CAN	LTL					4,799				4,799
CHN	LL	682		2,104		895				3,681
COK	LTL					71				71
CRI	NK	1,718		22						1,740
ECU	LL			39						39
	PS	44,896	128,987	33,392	0	0	112	40	18	207,445
HND	PS	2,073	6,107	3,601	0	0	0	0	0	11,781
JPN	LL			15,738						15,738
KOR	LL	532		11,580		172				12,284
MEX	LL	1								1
	LP	2,067	1,039							3,106
	PS	115,297	27,527	2	4,542	0	1,192	273	92	148,925
NIC	PS	6,497	2,805	33	0	0	0	0	0	9,335
PAN	LL								2,036	2,036
	PS	27,810	31,762	12,724	0	0	8	0	8	72,312
PER	NK	1,135	1,754				5		414	3,308
PYF	LL	530	14	398		1,572			146	2,660
SLV	PS	6,439	5,955	985	0	0	73	0	60	13,512
TWN	LL	1,974	94	6,901		3,293				12,262
USA	GN	2			5	20				27
	LL	7	1	536		9			9	562
	LP					66				66
	LTL					9,069				9,069
	RG	847	20		95	1,719				2,681
VEN	PS	38,941	15,948	172			41		2	55,104
VUT	LL			1,031						1,031
OTR[1]	PS[2]	26,203	41,177	19,385	201	2	20	0	0	86,988

[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-4a Preliminary estimates of the retained catches and landings, in metric tons, of tunas and bonitos caught by purse-seine, pole-and-line, and recreational vessels in 2004, by species and vessel flag (upper panel) and locations where processed (lower panel). The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.
TABLA A-4a. Estimaciones preliminares de las capturas retenidas y descargas de atunes y bonitos capturado por buques cerqueros, cañeros y deportivos en el OPO en 2004, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a las estimaciones de composición por especie, y son preliminares.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches–Capturas retenidas									
ECU	36,973	86,283	32,356			97	7	8	155,724	28.3
HND	1,073	3,798	1,763					1	6,635	1.2
MEX	94,781	23,229		8,880	104	418	7	54	127,473	23.2
PAN	31,758	21,284	10,853			25		2	63,922	11.6
USA	3,726	5,365	3,559	53	1,633	296	1	178	14,811	2.7
VEN	54,999	13,647	1,001			47		1	69,695	12.7
VUT	1,648	8,766	4,911						15,325	2.8
OTR	48,003	36,241	12,740			1		12	96,997	17.5
Total	**272,961**	**198,613**	**67,183**	**8,933**	**1,737**	**884**	**15**	**256**	**550,582**	
	Landings–Descargas									
COL	47,965	10,859	1,846	0	0	0	0	0	60,670	10.7
CRI	16,631	4,273	2,217	0	0	41	0	3	23,165	4.1
ECU	72,987	142,413	58,571	0	0	121	7	11	274,110	48.4
MEX	99,530	29,540	1,203	8,879	104	417	7	54	139,734	24.7
VEN	22,632	2,566	0	0	0	45	0	0	25,243	4.4
OTR	27,785	11,820	1,889	54	1,633	259	0	187	43,627	7.7
Total	**287,530**	**201,471**	**65,726**	**8,933**	**1,737**	**883**	**14**	**255**	**566,549**	

[1] Includes Bolivia, Colombia, El Salvador, Guatemala, Nicaragua, Spain, and Unknown. This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye Bolivia, Colombia, El Salvador, España, Guatemala, Nicaragua, y Desconocido. Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador, Guatamala, Peru, Spain, and United States. This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador, España, Estados Unidos, Guatamala, y Perú. 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, pole-and-line, and recreational vessels in the EPO in 2005, by species and vessel flag (upper panel) and locations where processed (lower panel). The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.

TABLA A-4b. Estimaciones preliminares de las capturas retenidas y descargas de atunes y bonitos capturado por buques cerqueros, cañeros y deportivos en el OPO en 2005, por especie y bandera del buque (panel superior) y localidad donde fue procesado (panel inferior), en toneladas métricas. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a las estimaciones de composición por especie, y son preliminares.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
	Retained catches–Capturas retenidas									
ECU	44,896	128,987	33,392			112	40	18	207,445	33.9
HND	2,073	6,107	3,601						11,781	1.9
MEX	117,364	28,566	2	4,542		1,192	273	92	152,031	24.9
NIC	6,497	2,805	33						9,335	1.5
PAN	27,810	31,762	12,724			8		8	72,312	11.8
SLV	6,439	5,955	985			73		60	13,512	2.2
VEN	38,941	15,948	172			41		2	55,104	9.0
OTR	27,050	41,197	19,385	296	1,787	20	0	0	89,735	14.8
Total	**271,070**	**261,327**	**70,294**	**4,838**	**1,787**	**1,446**	**313**	**180**	**611,255**	
	Landings–Descargas									
COL	27,325	12,218	1,588					2	41,133	6.8
CRI	14,926	5,894	775						21,595	3.5
ECU	69,788	186,074	58,365			140	40	24	314,431	51.7
MEX	112,981	28,438	304	4,513		1,193	273	92	147,794	24.3
VEN	15,702	3,302	0	0		0	0	0	19,004	3.1
OTR	33,931	22,356	5,879	296	1,787	114	0	60	64,423	10.6
Total	**274,653**	**258,282**	**66,911**	**4,809**	**1,787**	**1,447**	**313**	**178**	**608,380**	

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

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

[2] Includes 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 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. Source**:** Western and Central Pacific Fisheries Commission, International Scientific Committee**,** Report of the Fourth ISC Pacific Bluefin Tuna Working Group.

TABLA A-5. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas métricas. Fuente: Comisión de Pesca del Pacífico Occidental y Central, Comité Científico Internacional, Informe del Cuarto Grupo de Trabajo sobre el Atún Aleta Azul del Pacífico.

PBF	Western Pacific flags—Banderas del Pacífico occidental									Eastern Pacific flags—Banderas del Pacífico oriental					Total
	JPN				KOR[1]		TWN		Sub-total	USA[2]		MEX		Sub-total	
	PS	LP	LL	OTR	PS	OTR	PS	LL		PS	OTR	PS	OTR		
1976	1,964	1,082	520	5,143				17	8,726	10,646	23	1,968		12,637	21,363
1977	3,960	2,256	712	5,519				131	12,577	5,473	21	2,186		7,680	20,257
1978	8,878	1,154	1,049	9,486				66	20,633	5,396	5	545		5,946	26,579
1979	12,266	1,250	1,223	9,418				58	24,215	6,118	12	213		6,343	30,558
1980	10,414	1,392	1,170	5,945				114	19,036	2,938	8	582		3,528	22,563
1981	23,219	754	796	6,428				179	31,376	867	21	218		1,106	32,482
1982	16,180	1,777	880	4,161	31		0	207	23,236	2,639	11	506		3,156	26,392
1983	14,105	356	707	3,883	13		0	175	19,239	629	155	214		998	20,237
1984	4,016	587	360	4,797	4		0	477	10,242	673	65	166		904	11,146
1985	4,239	1,817	496	5,475	1		0	210	12,237	3,320	210	676		4,206	16,443
1986	7,466	1,086	249	4,944	344		0	70	14,159	4,851	346	189		5,386	19,545
1987	7,771	1,565	346	3,536	89		0	365	13,672	861	135	119		1,115	14,787
1988	2,931	907	241	2,436	32		197	108	6,852	923	85	447	1	1,456	8,308
1989	5,624	754	440	1,977	71		259	205	9,330	1,046	135	57		1,238	10,568
1990	2,960	536	396	2,359	132		149	189	6,721	1,380	205	50		1,635	8,356
1991	8,217	286	285	3,994	265			342	13,389	410	68	9		487	13,876
1992	6,147	166	573	3,102	288		73	464	10,813	1,928	221			2,149	12,962
1993	5,675	129	857	1,645	40		4	471	8,820	580	217			797	9,617
1994	6,919	206	1,138	4,887	50			559	13,758	906	184	63	2	1,155	14,913
1995	15,978	307	769	6,715	821		2	335	24,928	689	215	10	0	914	25,842
1996	6,641	256	978	4,722	102			956	13,655	4,523	100	3,700		8,323	21,978
1997	11,123	71	1,383	3,859	1,054			1,814	19,304	2,240	175	367		2,782	22,086
1998	4,371	120	1,260	3,814	188			1,910	11,662	1,771	484	1		2,256	13,918
1999	13,440	124	1,155	4,483	256			3,089	22,547	184	482	2,369	35	3,070	25,617
2000	14,021	256	1,005	5,899	794		2	2,780	24,757	693	281	3,025	103	4,102	28,859
2001	6,727	332	1,004	5,089	995	10	104	1,839	16,100	149	273	863		1,285	17,385
2002	8,009	187	889	4,049	674	1	4	1,523	15,335	50	360	1,708	6	2,124	17,459
2003	5,680	59	1,230	1,950	1,591	0	21	1,863	12,395	22	246	3,211	46	3,525	15,920
2004	6,340	237	1,311	2,533	636	0	0	1,714	12,771	0	45	8,880	11	8,936	21,707
2005	3,090	604	870	1,870	950	0	0	1,366	8,749	165	56	4,542		4,763	13,512

[1] The catch statistics for the Republic of Korea were derived from Japanese import statistics, 1982-1999 (minimum estimates).—Las estadísticas de captura de la República de Corea fueron derivadas de estadísticas de importación japonesas, 1982-1999 (estimaciones mínimas)

[2] The catch statistics for United States were categorized into commercial fishing and sport fishing during 1975-1980.—Las estadísticas de captura de Estados Unidos fueron categorizadas en pesca comercial y pesca deportiva durante 1975-1980

TABLE A-6. Annual retained catches, in metric tons, of north and south Pacific albacore, by gear type. Compiled from IATTC data (EPO) and the ISC and SPC data (WCPO).
TABLA A-6. Capturas retenidas anuales, en toneladas métricas, de atún albacora del Pacífico norte y sur, por tipo de arte. Compiladas de datos de la CIAT (OPO) y del ISC y SPC (WCPO).

ALB	North Pacific Ocean Océano Pacífico Norte					South Pacific Ocean Océano Pacífico Sur					Total
	LL	LP	LTL	OTR	Subtotal	LL	LP	LTL	OTR	Subtotal	
1976	17,393	88,036	16,183	3,204	124,816	28,952	100	25	-	29,077	153,893
1977	17,097	33,431	10,022	2,249	62,799	38,014	100	621	-	38,735	101,534
1978	13,311	60,827	16,636	8,048	98,822	32,888	100	1,686	-	34,674	133,496
1979	14,555	44,965	7,302	4,182	71,004	26,157	100	814	-	27,071	98,075
1980	15,535	47,124	7,768	4,699	75,126	30,967	101	1,468	-	32,536	107,662
1981	18,549	28,174	12,837	11,482	71,042	32,693	0	2,085	5	34,783	105,825
1982	17,297	30,039	6,713	13,910	67,960	28,347	1	2,434	6	30,788	98,748
1983	15,565	21,705	9,584	7,673	54,527	24,309	0	744	39	25,092	79,619
1984	15,198	27,043	9,354	18,663	70,258	20,340	2	2,773	1,589	24,704	94,962
1985	14,642	22,212	6,471	14,845	58,170	27,138	0	3,253	1,937	32,328	90,498
1986	13,169	16,528	4,738	10,909	45,344	32,637	0	2,003	1,946	36,586	81,930
1987	15,401	19,240	2,870	11,475	48,986	21,969	9	2,134	930	25,042	74,028
1988	15,448	6,814	4,367	18,925	45,554	28,284	0	4,296	5,283	37,863	83,417
1989	13,543	8,683	2,000	19,913	44,140	18,224	0	8,370	21,968	48,562	92,702
1990	15,976	8,647	2,905	26,155	53,683	19,366	245	6,975	7,538	34,124	87,807
1991	17,374	7,103	1,984	10,791	37,253	23,385	14	7,805	1,489	32,693	69,946
1992	19,401	13,888	4,935	16,573	54,796	30,592	11	6,578	65	37,246	92,042
1993	30,443	12,797	6,748	4,079	54,067	30,230	74	4,296	70	34,670	88,737
1994	30,274	26,389	13,134	3,451	73,248	34,286	67	7,164	89	41,606	114,854
1995	34,678	21,061	10,758	1,700	68,197	29,380	139	7,708	104	37,331	105,528
1996	43,169	20,296	21,849	1017	86,506	23,862	57	7,367	156	31,442	117,948
1997	52,949	32,311	18,674	2,684	106,533	27,178	21	4,679	133	32,011	138,544
1998	51,639	23,005	20,074	3,179	97,967	37,828	47	6,258	85	44,218	142,185
1999	49,497	50,429	13,853	11,130	124,917	31,939	138	3,391	74	35,542	160,459
2000	43,497	21,618	15,245	4,585	85,692	33,980	102	6,120	139	40,341	126,033
2001	40,333	29,569	16,738	2,989	89,644	47,486	37	5,747	199	53,469	143,113
2002	32,943	48,832	16,323	6,188	104,292	58,095	18	4,738	152	63,003	167,295
2003	31,149	36,180	21,886	3,163	92,381	56,290	12	5,880	138	62,320	154,701
2004	23,409	32,441	22,323	7,900	86,107	50,306	78	5,139	59	55,582	141,689

TABLE A-7. Catches per cubic meter of well volume for the purse-seine fleet in the EPO, by species and vessel capacity group. All = YFT, SKJ, BET, PBF, ALB, BKJ, BZX, and TUN (see Table A-2a).
TABLA A-7. Capturas por metro cúbico de volumen de bodega de la flota cerquera en el OPO, por especie y clase de arqueo del buque. All = YFT, SKJ, BET, PBF, ALB, BKJ, BZX, y TUN (ver Tabla A-2a).

	Species—Especie	Well volume—Volumen de bodega (m^3)								
		<401	401-800	801-1100	1101-1300	1301-1500	1501-1800	1801-2100	>2100	Total
2000	YFT	1.8	0.9	1.0	2.2	1.4	1.7	0.6	0.5	1.5
	SKJ	2.5	1.5	1.8	0.5	0.9	0.7	1.4	1.4	1.1
	BET	0.1	0.4	0.5	0.1	0.3	0.2	1.0	1.5	0.4
	All	4.5	2.8	3.3	2.9	2.6	2.6	3.0	3.4	3.0
2001	YFT	2.3	1.4	1.4	3.0	2.1	2.5	0.8	0.6	2.0
	SKJ	1.2	1.0	1.0	0.2	0.5	0.4	1.3	1.2	0.7
	BET	0.0	0.3	0.3	0.1	0.2	0.1	0.6	0.5	0.2
	All	3.7	2.8	2.8	3.3	3.0	3.0	2.8	2.2	3.0
2002	YFT	1.6	1.6	1.0	3.3	2.8	2.3	0.7	0.5	2.0
	SKJ	1.3	1.3	1.0	0.3	0.5	0.2	1.3	1.4	0.8
	BET	0.0	0.1	0.2	0.1	0.2	0.1	0.5	0.5	0.2
	All	3.2	3.1	2.3	3.7	3.5	2.5	2.5	2.4	3.0
2003	YFT	1.7	1.8	1.1	3.0	2.1	2.0	0.8	0.6	1.9
	SKJ	2.9	2.4	1.8	0.6	0.9	0.4	1.8	1.3	1.3
	BET	0.0	0.2	0.3	0.1	0.2	0.1	0.5	0.4	0.2
	All	4.9	4.4	3.2	3.7	3.2	2.5	3.1	2.4	3.5
2004	YFT	1.1	1.2	1.0	1.8	1.6	1.2	0.6	0.8	1.3
	SKJ	1.7	1.6	1.3	0.6	0.8	0.5	1.3	1.3	0.9
	BET	0.1	0.3	0.3	0.1	0.3	0.1	0.6	0.6	0.2
	All	3.1	3.0	2.8	2.6	2.6	1.8	2.4	2.7	2.6
2005	YFT	1.1	1.2	0.8	1.7	1.5	1.5	0.8	0.7	1.3
	SKJ	3.1	2.1	1.6	0.7	0.9	0.8	2.1	1.6	1.3
	BET	0.0	0.2	0.3	0.1	0.2	0.1	0.6	0.9	0.2
	All	4.5	3.5	2.8	2.5	2.6	2.4	3.4	3.3	2.9

TABLE A-8. Estimated numbers of sets, by set type and vessel size class, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2005 are preliminary. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary.

TABLA A-8. Números estimados de lances, por tipo de lance y clase de arqueo de los buques, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de 2005 son preliminares. Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a la estimación de composición por especie, y son preliminares.

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Class—Clase		Total	YFT	SKJ	BET
	1-5	6				
DEL	**Sets on fish associated with dolphins Lances sobre peces asociados con delfines**					
1988	49	11,160	11,209	153,936	5,392	37
1989	33	12,827	12,860	191,660	1,729	26
1990	31	10,997	11,028	173,893	1,351	0
1991	0	9,661	9,661	155,283	1,332	0
1992	26	10,398	10,424	165,647	1,262	0
1993	34	6,953	6,987	111,219	582	51
1994	5	7,804	7,809	125,486	1,096	1
1995	0	7,185	7,185	133,180	2,561	1
1996	14	7,472	7,486	138,595	1,753	57
1997	43	8,977	9,020	152,308	8,154	0
1998	0	10,645	10,645	154,734	4,982	5
1999	0	8,648	8,648	143,297	1,693	5
2000	0	9,235	9,235	147,562	541	15
2001	0	9,823	9,823	237,966	1,808	6
2002	0	12,446	12,446	301,388	3,180	2
2003	0	13,839	13,839	264,156	13,359	1
2004	0	11,783	11,783	176,160	10,801	3
2005	0	12,173	12,173	166,532	11,812	3
OBJ	**Sets on fish associated with floating objects Lances sobre peces asociados con objetos flotantes**					
1988	823	2,281	3,104	25,210	38,616	809
1989	974	2,339	3,313	28,383	44,684	1,527
1990	719	2,558	3,277	35,526	35,572	3,994
1991	819	2,165	2,984	25,501	39,049	2,747
1992	868	1,763	2,631	15,010	49,144	2,048
1993	493	2,063	2,556	19,304	53,079	6,125
1994	668	2,770	3,438	20,842	51,121	33,960
1995	707	3,521	4,228	21,097	80,049	41,964
1996	1,230	4,007	5,237	27,820	69,737	58,367
1997	1,699	5,653	7,352	30,051	116,792	62,703
1998	1,198	5,481	6,679	26,328	110,326	41,911
1999	630	4,620	5,250	43,052	181,650	49,326
2000	494	3,916	4,410	42,672	120,842	91,827
2001	697	5,744	6,441	66,317	122,987	60,623
2002	778	5,781	6,559	37,795	116,653	55,936
2003	694	5,497	6,191	29,765	181,553	52,345
2004	606	5,083	5,689	27,562	117,244	65,674
2005	614	5,128	5,742	28,070	131,672	68,892

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

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Class—Clase		Total	YFT	SKJ	BET
	1-5	6				
NOA	**Sets on unassociated schools Lances sobre cardúmenes no asociados**					
1988	4,147	7,536	11,683	98,147	43,105	689
1989	2,955	5,878	8,833	57,952	48,521	477
1990	3,683	5,397	9,080	53,832	37,447	1,926
1991	3,571	3,612	7,183	50,473	21,848	2,123
1992	4,010	4,079	8,089	47,463	33,876	5,130
1993	5,739	6,267	12,006	88,971	30,169	3,481
1994	5,440	5,064	10,504	62,081	17,910	938
1995	6,120	4,782	10,902	61,158	44,436	3,354
1996	5,807	5,118	10,925	72,191	32,486	2,888
1997	5,334	4,693	10,027	62,519	28,509	1,567
1998	5,700	4,631	10,331	72,897	25,323	2,213
1999	5,632	6,143	11,775	95,571	78,222	1,827
2000	6,119	5,482	11,601	64,695	83,747	2,273
2001	4,481	3,030	7,511	77,740	19,264	775
2002	5,008	3,409	8,417	73,205	33,561	1,520
2003	7,300	5,781	13,081	86,661	80,130	1,791
2004	4,932	5,083	10,015	66,196	70,022	1,502
2005	6,098	7,851	13,949	73,553	116,784	1,399
ALL	**Sets on all types of schools Lances sobre todos tipos de cardumen**					
1988	5,019	20,977	25,996	277,293	87,113	1,535
1989	3,962	21,044	25,006	277,995	94,935	2,031
1990	4,433	18,952	23,385	263,251	74,370	5,920
1991	4,390	15,438	19,828	231,257	62,229	4,870
1992	4,904	16,240	21,144	228,121	84,283	7,179
1993	6,266	15,283	21,549	219,494	83,829	9,657
1994	6,113	15,638	21,751	208,409	70,127	34,900
1995	6,827	15,488	22,315	215,434	127,045	45,319
1996	7,051	16,597	23,648	238,606	103,976	61,312
1997	7,076	19,323	26,399	244,878	153,456	64,270
1998	6,898	20,757	27,655	253,959	140,631	44,128
1999	6,262	19,411	25,673	281,920	261,564	51,158
2000	6,613	18,633	25,246	254,928	205,130	94,115
2001	5,178	18,597	23,775	382,023	144,059	61,404
2002	5,786	21,636	27,422	412,389	153,394	57,457
2003	7,994	25,117	33,111	380,582	275,042	54,137
2004	5,538	21,949	27,487	269,918	198,067	67,179
2005	6,712	25,152	31,864	268,156	260,268	70,294

TABLE A-9. Types of floating objects on which sets were made. The 2005 data are preliminary.
TABLA A-9. Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2005 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
1992	1,087	61.7	556	31.5	120	6.8	1,763
1993	1,138	55.2	825	40.0	100	4.8	2,063
1994	773	27.9	1,899	68.6	98	3.5	2,770
1995	729	20.7	2,704	76.8	88	2.5	3,521
1996	537	13.4	3,447	86.0	23	0.6	4,007
1997	832	14.7	4,768	84.4	52	0.9	5,652
1998	752	13.7	4,627	84.4	102	1.9	5,481
1999	833	18.0	3,758	81.4	29	0.6	4,620
2000	488	12.5	3,381	86.3	47	1.2	3,916
2001	567	9.9	5,076	88.4	100	1.7	5,743
2002	756	13.1	4,953	85.8	66	1.1	5,775
2003	713	13.0	4,744	86.3	40	0.7	5,497
2004	590	11.6	4,469	87.9	24	0.5	5,083
2005	595	11.6	4,425	86.3	108	2.1	5,128

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

LL	CHN		JPN		KOR		MEX		PAN		PYF		TWN		USA		VUT	
	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C	E	C
1976			117,301	68,895	3,931	2,043							2,364	1,634				
1977			132,875	83,725	10,958	5,628							11,973	7,789				
1978			140,006	79,320	8,571	7,012							8,743	6,524				
1979			137,769	67,932	5,021	2,305							3,138	2,293				
1980			138,141	75,639	11,788	5,907							3,000	1,611				
1981			131,275	59,226	19,731	6,540							5,952	2,948				
1982			116,200	61,369	18,612	7,489							8,117	3,910				
1983			127,176	69,563	14,675	6,478	1	49					4,850	2,311				
1984			119,635	57,262	11,767	4,490							3,730	1,734				
1985			106,758	74,347	19,785	10,508	0	2					3,126	1,979				
1986			160,553	111,673	30,765	17,432	3	68					4,874	2,569				
1987			188,393	104,053	36,436	19,405	5	273					12,267	5,335				
1988			182,694	82,384	43,056	10,172	4	234					9,567	4,590				
1989			170,373	84,961	43,365	4,879	0	9					16,360	4,962				
1990			178,419	117,923	47,167	17,415							12,543	4,755				
1991			200,365	112,337	65,024	24,644							17,969	5,862	43	12		
1992			191,284	93,011	45,634	13,104					500	88	33,025	14,142	325	106		
1993			159,955	87,976	46,375	12,843	3	2			2,605	80	18,064	6,566	417	81		
1994			163,976	92,606	44,788	13,249	14	41			3,410	574	12,588	4,883	302	26		
1995			129,598	69,435	54,979	12,778	27	7			3,452	559	2,910	1,639	823	179		
1996			103,653	52,298	40,290	14,120					4,219	931	5,830	3,554	507	181		
1997			96,383	59,325	30,493	16,663					5,490	1,941	8,720	5,673	462	216		
1998			106,569	50,167	51,817	15,089	12	16			6,415	2,858	10,586	5,039	1,020	405		
1999			80,958	32,886	54,269	13,295	48	74			9,190	4,446	23,247	7,865	1,680	470		
2000			79,311	45,216	33,585	18,758	192	237	54	378	10,230	4,382	18,152	7,809	1,076	204	34	3,080
2001	13,056	5,162	102,219	54,775	72,261	18,200	196	31	138	866	11,200	5,086	53,224	20,060	1,400	238	26	3,584
2002	36,756	10,398	104,193	45,528	96,273	14,370	151	5	153	816	10,700	3,238	77,051	31,773	236	138	45	4,187
2003	43,289	14,548	103,713	36,862	71,006	15,551	179	408	10	*	14,048	4,101	74,322	28,328	1,314	262	85	6,090
2004	15,889	4,033	68,988	27,256	*	14,540	55	46	*	*	17,865	3,030	51,317	19,535	1,040	166	21	3,132
2005	*	3,681	*	15,738	*	12,284	2	1	*	*	*	2,514	50,000	12,262	*	553	*	1,031

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

TABLE A-11. Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet, 1975-2005. The data for 2005 are preliminary.
TABLA A-11. Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO, 1975-2005. Los datos de 2005 son preliminares.

	PS		LP		Total	
	No.	**Vol. (m^3)**	**No.**	**Vol. (m^3)**	**No.**	**Vol. (m^3)**
1975	253	174,016	111	8,055	364	182,072
1976	254	187,512	137	8,471	391	195,983
1977	253	189,967	116	6,780	369	196,746
1978	271	192,259	118	6,736	389	198,995
1979	282	195,494	50	4,341	332	199,835
1980	270	196,476	50	4,186	320	200,662
1981	251	196,484	41	3,308	292	199,792
1982	223	178,234	40	3,016	263	181,250
1983	215	149,404	60	3,940	275	153,344
1984	175	121,650	40	3,245	215	124,895
1985	178	137,814	25	2,574	203	140,387
1986	166	131,806	17	2,060	183	133,867
1987	177	152,351	29	2,376	206	154,727
1988	189	156,636	36	3,274	225	159,910
1989	178	141,956	30	3,135	208	145,091
1990	172	143,946	23	2,044	195	145,990
1991	155	124,501	19	1,629	174	126,131
1992	160	117,017	19	1,612	179	118,629
1993	152	118,730	15	1,543	167	120,272
1994	167	122,214	20	1,725	187	123,939
1995	175	124,096	20	1,784	195	125,880
1996	183	132,731	17	1,639	200	134,370
1997	194	146,533	23	2,105	217	148,637
1998	203	161,560	22	2,217	225	163,777
1999	208	180,652	14	1,656	222	182,308
2000	205	180,625	13	1,311	218	181,936
2001	205	189,966	10	1,259	215	191,225
2002	218	200,075	6	925	224	201,000
2003	215	202,674	3	338	218	203,012
2004	217	206,302	3	338	220	206,640
2005	219	212,923	4	498	223	213,421

TABLE A-12a. 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 2004 by flag, gear, and size class. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.
TABLA A-12a. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2004, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag Bandera	Gear Arte	Size class—Clase de arqueo 1	2	3	4	5	6	Total	Well volume Volumen de bodega
		Number—Número							**m^3**
BOL	PS	-	-	2	1	-	5	8	6,412
COL	PS	-	-	-	1	1	9	11	11,466
ECU	PS	-	5	11	13	10	40	79	51,642
ESP	PS	-	-	-	-	-	4	4	8,859
GTM	PS	-	-	-	-	-	2	2	3,415
HND	PS	-	-	-	-	-	3	3	2,810
MEX	PS	-	-	2	7	11	39	59	52,443
	LP	-	1	2	-	-	-	3	338
NIC	PS	-	-	-	-	-	3	3	3,926
PAN	PS	-	-	-	2	1	18	21	25,531
SLV	PS	-	-	-	-	-	3	3	5,377
USA	PS	-	-	1	-	-	6	7	8,178
VEN	PS	-	-	-	-	-	23	23	29,961
VUT	PS	-	-	-	-	-	4	4	5,082
UNK	PS	-	-	1	-	-	-	1	180
Grand total—Total general	PS	-	5	14	24	22	152	217	
	LP	-	1	2	-	-	-	3	
	PS + LP	-	6	16	24	22	152	220	
		Well volume—Volumen de bodega (m^3)							
Grand total—Total general	PS	-	489	2,462	6,712	9,727	186,912	206,302	
	LP	-	101	237	-	-	-	338	
	PS + LP	-	590	2,699	6,712	9,727	186,912	206,640	

- : none—ninguno

TABLE A-12b. 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 2005 by flag, gear, and size class. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.
TABLA A-12b. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2005, por bandera, arte de pesca, y clase de arqueo. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag	Gear	Size class—Clase de arqueo						Total	Well Volume
Bandera	Arte	1	2	3	4	5	6		Volumen de bodega
		Number—Número							m^3
COL	PS	-	-	-	1	1	11	13	14,439
ECU	PS	-	4	11	13	10	42	80	54,993
ESP	PS	-	-	-	-	-	3	3	6,955
GTM	PS	-	-	-	-	-	1	1	1,475
HND	PS	-	-	-	-	-	3	3	2,810
MEX	PS	-	-	2	5	11	41	59	56,163
	LP	-	1	3	-	-	-	4	498
NIC	PS	-	-	-	-	-	6	6	8,060
PAN	PS	-	-	-	2	1	22	25	32,320
SLV	PS	-	-	-	-	-	4	4	6,324
USA	PS	-	-	1	-	-	1	2	1,365
VEN	PS	-	-	-	-	-	26	26	33,839
VUT	PS	-	-	-	-	-	2	2	2,163
UNK	PS	-	-	-	1	-	-	1	222
Grand total—Total general	PS	-	4	14	22	23	156	219	
	LP	-	1	3	-	-	-	4	
	PS + LP	-	5	17	22	23	156	223	
		Well volume—Volumen de bodega (m^3)							
Grand total—Total general	PS	-	407	2,616	6,356	10,440	193,104	212,923	
	LP	-	101	397	-	-	-	498	
	PS + LP	-	508	3,013	6,356	10,440	193,104	213,421	

- : none—ninguno

TABLE A-13. Minimum, maximum, and average capacity, in thousands of metric tons, of purse-seine and pole-and-line vessels at sea in the EPO during l995-2004 and in 2005, by month.
TABLA A-13. Capacidad mínima, máxima, y media, en miles de toneladas métricas, de los buques cerqueros y cañeros en el mar en el OPO durante 1995-2004 y en 2005, por mes.

Month Mes	**1995-2004**			**2005**
	Min	**Max**	**Ave-Prom**	
1	67.0	121.6	96.8	144.3
2	67.9	144.1	106.3	150.8
3	70.3	149.8	104.0	141.0
4	64.2	143.0	107.1	142.8
5	65.3	135.4	103.0	147.9
6	74.1	144.7	105.0	162.9
7	70.8	153.5	108.6	155.5
8	66.7	140.2	105.7	62.2
9	64.2	137.7	104.9	108.1
10	72.3	145.6	109.3	172.2
11	60.0	145.0	103.4	137.3
12	33.1	116.4	71.3	105.8
Ave-Prom	64.7	139.8	102.1	135.9

B. YELLOWFIN TUNA

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

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

The stock assessment requires a substantial amount of information. This includes data on retained catch, discards, fishing effort, and the size compositions of the catches from several different fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure. Several inputs into the latest assessment differ from that for 2004. Recent catch and effort data (2005 for purse-seine and 2004 for most of the longline catches) have been incorporated. Earlier data have been updated. The catches are shown in Figure B-1.

Significant levels of fishing mortality have been observed in the yellowfin tuna fishery in the EPO (Figure B-2). These levels are highest for middle-aged yellowfin. Both recruitment (Figure B-3) and exploitation have had substantial impacts on the yellowfin biomass trajectory (Figure B-4). Most of the yellowfin catch is taken by catching schools associated with dolphins, and, accordingly, this fishery has the greatest impact on the yellowfin tuna population (Figure B-4), although it has almost the least impact per weight captured of all fisheries. It appears that the yellowfin population has experienced two different productivity regimes (1975-1983 and 1984-2005), with greater recruitment during the second regime. The two recruitment regimes (Figure B-3) correspond to two regimes in biomass (Figure B-4), the high-recruitment regime corresponding to greater biomasses. The spawning biomass ratio (the ratio of the current spawning biomass to that for the unfished stock; SBR) of yellowfin in the EPO was below the level that would permit the average maximum sustainable yields (AMSYs) during the low-recruitment regime, but close to that level during the high-recruitment regime (Figure B-5). The two different productivity regimes may support two different levels of AMSY and associated SBRs, and the AMSY reported here is an average for the 1975-2005 period.

The current SBR is above the SBR level at AMSY (Figure B-5). However, there is substantial uncertainty in the most recent estimate of SBR, and there is a moderate probability that the current SBR is below the level that would support the AMSY. The effort levels are estimated to be about those capable of supporting the AMSY (Table B-1 based on the recent (2003-2004) distribution of effort among the different fisheries). Future projections under the current effort levels and average recruitment indicate that the population will remain at approximately the same level over the next 5 years (Figure B-6). These simulations were carried out using the average recruitment for the 1975-2005 period. Both the purse-seine and longline catches are expected to remain, on average, close to 2005 levels (Figure B-6).

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

The analysis indicates that strong cohorts entered the fishery in 1998-2000, and that these cohorts increased the size of the spawning stock during 1999-2001. However, they have now moved through the population, so the size of the spawning stock decreased during 2002-2005.

The overall average weights of yellowfin tuna that are caught have consistently been much less than those that would maximize the AMSY, indicating that, from the yield-per-recruit standpoint, the yellowfin in the EPO are not harvested at the optimal size. There is substantial variability in the average weights of the yellowfin taken by the different fisheries, however. In general, the floating-object, unassociated, and pole-and-line fisheries capture younger, smaller fish than do the dolphin-associated and longline fisheries. The longline fisheries and the purse-seine sets in the southern area on yellowfin associated with dolphins capture older, larger yellowfin than do the coastal and northern dolphin-associated fisheries. The AMSY calculations indicate that the yield levels could be increased if the fishing effort were diverted to the fisheries that catch larger yellowfin, or would be diminished if fishing effort were diverted to catching smaller fish. Any such changes would also affect the SBR levels in a similar way.

The conservation measures imposed in 2004 under Resolution C-04-09 are predicted to maintain the stock at about the AMSY level, slightly higher than would otherwise have been the case.

Catches during the first quarter of 2006 have been markedly less than those of the same period in 2004 and 2005. The estimates of the stock size in 2005 and 2006 are similar in both the base case and the sensitivity analysis with a stock-recruitment relationship. The most likely cause of lesser catches is a decline in catchability.

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

Summary

1. The biomass is estimated to have declined very slightly in 2005.
2. There is uncertainty about recent and future recruitment and biomass levels.
3. The estimate of current SBR is above that required to permit AMSY, but its confidence interval encompasses the AMSY.
4. The recent fishing mortality rates are about those required to produce AMSY.
5. Increasing the average weight of the yellowfin caught could substantially increase AMSY.
6. There have been two different productivity regimes, and the levels of AMSY and the biomass required to produce AMSY may differ between the regimes.
7. The results are more pessimistic if a stock-recruitment relationship is assumed.

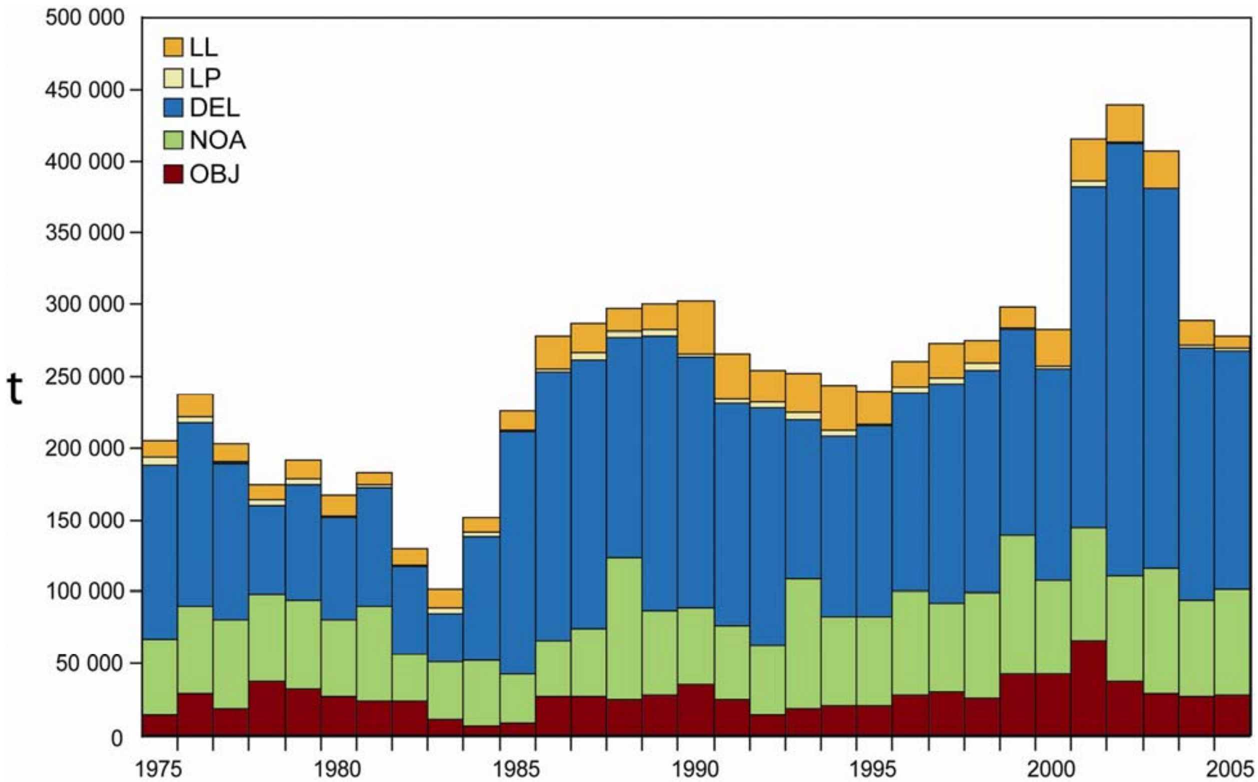


FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2005. The purse-seine catches for 1975-1992 are based on unloading data, adjusted to the species composition estimate. The data for the longline catches for 1975-2004 are those reported to the IATTC by governments.

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, 1975-2005. Las capturas cerqueras de 1975-1992 se basan en datos de descargas, ajustados a la estimación de la composición por especie. Los datos de las capturas palangreras de 1975-2004 son las que reportaron los gobiernos a la CIAT.

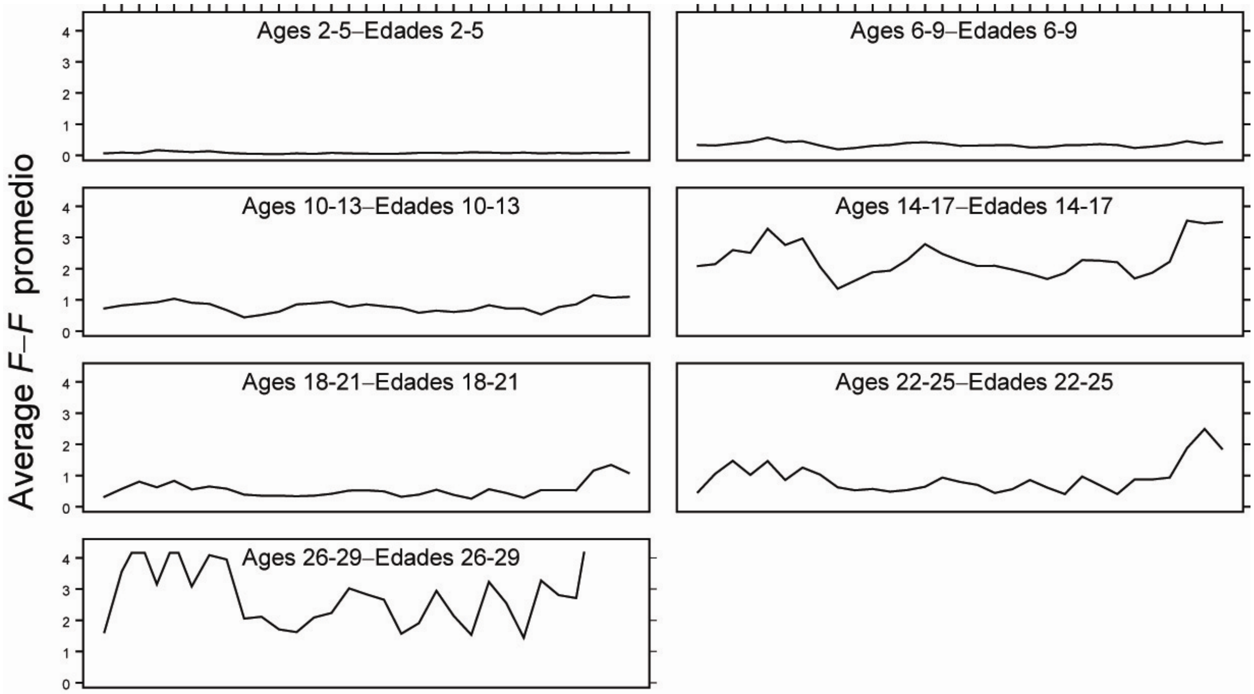


FIGURE B-2. Time series of average total annual fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish of the age range indicated in the title of each panel. For example,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

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

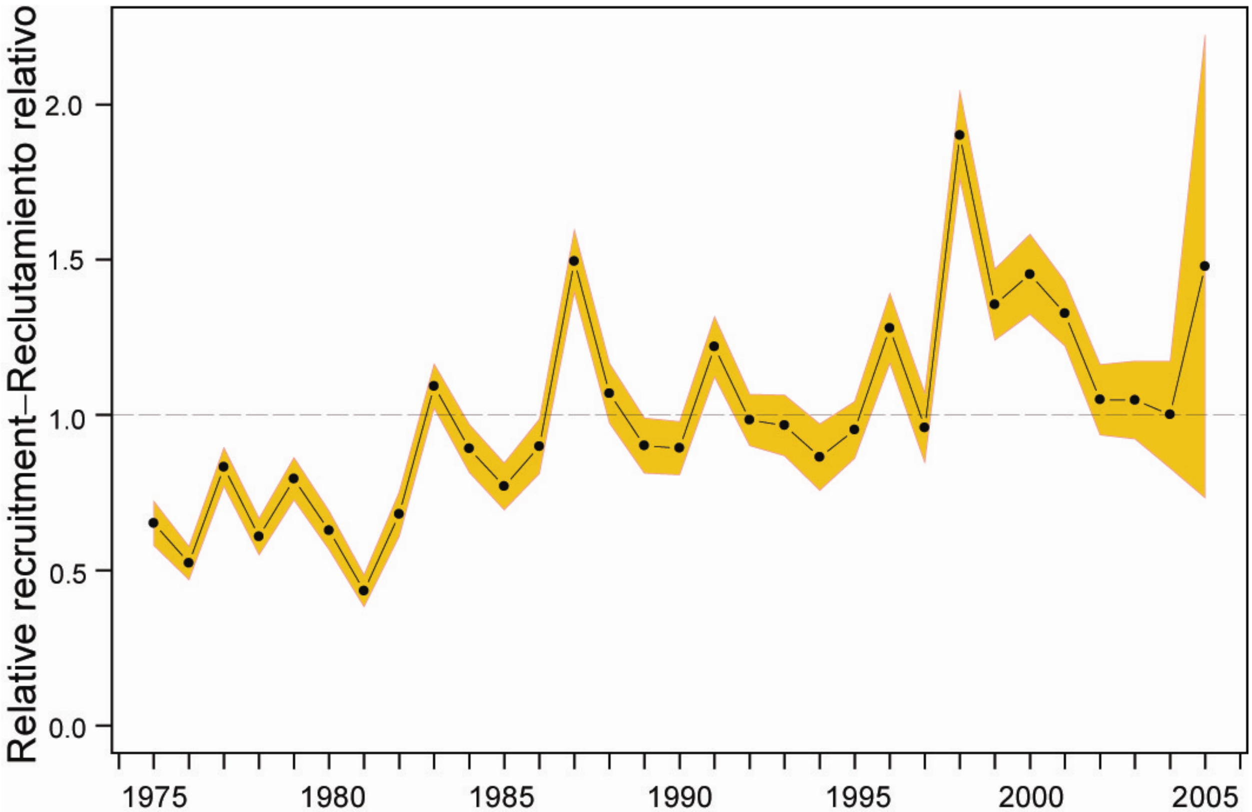


FIGURE B-3. Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals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

FIGURA B-3. Reclutamiento estimado de atún aleta amarilla a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea gruesa ilustra las estimaciones de probabilidad máxima del reclutamiento, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

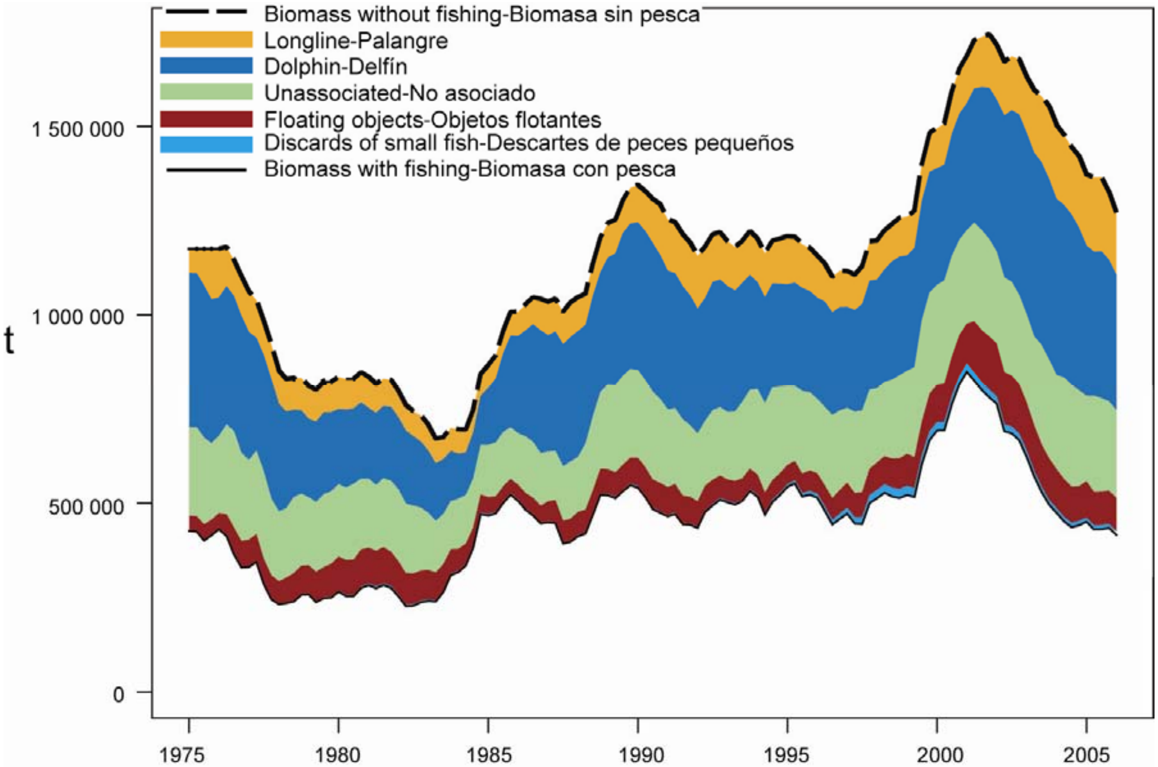


FIGURE B-4. Biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing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

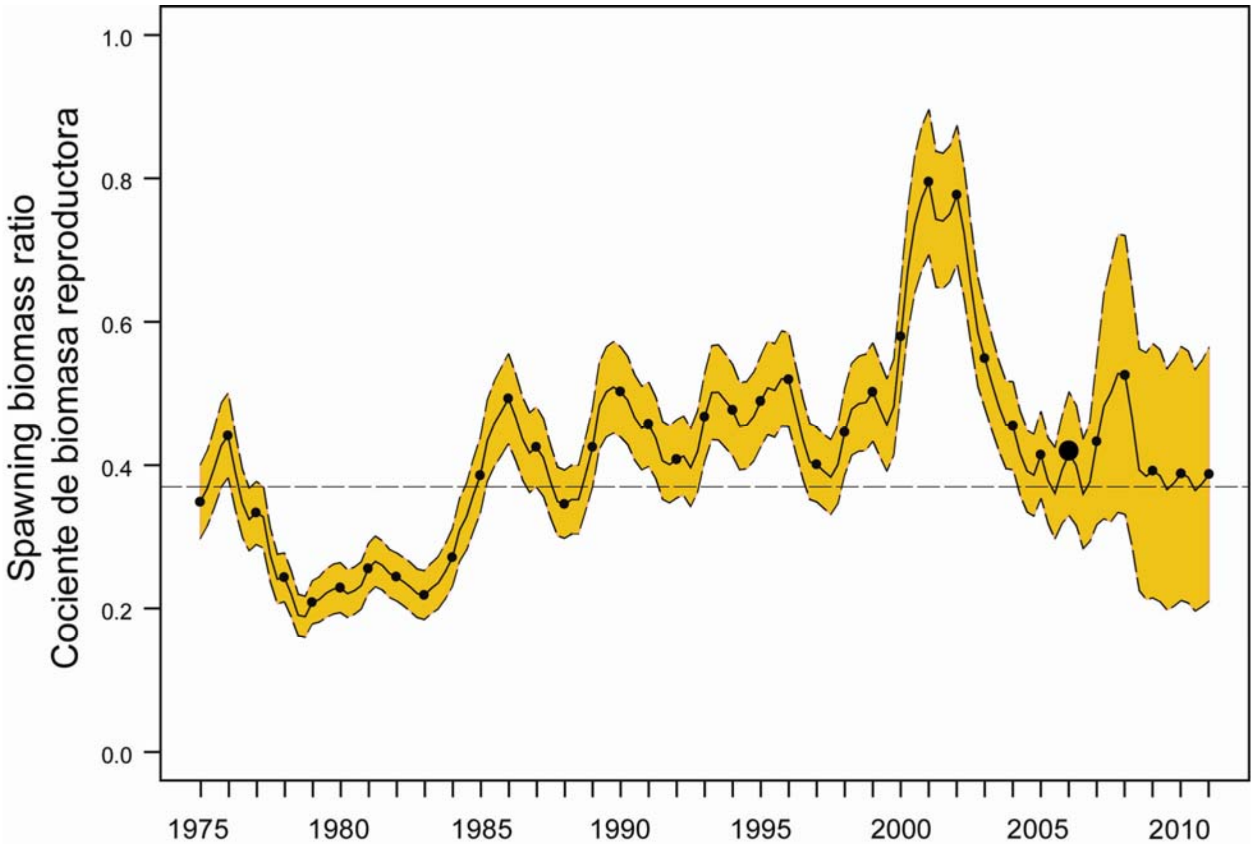


FIGURE B-5. Spawning biomass ratios (SBRs) for 1975-2005 and SBRs projected during 2006-2011 for yellowfin tuna in the EPO. The dashed horizontal line (at 0.37) identifies SBR_{AMSY}. The shaded area represents the 95% confidence limits of the estimates. The estimates after 2006 (the large dot) indicate the SBR predicted to occur if effort continues at the average of that observed in 2005, catchability (with effort deviates) continues at the average for 2003 and 2004, and average environmental conditions occur during the next 5 years.

FIGURA B-5. Cocientes de biomasa reproductora (SBR) para 1975-2005 y SBR proyectados durante 2006-2011 para el atún aleta amarilla en el OPO. La línea de trazos horizontal (en 0.37) identifica SBR_{RPMS}. El área sombreada representa los límites de confianza de 95% de las estimaciones. Las estimaciones a partir de 2006 (el punto grande) señalan el SBR predicho si el esfuerzo continúa en el nivel promedio observado en 2005, la capturabilidad (con desvíos de esfuerzo) continúa en el promedio de 2003 y 2004, y ocurren condiciones ambientales medias en los 5 próximos años.

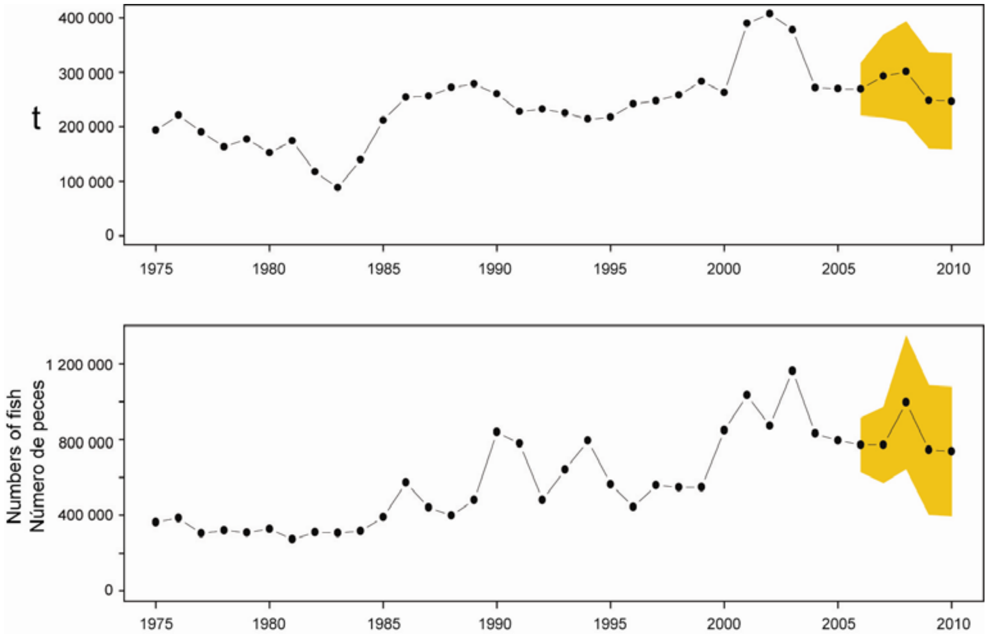


FIGURE B-6. Catches of yellowfin tuna during 1975-2005 and simulated catches of yellowfin tuna during 2006-2010 taken by the purse-seine and pole-and-line fleets (upper panel) and the longline fleet (lower panel). The shaded area represents the 95% confidence limits of the estimates.
FIGURA B-6. Capturas de atún aleta amarilla durante 1975-2005 y capturas simuladas de aleta amarilla durante 2006-2010 por las flotas de cerco y de caña (recuadro superior) y la flota palangrera (recuadro inferior). El área sombreada representa los intervalos de confianza de 95% estimades de las estimaciones.

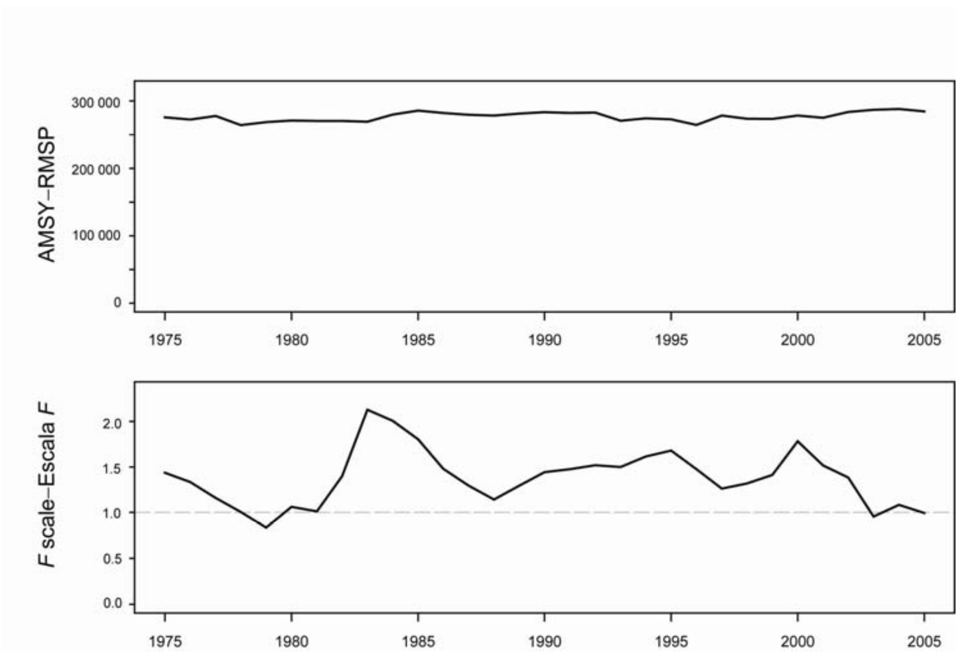


FIGURE B-7. AMSY (upper panel), 1975-2005, and the change (increase or reduction) in the effort corresponding to the AMSY (lower panel), estimated separately for each year, using the average age-specific fishing mortality for that year.
FIGURA B-7. RMSP (recuadro superior), 1975-2005, y cambio (aumento o reducción) del esfuerzo correspondiente al RMSP (recuadro inferior), estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

TABLE B-1. AMSY 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 2003 and 2004. B_{recent} and B_{AMSY} are the biomass of yellowfin tuna 2+ quarters old at the start of 2006 and at AMSY, respectively, and S_{recent} and S_{AMSY} are indices of spawning biomass (therefore, they are not in metric tons). C_{recent} is the estimated total catch in 2005.

TABLA B-1. El RMSP 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 2003 y 2004. $B_{reciente}$ y B_{RMSP} son la biomasa de peces de 2+ trimestres de edad al principio de 2006 y en RMSP, respectivamente, y $S_{reciente}$ y S_{RMSP} son índices de la biomasa reproductora (por tanto, no se expresan en toneladas). $C_{reciente}$ es la captura total estimada en 2005.

	Base case **Caso base**	**h = 0.75**	**$L_{inf.}$170**	**$L_{inf.}$200**
AMSY–RMSP	287,519	300,282	288,809	287,695
B_{AMSY} –B_{rm2}	416,379	546,213	409,895	419,322
S_{AMSY} —S_{rm2}	4,677	6,444	4,662	4,661
C_{recent}/AMSY—$C_{reciente}$/RMSP	1.06	1.01	1.05	1.06
B_{recent}/B_{AMSY} –$B_{reciente}/B_{RMSP}$	1.00	0.77	1.02	1.02
S_{recent}/S_{AMSY} –$S_{reciente}/S_{RMSP}$	1.14	0.83	1.16	1.15
$S_{AMSY}/S_{F=0}$ –$S_{RMSP}/S_{F=0}$	0.37	0.43	0.36	0.37
F multiplier—Multiplicador de *F*	1.02	0.68	1.04	1.04

C. SKIPJACK TUNA

An age-structured catch-at-length analysis (A-SCALA) is used to assess skipjack tuna in the eastern Pacific Ocean (EPO). The 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 for the most recent assessment of skipjack tuna, conducted in 2004 (IATTC Stock Assessment Report 5; available on the IATTC web site), which included data up to and including 2003.

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

The recruitment of skipjack tuna to the fisheries of the EPO is highly variable, and greater-than-average recruitment has been estimated for the period following the introduction of the use of FADs in the early 1990s, which was associated with a southward expansion of the fishery (Figure C-2). The fishing mortality (Figure C-3) is estimated to be about the same or less than the rate of natural mortality. These estimates of fishing mortality are supported by estimates from tagging data. The biomass fluctuates in response to variations in both recruitment and exploitation (Figure C-4). The estimates of absolute biomass are moderately sensitive to weights given to the information about abundance in the catch and effort data for the floating-object fisheries and the monotonic selectivity assumption, but the trends in biomass are not.

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

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

The results of a new analysis in 2006, 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.

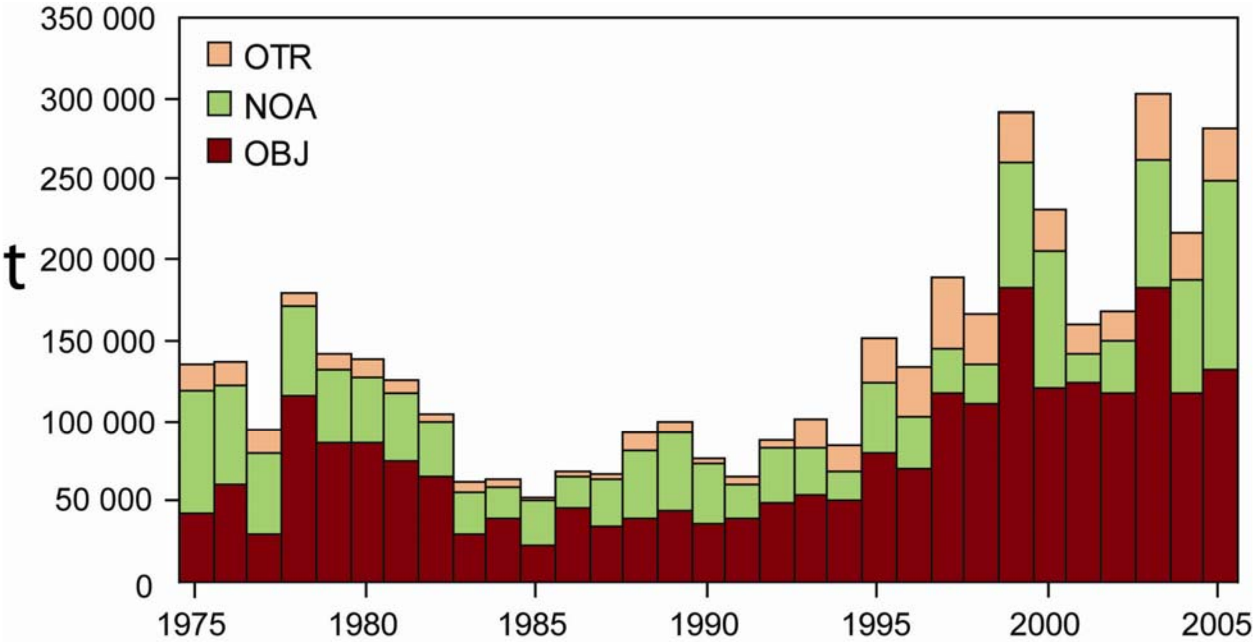


FIGURE C-1. Total catches (retained catches plus discards) of skipjack tuna by the purse-seine fisheries on floating objects and unassociated schools, and by other fisheries combined, in the eastern Pacific Ocean, 1975-2005. The purse-seine catches for 1975-1992 are based on unloading data, adjusted 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, 1975-2005. Las capturas cerqueras de 1975-1992 se basan en datos de descargas, ajustados a la estimación de la composición por especie.

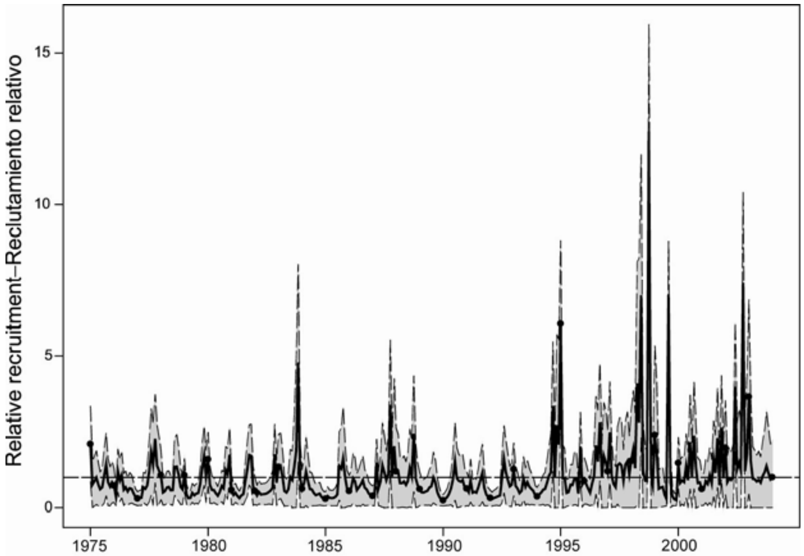


FIGURE C-2. Estimated recruitment of skipjack tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The solid line illustrates the maximum-likelihood estimates of recruitment, and the shaded area the 95% confidence intervals. The labels on the time axis are drawn at the start of each year, but, since the assessment model represents time on a monthly basis, there are 12 estimates of recruitment for each year.
FIGURA C-2. Reclutamiento estimado de atún barrilete a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea sólida ilustra las estimaciones de reclutamiento de probabilidad máxima, y el área sombreada los intervalos de confianza de 95%. Se dibujan las leyendas en el eje de tiempo al principio de cada año, pero, ya que el modelo de evaluación representa el tiempo por meses, hay 12 estimaciones de reclutamiento para cada año.

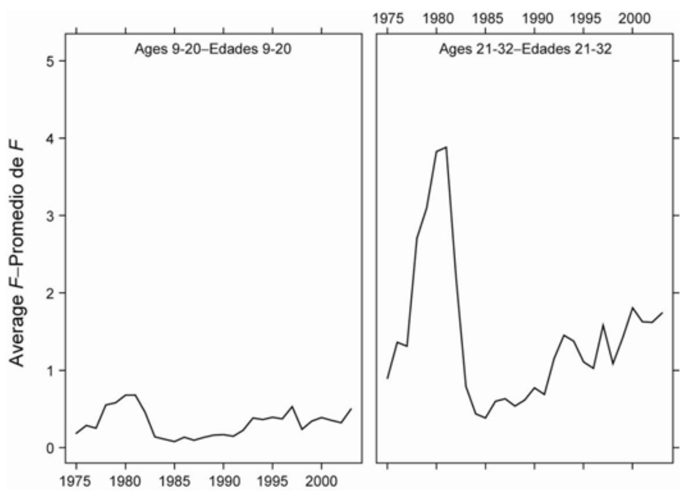


FIGURE C-3. Time series of average total monthly fishing mortality of skipjack tuna recruited to the fisheries of the EPO. Each panel illustrates an average of 12 monthly fishing mortality vectors that affected fish of the age range indicated in the title of each panel. For example, the trend illustrated in the left panel is an average of the fishing mortalities that affected fish that were 9-20 months old.
FIGURA C-3. Series de tiempo de la mortalidad por pesca mensual total media de atún barrilete reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de 12 vectores mensuales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro izquierdo es un promedio de las mortalidades por pesca que afectaron a los peces de entre 9 y 20 meses de edad.

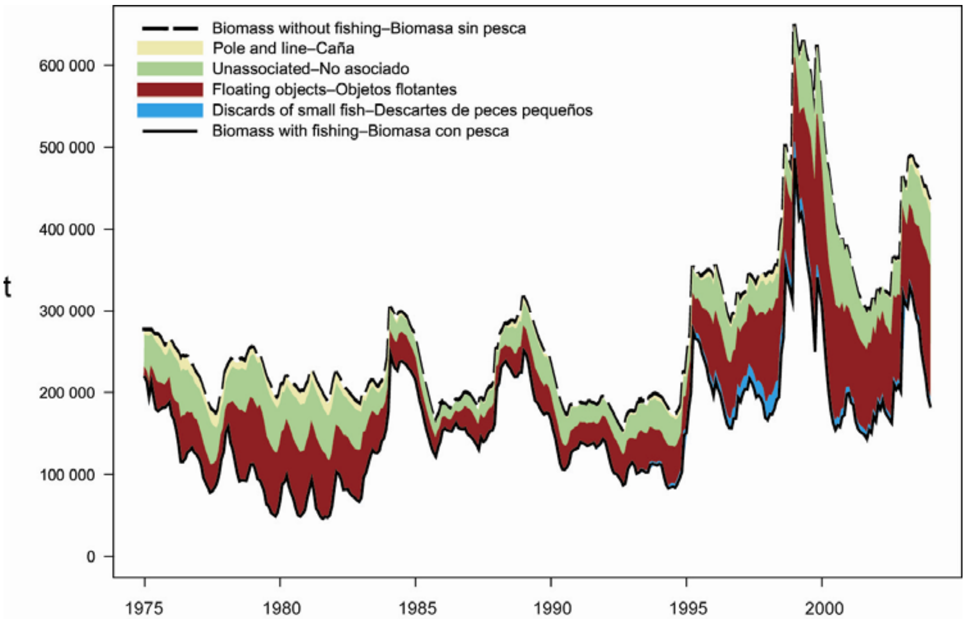


FIGURE C-4. Biomass trajectory of a simulated population of skipjack tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing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

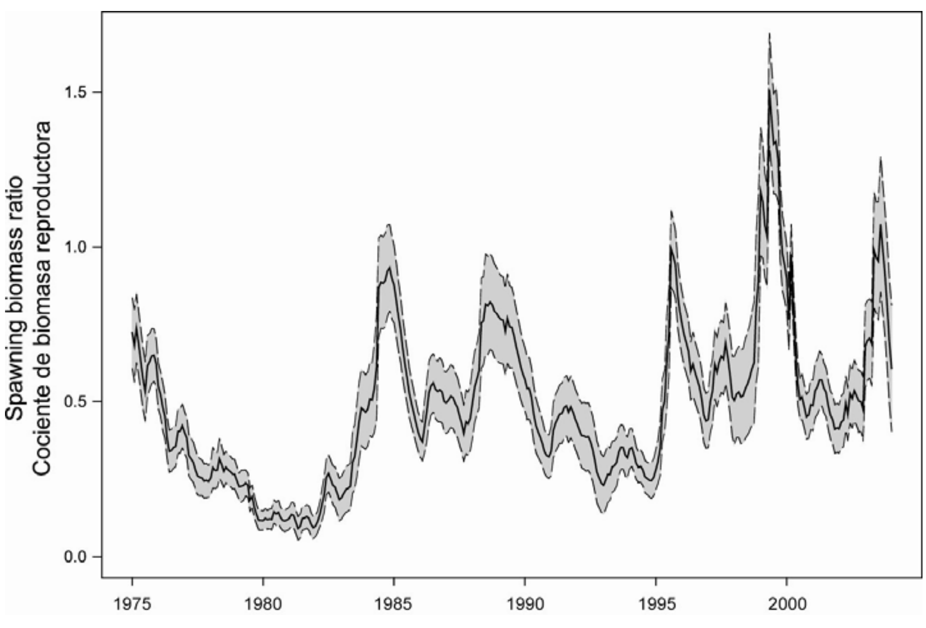


FIGURE C-5. Estimated time series of spawning biomass ratios (SBRs) for skipjack tuna in the EPO, from the monotonic selectivity assessment. The shaded area represents the 95% confidence limits of the estimates.
FIGURA C-5. Series de tiempo estimadas de los cocientes de biomasa reproductora (SBR) de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

D. BIGEYE TUNA

There have been substantial changes in the bigeye tuna fishery in recent years (Figure D-1). Initially, the majority of the bigeye catch was taken by longline vessels. With the expansion of the FAD fishery since 1993, the purse-seine fishery has taken an increasing component of the bigeye catch. The FAD fishery captures smaller bigeye, and has therefore reduced the yield per recruit and the average maximum sustainable yield (AMSY). On average, the fishing mortality of bigeye less than about four and a half years old has increased substantially since 1993, and that of older fish has increased slightly (Figure D-3).

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

Bigeye are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. Purse-seine catches of bigeye tuna are substantially lower close to the western boundary (150ºW) of the EPO (Figure A-3); longline catches are more continuous, but show lower levels between 160ºW and 180º (Figure A-4). Bigeye tuna do not show large movements (95% of tagged bigeye showed net movements of less than 1000 nautical miles), and current information indicates little exchange between the eastern and western Pacific Ocean (Figure D-2). 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. The assessment reported here is conducted as if there were a single stock in the EPO. Its results are consistent with results of other analyses of bigeye tuna on a Pacific-wide basis. In addition, analyses have shown that the results are insensitive to the spatial structure of the analysis. Currently, there are not enough tagging data to provide adequate estimates of movement between the eastern and western Pacific.

Several inputs into the latest assessment differ from that for 2004. Recent catch and effort data have been incorporated. Earlier data have been updated.

There are several important features in the estimated time series of bigeye recruitment (Figure D-4). First, estimates of recruitment before 1993 are very uncertain, as the floating-object fisheries, which catch small bigeye, were not operating. There was a period of above-average recruitment in 1995-1998, followed by a period of below-average recruitment in 1999-2000. The recruitments were above average in 2001 and 2002. The most recent recruitment is very uncertain, due to the fact that recently-recruited bigeye are represented in only a few length-frequency data sets. The extended period of relatively large recruitments in 1995 to 1998 coincided with the expansion of the fisheries that catch bigeye in association with floating objects.

The biomass of bigeye in the EPO has been declining since 1987, initially because of the impact of longline fishing and, since 1993, purse seining, which now has a greater impact. The decline was interrupted by strong recruitment during 1995-1998, which produced a peak biomass in 2000, and (with less certainty) strong recruitment during 2004 and 2005.

At the beginning of 2006, the spawning biomass of bigeye tuna in the EPO (Figure D-6; large dot) was recovering from the lowest level previously seen. At that time the spawning biomass ratio (the ratio of current spawning biomass to biomass of spawners in the absence of fishing mortality; SBR) was estimated to be slightly less than the level corresponding to the AMSY (SBR_{AMSY}), with a confidence interval (±2 standard deviations) overlapping the SBR_{AMSY}.

Estimates of the average SBR projected to occur during 2006-2011 indicate that the SBR is likely to increase to the level corresponding to the AMSY and subsequently continue its decline unless fishing mortality is greatly reduced (Figure D-7).

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

In the base case assessment, recent catches are estimated to have been at about the level corresponding to the AMSY (Table D-1). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the AMSY is about 69% of the recent (2003-2004) level of effort. Decreasing the effort to 69% of its present level would increase the long-term average yield by about 5% and would increase the spawning potential of the stock by about 75%. The AMSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that for the longline fishery that operates south of 15°N because it catches larger individuals. Before the expansion of the floating-object fishery that started in 1993, AMSY was greater than the current AMSY and the fishing mortality was less than that corresponding to AMSY (Figure D-8).

Several sensitivity analyses were performed that investigated incorporating a stock-recruitment relationship in the assessment and changing the average maximum length of bigeye.

All analyses considered, except one with a low maximum length, suggested that at the start of 2006 the spawning biomass was below the level corresponding to the AMSY (Table D-1). AMSY and the fishing mortality (F) multiplier are sensitive to how the assessment model is parameterized, the data that are included in the assessment, and the periods assumed to represent average fishing mortality, but under all but one of the scenarios considered, fishing mortality is well above the level corresponding to the AMSY.

The estimates of recruitment and biomass were not sensitive to the steepness of the stock-recruitment relationship. The current status and future projections are considerably more pessimistic, in terms of stock status relative to the levels that support AMSY, if a stock-recruitment relationship (h = 0.75) exists.

The effects of Resolution C-04-09 are insufficient to maintain the stock at levels that will permit the AMSY. If the effort is reduced to levels corresponding to AMSY, the stock will rebuild to SBR_{AMSY} by 2007 and remain above that until 2011.

Summary:

1. Recent fishing mortality levels are nearly 50% greater than those corresponding to the AMSY.
2. As a consequence, if fishing effort is not reduced, total biomass and spawning biomass will eventually decline to levels at least as low as that observed in 2004.
3. The current status and future projections are considerably more pessimistic in terms of stock status if a stock-recruitment relationship (h = 0.75) exists.
4. These conclusions are robust to all but one alternative model and data formulations considered in this and previous analyses.

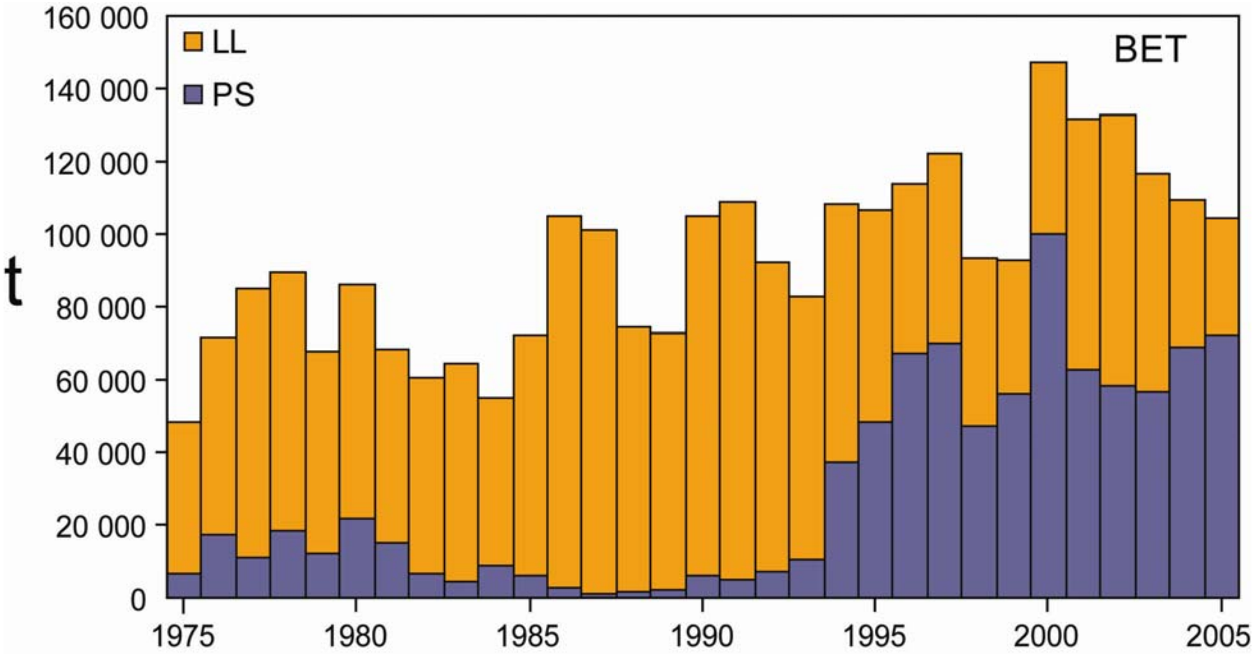


FIGURE D-1. Total catches (retained catches plus discards) of bigeye tuna by the purse-seine fisheries, and retained catches for the longline fisheries, in the eastern Pacific Ocean, 1975-2005. The purse-seine catches for 1975-1992 are based on unloading data, adjusted to the species composition estimate.

FIGURA D-1. Capturas totales (capturas retenidas más descartes) de atún patudo por las pesquerías de cerco y capturas retenidas de las pesquerías palangreras en el Océano Pacífico oriental, 1975-2005. Las capturas cerqueras de 1975-1992 se basan en datos de descargas, ajustados a la estimación de la composición por especie.

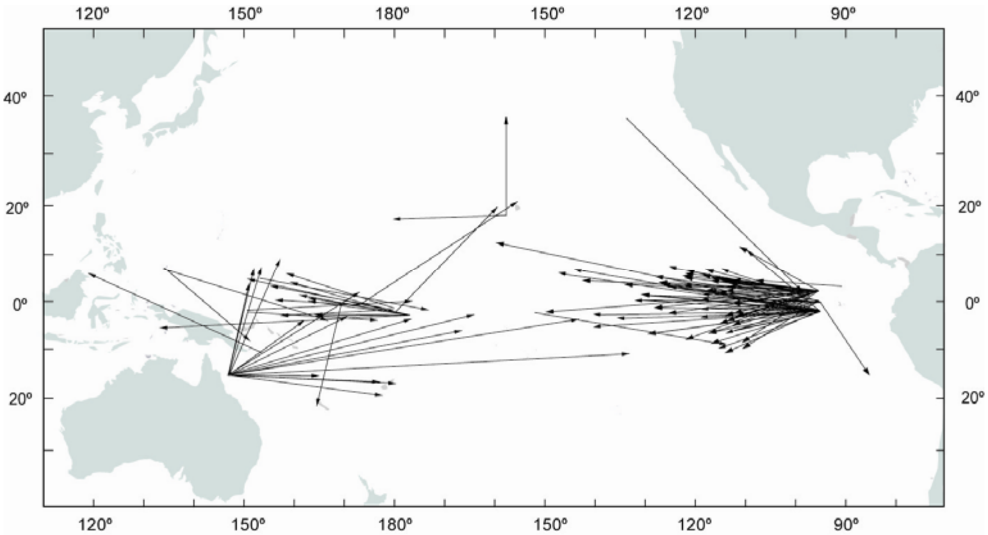


FIGURE D-2. Movements of more than 1000 nm by tagged bigeye tuna in the Pacific Ocean.
FIGURA D-2. Desplazamientos de más de 1000 mn de atunes patudo marcados en el Océano Pacífico.

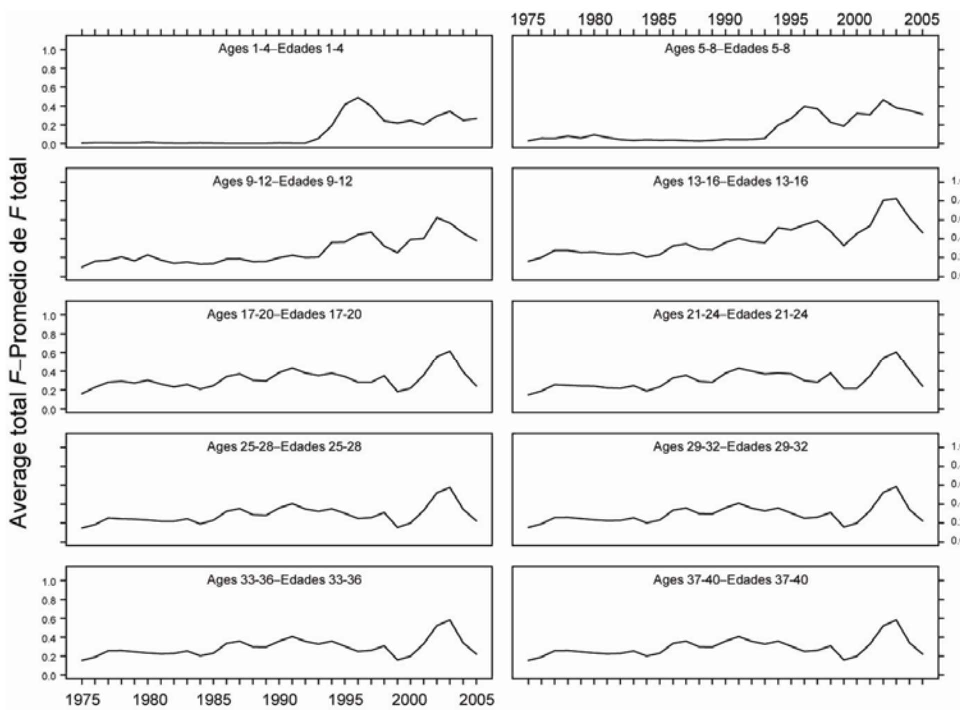


FIGURE D-3. Time series of average total annual fishing mortality on bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated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

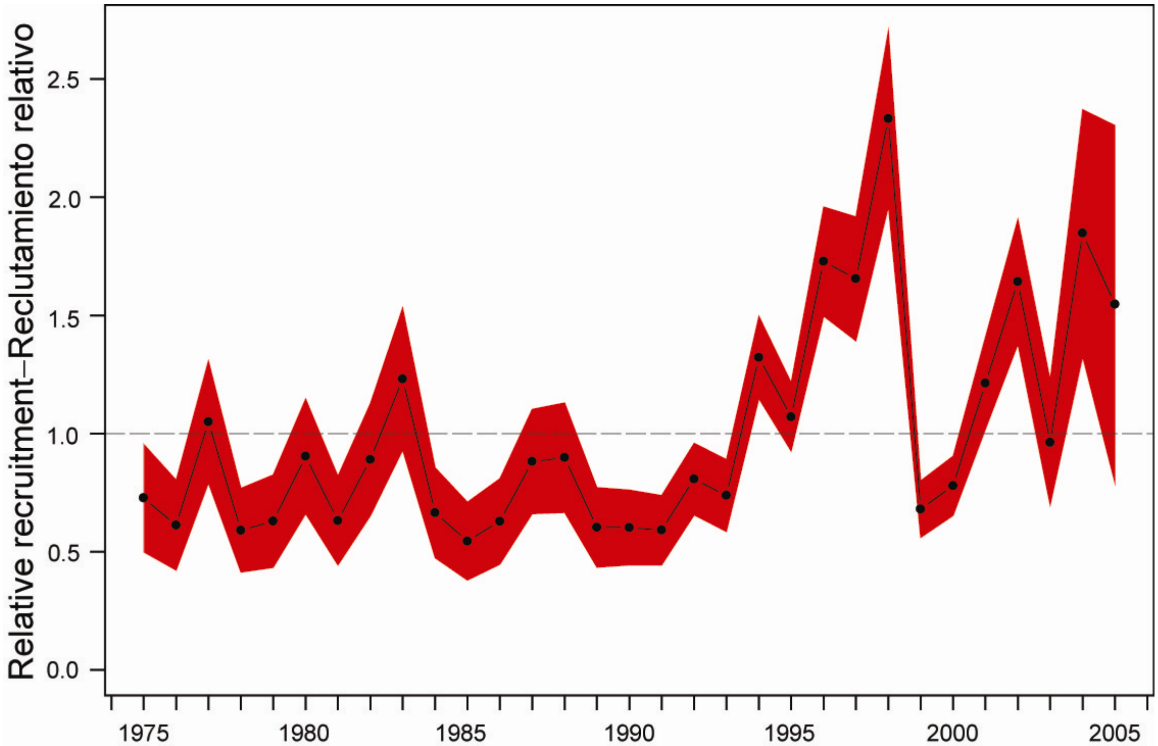


FIGURE D-4. Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The solid line shows the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals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

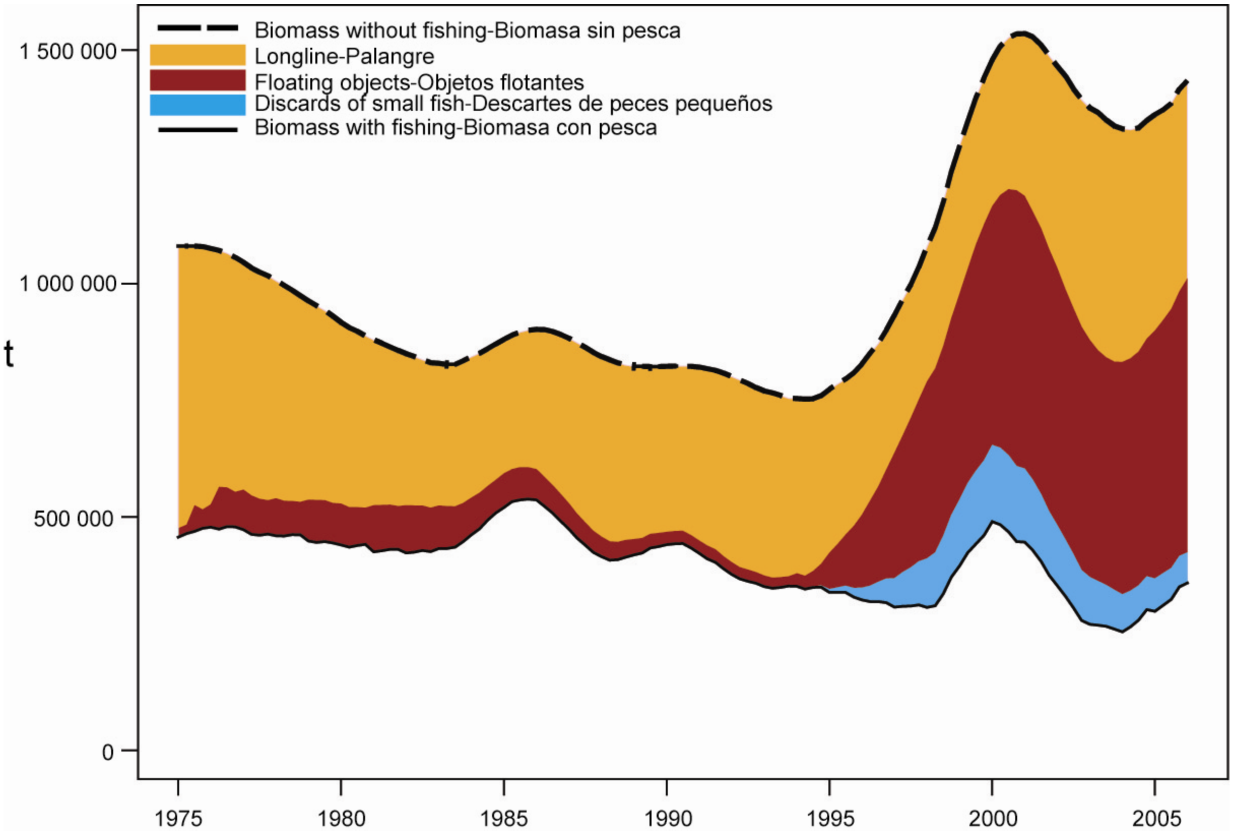


FIGURE D-5. Biomass trajectory of a simulated population of bigeye tuna that was not exploited during 1975-2005 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishery.

FIGURA D-5. Trayectoria de la biomasa de una población simulada de atún patudo no explotada durante 1975-2005 (línea de trazos) y la que predice el modelo de evaluación (línea sólida). Las áreas sombreadas entre las dos líneas señalan la porción del impacto de la pesca atribuida a cada método de pesca.

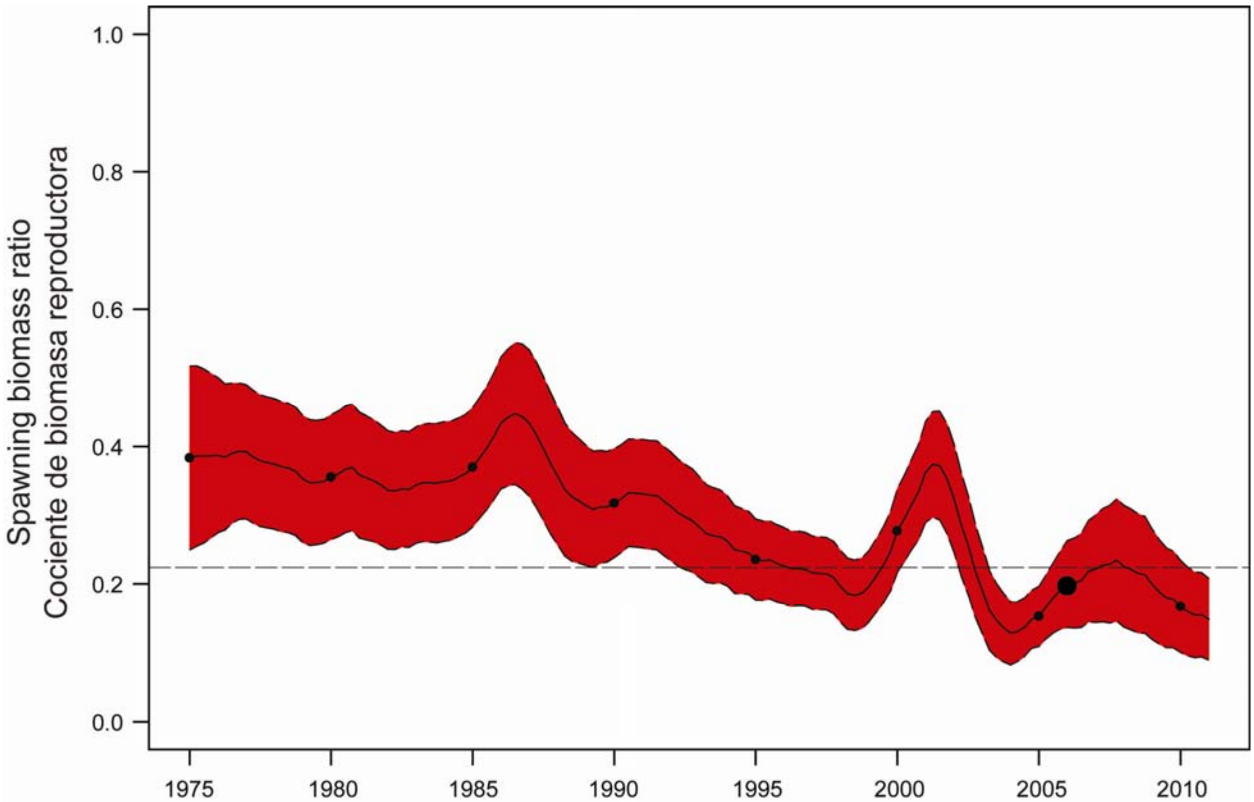


FIGURE D-6. Estimated time series of spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.22) identifies the SBR at AMSY. The solid line shows the maximum likelihood estimates, and the shaded areas are 95% confidence intervals around those estimates. The estimates after 2006 (the large dot) indicate the SBR predicted to occur if effort continues at the average of that observed in 2005 for purse seine and 2004 for longline, catchability (with effort deviates) continues at the average for 2003 and 2004, and average environmental conditions occur during the next 5 years.

FIGURA D-6. Serie de tiempo estimada de los cocientes de biomasa reproductora (SBR) para el atún patudo en el OPO. La línea de trazos horizontal (en aproximadamente 0.22) identifica el SBR en RMSP. La línea sólida señala las estimaciones de verosimilitud máxima, y el área sombreada representa los intervalos de confianza de 95% alrededor de esas estimaciones. Las estimaciones a partir de 2006 (el punto grande) señalan el the SBR predicho si el esfuerzo cerquero y palangrero continúa en el nivel observado en 2005 y 2004, respectivamente, la capturabilidad (con desvíos de esfuerzo) continúa en el promedio de 2003 y 2004, y con condiciones ambientales promedio en los 5 próximos años.

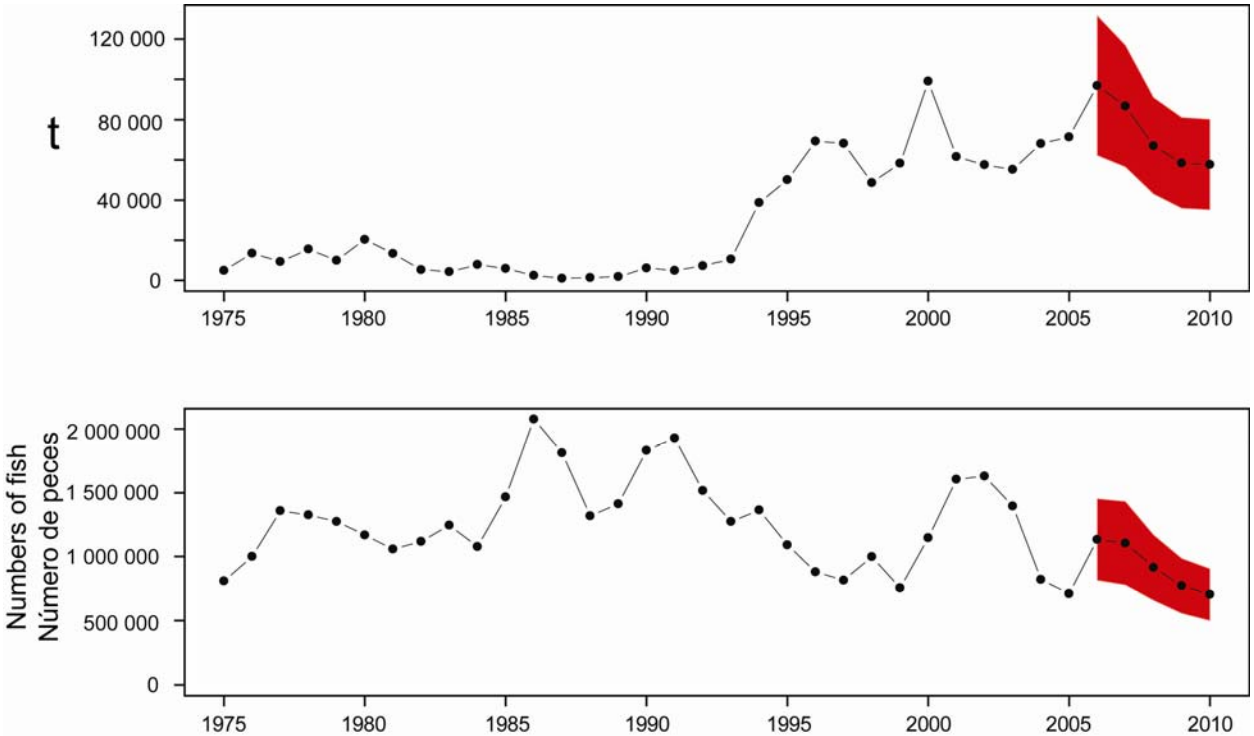


FIGURE D-7. Catches for 1975-2005, and predicted catches for 2006-2010, of bigeye tuna by the purse-seine and pole-and-line (upper panel) and longline (lower panel) fisheries. The predicted catches are based on average effort for 2005 for purse seine and 2004 for longline and average catchability for 2003 and 2004. The shaded areas represent 95% confidence intervals for the predictions of the future catches. Note that the vertical scales of the panels are different.

FIGURA D-7. Capturas de atún patudo registradas durante 1975-2005, y predichas para 2006-2010, por las pesquerías de cerco y de caña (recuadro superior) y palangreras (recuadro inferior). Las capturas predichas se basan en el esfuerzo medio cerquero en 2005 y palangrero en 2004 y la capturabilidad promedio de 2003 y 2004. Las zonas sombreadas representan los intervalos de confianza de 95% de las predicciones de capturas futuras. Nótese que las escalas verticales de los recuadros son diferentes.

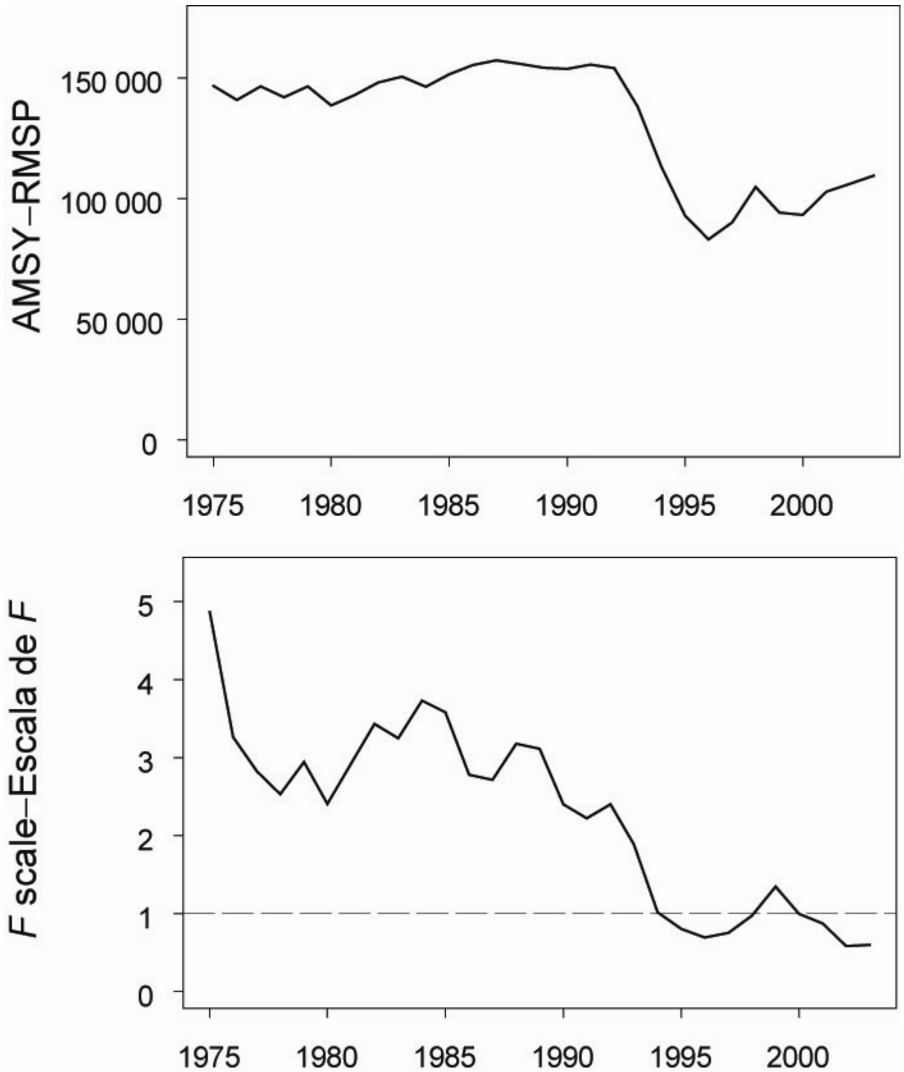


FIGURE D-8. AMSY (upper panel), 1975-2005, and the change (increase or reduction) in the effort required to produce the AMSY (lower panel) for bigeye tuna, estimated separately for each year, using the average age-specific fishing mortality for that year.

FIGURA D-8. RMSP (recuadro superior), 1975-2005, y cambio (aumento o reducción) del esfuerzo necesario para producir el RMSP (recuadro inferior), de atún patudo, estimado por separado para cada año, usando la mortalidad por pesca promedio por edad de ese año.

TABLE D-1. Estimates of the AMSY of bigeye tuna, and associated quantities for the base case assessment and the sensitivity analysis, including a stock-recruitment relationship with a steepness (*h*) of 0.75. All analyses are based on average fishing mortality for 2003 and 2004. B_{2006}, B_{AMSY}, and B_0 are the biomass of bigeye 1+ years old at the start of 2006, at AMSY, and without fishing, respectively, and S_{2006}, S_{AMSY}, and S_0 are the relative number of eggs at the start of 2006, at AMSY, and without fishing, respectively. C_{2005} is the estimated total catch in 2005.

TABLA D-1. Estimaciones del RMSP 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 2003 y 2004. B_{2006}, B_{RMSP}, y B_0 son la biomasa de patudo de edad 1+ años al principio de 2006, en RMSP, y sin pesca, respectivamente, y S_{2006}, S_{RMSP}, y S_0 son el número relativo de huevos al principio de 2006, en RMSP, y sin pesca, respectivamente. C_{2005} es la captura total estimada en 2005.

		Base case	**Steepness = 0.75**
		Caso base	**Inclinación = 0.75**
AMSY—RMSP	(t)	105,575	101,150
B_{AMSY}—B_{RMSP}	(t)	324,629	500,733
S_{AMSY}—S_{RMSP}	(t)	539	952
B_{AMSY}/B_0—B_{RMSP}/B_0		0.30	0.36
S_{AMSY}/S_0—S_{RMSP}/S_0		0.22	0.31
C_{2005}/AMSY—C_{2005}/RMSP		1.01	1.07
B_{2006}/B_{AMSY}—B_{2006}/B_{RMSP}		1.11	0.79
S_{2006}/S_{AMSY}—S_{2006}/S_{RMSP}		0.89	0.61
F multiplier—Multiplicador de *F*		0.69	0.51

E. PACIFIC BLUEFIN TUNA

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

Most of the catches of bluefin in the EPO are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 35°N. Ninety percent of the catch is estimated to have been between 60 and 100 cm, representing mostly ages 1 to 3. In recent years a considerable portion of the purse-seine catch of bluefin has been transported to holding pens, where the fish are held for fattening and later sale as sashimi-grade fish. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

Bluefin are exploited by various gears in the WPO from Taiwan to Hokkaido. Age-0 fish about 15 to 30 cm in length are caught by trolling during July-October south of Shikoku Island and south of Shizuoka Prefecture. During November-April age-0 fish about 35 to 60 cm in length are taken by trolling south and west of Kyushu Island. Age-1 and older fish are caught by purse seining, mostly during May-September, between about 30°-42°N and 140°-152°E. Bluefin of various sizes are also caught by traps, gillnets, and other gear, especially in the Sea of Japan. Small amounts of bluefin are caught near the southeastern coast of Japan by longlining. The Chinese Taipei small-scale longline fishery, which has expanded since 1996, takes 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. As stated above, it appears that spawning occurs only in the WPO. Some fish apparently remain their entire lives in the WPO, while others migrate to the EPO. These migrations begin mostly during the first and second years of life. The first- and second-year migrants are exposed to various fisheries before beginning their journey to the EPO. The migrants, after crossing the ocean, are exposed to commercial and recreational fisheries off California and Baja California. Eventually, the survivors return to the WPO.

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

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

A preliminary stock assessment carried out by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) has indicated that the biomass of the spawning stock had local peaks during the early 1960s, late 1970s and late 1990s, with a decline after the last peak. However, the relative strengths of these peaks are highly uncertain. The recruitment was estimated to be highly variable, with four to seven strong cohorts produced during the 1960-2003 period. A strong recruitment event that may have occurred in 2001 would maintain spawning stock biomass above recent levels until about 2010. Further work is necessary to provide a scientific basis for any management actions.

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

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

t

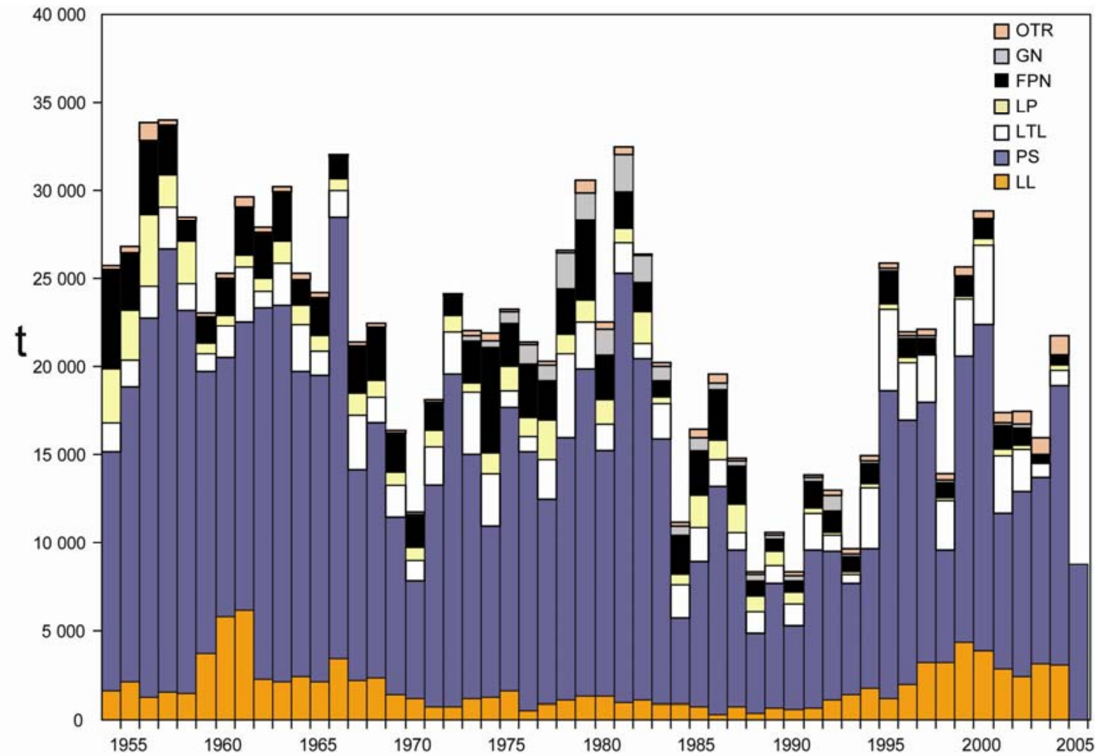


FIGURE E-1. Retained catches of Pacific bluefin, 1952-2004.
FIGURA E-1. Capturas retenidas de aleta azul del Pacífico, 1952-2004.

F. ALBACORE TUNA

There are two stocks of albacore in the Pacific, one occurring in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longliners in most of the North and South Pacific, but not often between about 10°N and 5°S, by trollers in the eastern and central North Pacific and the central South Pacific, and by pole-and-line vessels in the western North Pacific. In the North Pacific about 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 is taken by longline. The total annual catches of North Pacific albacore peaked in 1976 at about 125,000 t, and then declined. The catches increased during the 1990s, reaching 121,500 t in 1999 (Figure F-1a). The total annual catches of South Pacific albacore have ranged between about 25,000 and 55,000 t since 1980 (Figure F-1b).

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

The movements of North Pacific albacore are strongly influenced by oceanic conditions, and migrating albacore tend to concentrate along oceanic fronts in the North Pacific Transition Zone. Most of the catches are made in water temperatures between 15º and 19.5ºC. Details of the migration remain unclear, but juvenile fish (2- to 5-year-olds) are believed to move into the eastern Pacific 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 40ºN in the EPO, with the northern subgroup more likely to migrate to the western and central Pacific Ocean.

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

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

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

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

The 2005 meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North

Pacific Ocean (ISC) gave the following advice:

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

The IATTC staff considers the higher level for current fishing mortality (0.68) to be more likely, based on the methods used to calculate the estimates. Furthermore, even the high estimate may be too low, given the retrospective bias shown by the model. According to the 2004 North Pacific Albacore Workshop estimates, the higher fishing mortality of 0.68 implies an equilibrium spawning stock biomass at 17% of unfished levels. Projections assuming fishing mortality of 0.68, under low and high scenarios of future recruitment, suggest that the biomass may decline if the current levels of fishing mortality persist.

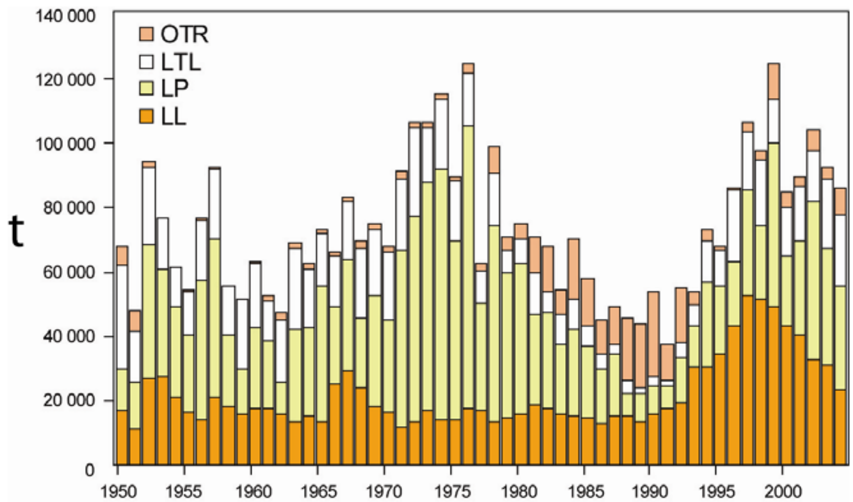


FIGURE F-1a. Retained catches of North Pacific albacore, 1950-2004.
FIGURA F-1a. Capturas retenidas de albacora del Pacífico norte, 1950-2004.

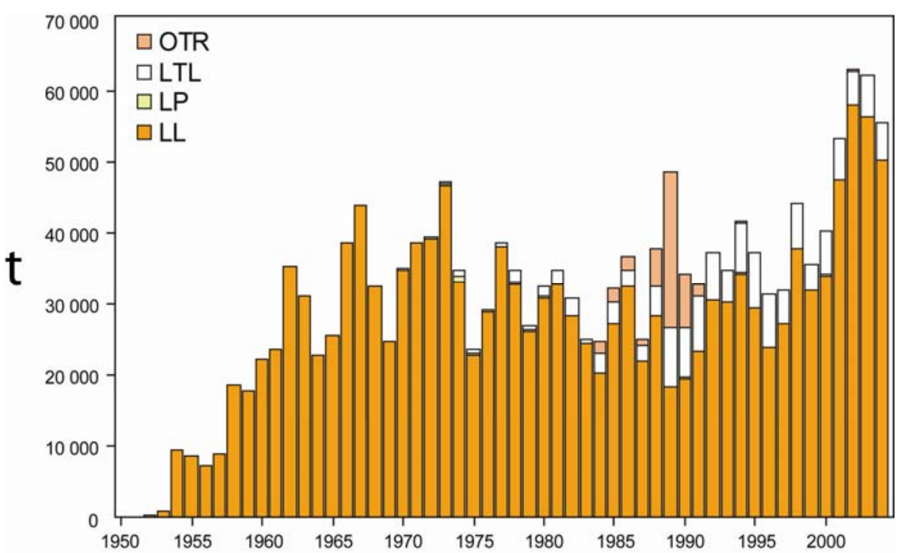


FIGURE F-1b. Retained catches of South Pacific albacore, 1950-2004.

FIGURA F-1b. Capturas retenidas de albacora del Pacífico sur, 1950-2004.

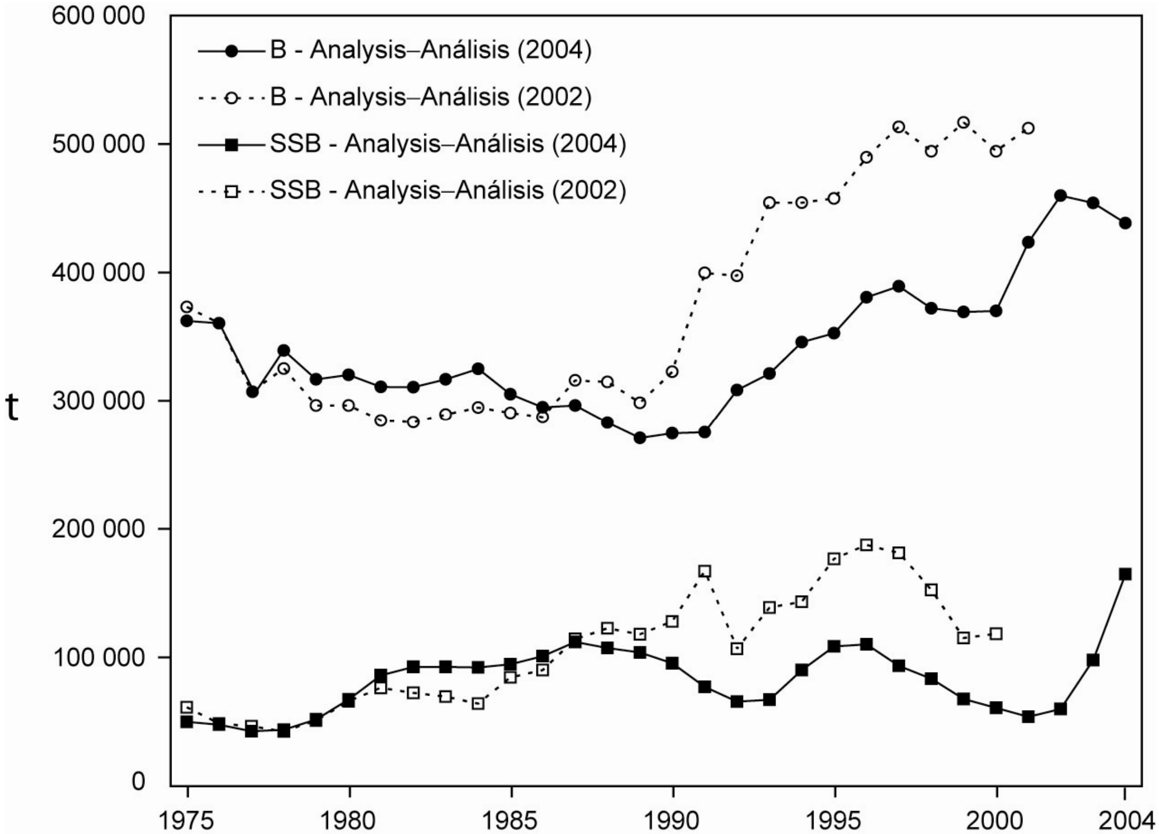


FIGURE F-2. Time series of total biomass (B), and spawning stock biomass (SSB) of North Pacific albacore tuna, in metric tons (t), from the North Pacific Albacore Workshop analyses of 2004 and 2002. The time series for B are based on estimates of January 1 biomass, and those for SSB on estimates at the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

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

G. SWORDFISH

Swordfish (*Xiphias gladius*) occur throughout the Pacific Ocean between about 50°N and 50°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are taken by gillnet and harpoon fisheries. They are seldom caught by recreational fishermen. During the most recent three-year period the greatest catches in the EPO have been taken by vessels of Spain, Chile, and Japan, which together harvest about 70% of the total swordfish catch taken in the region. Of these three, Spain and Chile have fisheries that target swordfish, while the swordfish taken in the Japanese fishery are incidental catches of a fishery that predominately targets 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.

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

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

It is considered, based on genetic and fisheries data, that there are two stocks of swordfish in the EPO, north and south of 3ºS. As well, 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 135°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.

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 average maximum sustainable yield (AMSY), 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 historically 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 using Stock Synthesis II (SS2), version 1.23b, with the following preliminary 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 strength is uncertain. The trend in spawning biomass ratio (SBR: the ratio of the spawning biomass of the current stock to that of the unfished stock) 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 in the mid-1960s and again in the mid-1990s.

The AMSY for the southern EPO swordfish stock is about 13,000–14,000 t, and the SBR at AMSY is about 0.26. The current spawning biomass is estimated to be well above the biomass that would provide the AMSY.

The average annual catch from the this stock during 1993–2000 was about 6,900 t (range ~ 4,800–8,600 t). Catches in recent years have been on the order of 12,000–13,000 t (Figure G-1), which is about the estimated AMSY 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 AMSY 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.

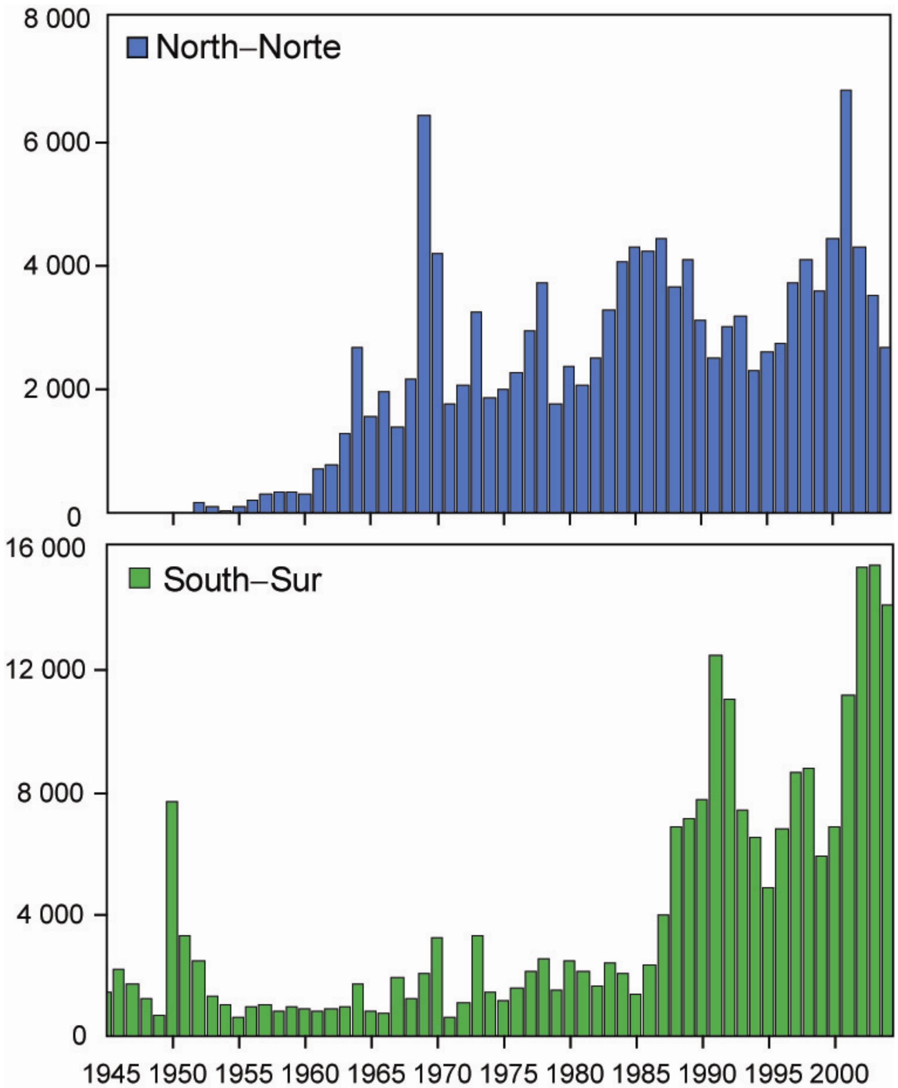


FIGURE G-1. Retained catch of swordfish in the eastern Pacific Ocean, 1945-2004, by stock (north and south).
FIGURA G-1. Captura retenida de pez espada en el Océano Pacífico oriental, 1945-2004, por población (norte y sur).

H. BLUE MARLIN

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

Blue marlin are taken by longline vessels of many nations that fish for tunas and billfishes between about 50°N and 50°S. Lesser amounts are taken by recreational fisheries and by various 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 acoustic tags and their activities monitored for short periods.

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

The Deriso-Schnute delay-difference population dynamics model, a form of production model, was used to assess the status of the blue marlin stock in the Pacific Ocean. Data for the estimated annual total retained catches for 1951-1997 and standardized 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 average maximum sustainable yield (AMSY).

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

The fisheries in the EPO have historically captured about 10 to 18% of the total harvest of blue marlin from the Pacific Ocean, with captures in the most recent 5-year period averaging about 3,000 t, or 14% of the total harvest.

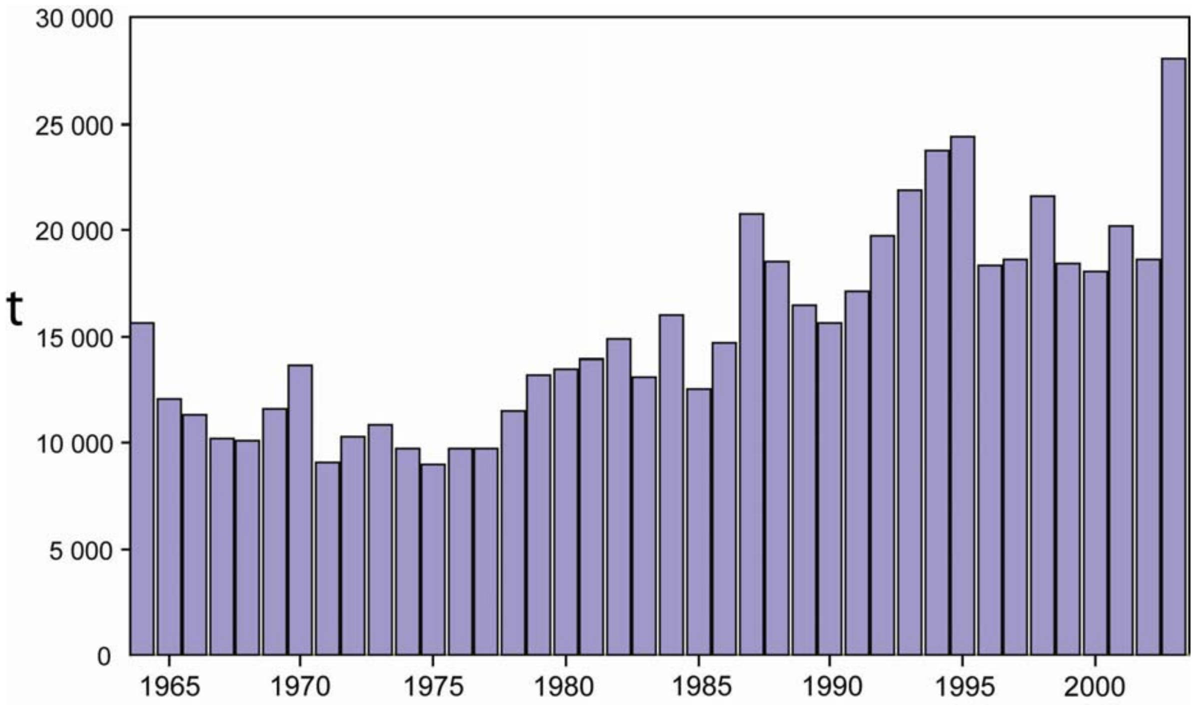


FIGURE H-1. Retained catches of blue marlin in the Pacific Ocean, 1964-2003.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, 1964-2003.

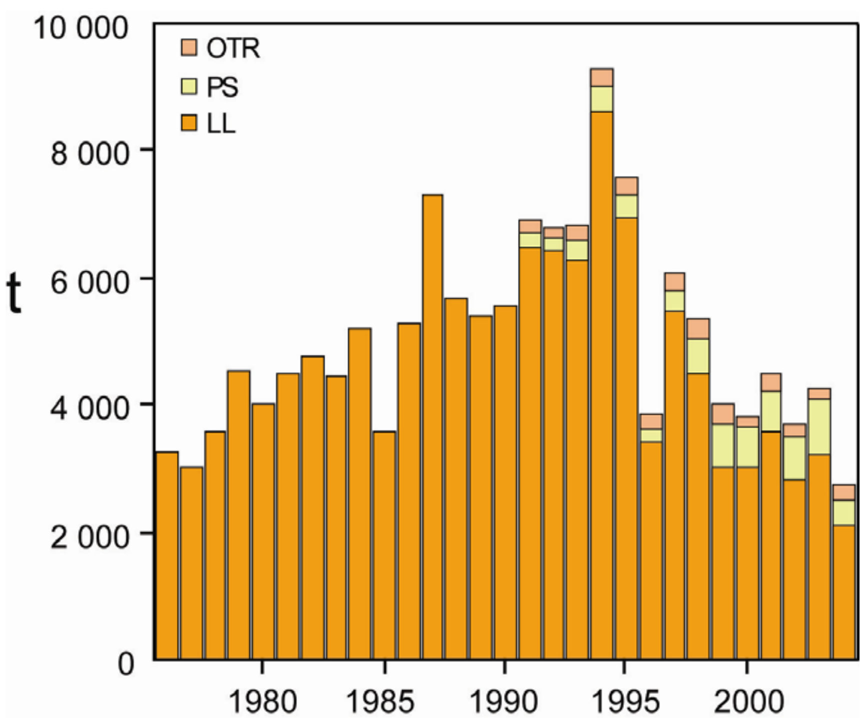


FIGURE H-2. Retained catches of blue marlin in the eastern Pacific Ocean, 1976-2004, by gear type.
FIGURA H-2. Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1976-2004, por arte de pesca.

I. STRIPED MARLIN

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

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

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

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

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

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

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

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

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

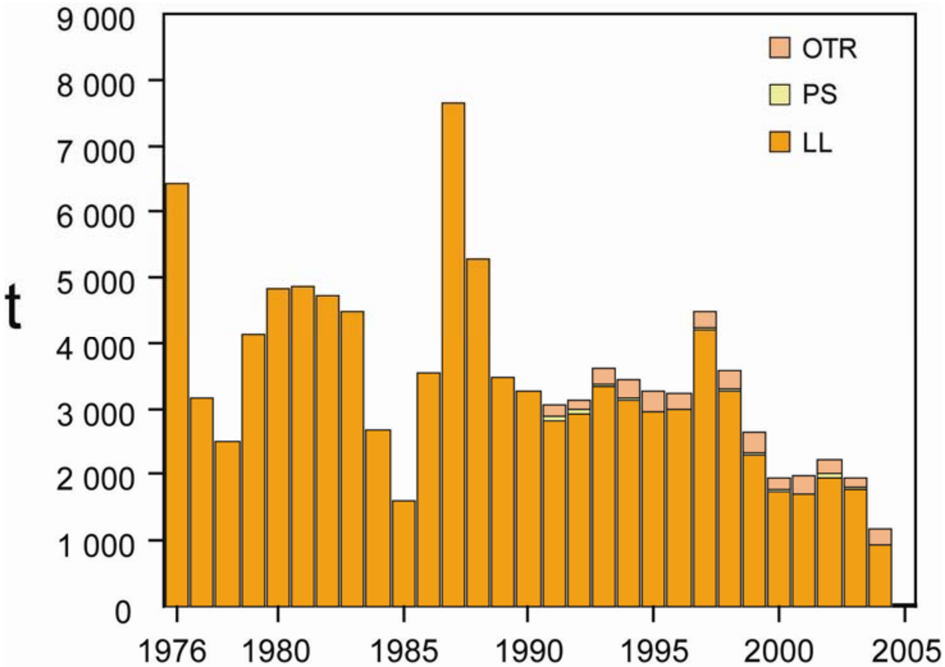


FIGURE I-1. Retained catches of striped marlin in the eastern Pacific Ocean, 1976-2004, by gear type.
FIGURA I-1. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1976-2004, por arte de pesca.

J. ECOSYSTEM CONSIDERATIONS

1. Introduction 87
2. Impact of catches 87
3. Other ecosystem components 93
4. Trophic interactions 94
5. Physical environment 95
6. Aggregate indicators 96
7. Ecosystem modeling 97
8. Actions by the IATTC and the AIDCP addressing ecosystem considerations 98
9. Future developments 100

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

This review does not suggest objectives for the incorporation of ecosystem considerations into the management of tuna or billfish fisheries, nor any new management measures. Rather, its prime purpose is to offer the Commission the opportunity to ensure that ecosystem considerations are 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 unexploited stock size, and, in any case, it would have varied from year to year. In addition, the unexploited stock size may be influenced by predator and prey abundance, which is not included in the single-species analyses.

2.2. Tunas

2.2.1. Yellowfin (*Thunnus albacares*)

Since 1984 the yellowfin stock has been close to or above the level corresponding to the average maximum sustainable yield. To meet this objective, the spawning stock size must be kept above 37% of its unexploited size with the current mix of fishing methods. One estimate of the effect of this reduced stock size is that the predation by yellowfin on other parts of the ecosystem is reduced to about 30% of what it was in the absence of a fishery.

2.2.2. Skipjack (*Katsuwonus pelamis*)

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

2.2.3. Bigeye (*Thunnus obesus*)

Up to 1993, bigeye tuna were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 28% 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 2004, after several years of poor recruitment and excessive levels of fishing mortality, the stock size was estimated to be at about 13% of its unexploited size. Due to recent spikes in recruitment, the current level has increased to 20%.

2.2.4. Pacific bluefin (*Thunnus orientalis*)

It is likely that there is a single stock of Pacific bluefin tuna in the Pacific Ocean, given that spawning is known to occur 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 Ocean 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. A strong recruitment event that may have occurred in 2001 would maintain spawning stock biomass above recent levels until 2010.

2.2.5. Albacore (*Thunnus alalunga*)

It is generally considered that there are two stocks of albacore in the Pacific Ocean, one in the North Pacific and the other in the South Pacific. An assessment for South Pacific albacore, done by the Secretariat of the Pacific Community in 2003, showed that the South Pacific stock was at about 60% of its unexploited size. An assessment by the 19th North Pacific Albacore Workshop in 2004 indicated the North Pacific stock to be at about 45% of its unexploited size.

2.3. Billfishes

2.3.1. Swordfish (*Xiphias gladius*)

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 indicate that the spawning biomass has declined significantly over the 1945-2003 period, and is now at about twice the level that will support the average maximum sustained yield (AMSY = 13,000–14,000 t). Catches have increased substantially since 2001. Recent harvests are on the order of 14,000–15,000 t annually.

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

2.3.2. Blue marlin (*Makaira nigricans*)

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

2.3.3. Striped marlin (*Tetrapturus audax*)

Preliminary genetics analyses suggest there are separate striped marlin stocks in the Pacific Ocean. Assessments for an EPO stock suggested that the current stock size is about 50 to 70% of the unexploited stock size. An analysis of the status of an hypothesized stock of striped marlin spanning the entire north Pacific was recently conducted; the results, although provisional, were consistent with the EPO stock assessment, though the north Pacific assumption suggested some decline in stock size.

2.3.4. Black marlin (*Makaira indica*), sailfish (*Istiophorus platypterus*), and shortbill spearfish (*Tetrapturus angustirostris*)

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

2.4. Summary

Preliminary estimates of the catches (including purse-seine discards), in metric tons, of tunas and billfishes in the EPO during 2005 are as follows.

	PS			LP	LL	OTR	Total
	OBJ	NOA	DEL				
Yellowfin tuna	30,326	74,302	166,630	2,067	128	1,555	275,007
Skipjack tuna	147,278	119,851	12,085	1,039	16	1,418	281,687
Bigeye tuna	70,787	1,399	3	0	32,082	0	104,270
Pacific bluefin	0	3,845	0	0	0	95	3,940
Albacore tuna	0	2	0	66	5,983	15,678	21,729
Swordfish	1	1	1	0	1,895	479	2,377
Blue marlin	392	15	15	0	1,092	805	2,316
Striped marlin	13	7	13	0	492	303	824
Black marlin	74	8	18	0	110	0	209
Sailfish	4	6	35	0	20	644	709
Shortbill spearfish	<1	<1	1	0	11	0	12

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 mortalities of dolphins in this operation were 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 2005 are as follows:

Species and stock	Incidental mortality	
	Number	tons
Offshore spotted dolphin		
Northeastern	274	18
Western-southern	99	6
Spinner dolphin		
Eastern	274	12
Whitebelly	115	7
Common dolphin		
Northern	114	8
Central	57	4
Southern	154	11
Other dolphins[1]	64	4
Total	**1,151**	**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 polyspecific 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 2003, scientists of the U.S. National Marine Fisheries Service (NMFS) conducted the latest in a series of research cruises under the *Stenella* Abundance Research Project (STAR). The primary objective of the multi-year study is to investigate trends in population size of the dolphins that have been taken as incidental catch by the purse-seine fishery in the EPO. During STAR 2003, data on cetacean distribution, herd size, and herd composition were collected to estimate dolphin abundance. Data from the large-scale line-transect survey produced preliminary abundance estimates for 10 dolphin species and/or stocks. The estimates for northeastern offshore spotted and eastern spinner dolphins for 2003 were somewhat greater than the estimates from the previous surveys in 1998-2000, and weighted linear regressions indicated a small positive trend in the abundance over the years 1979-2003, The estimates for western/southern offshore spotted, whitebelly spinner, striped (*S. coeruleoalba*), rough-toothed (*Steno bredanensis*), common, bottlenose (*Tursiops truncatus*), and Risso's (*Grampus griseus*) dolphins were generally similar to previous estimates using 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 upcoming 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

[1] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: striped dolphins, 15 (1 t); Central American spinner dolphin (*Stenella longirostris centroamericana*) 11 (0.5 t); bottlenose dolphin, 7 (0.7 t), Fraser's dolphin (*Lagenodelphis hosei*) 1 (0.1 t); unidentified dolphins, 30 (1.7 t).

whales (*Balaenoptera edeni*) also increased in estimated abundance, but there is very little diet overlap between these baleen whales and the upper-level predators impacted by the fisheries. Striped dolphins (*Stenella coeruleoalba*) showed no clear trend in estimated abundance over time, and the estimates of abundance of sperm whales (*Physeter macrocephalus*) tended to decrease in recent years.

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

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. The mortality rates due to longlining in the EPO are likely to be similar for other fleets targeting bigeye tuna, and possibly greater for those that set lines at shallower depths for albacore and swordfish. About 23 million of the 200 million hooks set each year in the EPO by distant-water longline vessels target swordfish with shallow longlines.

In addition, there is a sizeable fleet of locally-based longline vessels that fish for tunas and billfishes in the EPO. During 2005, the IATTC staff and some other organizations rendered advice and assistance to the governments of several Latin American nations bordering on the Pacific Ocean to reduce the mortality of sea turtles caused by the artisanal longline fishery for tunas and other species. 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 that location. The olive Ridley turtle is, by far, the species of sea turtle taken most often by purse seiners. It is followed by black or green sea turtles (*Chelonia agassizii*), 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 2005 were as follows:

	Set type		
	OBJ	**NOA**	**DEL**
Olive Ridley	4.8	6.3	3.8
Black or eastern Pacific green	1.4	0.0	0.0
Loggerhead	0.0	0.0	0.0
Hawksbill	0.0	0.0	0.0
Leatherback	0.0	0.0	0.0
Unidentified	2.0	7.4	1.8
Total	8.2	13.7	5.6

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

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

2.7. Sharks and other large fishes

Sharks and other large fishes are taken by both purse-seine and longline vessels. Silky sharks (*Carcharhinus falciformis*) are the most commonly-caught species of shark in the purse-seine fishery. 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 the purse-seine data, show a decreasing trend over the 1994-2004 period for each of the three types of purse-seine sets. It is not known whether this decreasing trend is due to incidental capture by the fisheries, changes in the environment (perhaps associated with the 1997-1998 El Niño event), or other processes. The trend does not appear to be due to changes in the density of floating objects.

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

Preliminary estimates of the discards (in metric tons) of sharks and other large fishes in the EPO during 2005, 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**
Dorado (*Coryphaena* spp.)	2,357	200	2
Wahoo (*Acanthocybium solandri)*	2,025	6	1
Rainbow runner (*Elagatis bipinnulata*) and yellowtail (*Seriola lalandi*)	190	7	<1
Sharks	522	75	85
Rays (Mobulidae and Dasyatidae)	10	108	84
Billfishes	479	44	81
Other large fishes	8	<1	<1

Apart from the assessments of billfishes, summarized in Sections G-I of this report, and blue shark there are no stock assessments available for these species in the EPO, and hence the 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, manta rays (Mobulidae), and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets and then floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch figures. The estimated numbers of purse-seine sets of each type in the EPO during 1987-2005 are shown in Table A-8.

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 flying squid (Ommastrephidae)). In addition to driving the prey to the surface, subsurface predators make prey available to the birds by injuring or disorienting the prey and by leaving scraps after feeding on large prey. Feeding opportunities for some seabird species are dependent on the presence of tuna schools feeding 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 U.S. 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 the 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. Data from the US pelagic longline fishery in the northeast Pacific Ocean indicate that bycatches of black-footed and Laysan albatross occur. Few comparable data for the longline fisheries in the central and southeast Pacific Ocean are available. In an externally-funded study, the IATTC staff is currently investigating the population status of the black-footed albatross in the entire north Pacific 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 U.S. NMFS have recorded data on the distributions and abundances of common prey groups, including lanternfishes (Myctophidae), flyingfishes, and some squids, in the tropical EPO during 1986-1990 and 1998-2000. Mean abundance estimates for all fish taxa, and to a lesser extent for squids, increased from 1986 through 1990. Estimates were low again for 1998, and then increased through 2000. Their interpretation of this pattern was that the El Niño events of 1986-1987 and 1997-1998 had negative effects on these prey populations. More data on these taxa were collected during the NMFS STAR 2003 cruises, and are currently being analyzed.

Some small fishes, many of which are forage for the larger predators, are incidentally caught by purse-seine vessels in the EPO. Frigate and bullet tunas (*Auxis* spp.), for example, are a common prey of many of the animals that occupy the upper trophic levels in the tropical EPO. In the tropical EPO ecosystem model (Section 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 2005 were as follows:

	Set type		
	OBJ	**NOA**	**DEL**
Triggerfishes (Balistidae) and filefishes (Monacanthidae)	150	1	<1
Other small fishes	38	2	<1
Frigate and bullet tunas (*Auxis* spp.)	1,699	276	6

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 Southwest Fisheries Science Center of the U.S. NMFS. Of the 314 taxonomic categories identified, 17 were found to be most likely to show the effects of environmental change. The occurrence, abundance, and distribution of these key taxa revealed no consistent temporal trends.

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

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

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. 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 item of yellowfin tuna caught by purse seines offshore are frigate and bullet tunas, squids and argonauts (cephalopods), and flyingfishes and other epipelagic fishes. Bigeye tuna feed at greater depths than do yellowfin and skipjack, and consume primarily cephalopods and mesopelagic fishes. The most important prey of skipjack overall were euphausiid crustaceans in a study during the late 1950s, whereas a 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 other species. In general, considerable resource partitioning is evident among the components of these communities, and scientists seek to understand the spatial scale of the observable trophic patterns, and the role of climate variability in influencing the patterns.

While diet studies have yielded many insights, stable isotope ratios of carbon and nitrogen provide an ideal complement to stomach contents for studying food webs. Stomach contents represent a relative snapshot of the most recent meal at the time of day an animal is captured, and under the conditions required for its capture. 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. Recent stable isotope studies place the average trophic position of yellowfin tuna in the EPO at 4.2-4.5, while previous diet analysis suggest it averages 4.6-4.7.

5. PHYSICAL ENVIRONMENT[2]

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 subtropical Pacific Ocean can have important effects on their distribution and abundance. Environmental conditions are thought to cause considerable variability in the recruitment of tunas and billfishes. Stock assessments by the IATTC have often included the assumption that oceanographic conditions might influence recruitment in the EPO.

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

The ocean environment varies on a variety of time scales, from seasonal to interannual, decadal, and longer (*e.g.* climate phases or regimes). The dominant source of variability in the upper layers of the EPO 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 intervals of about 2 to 7 years, and are characterized by weaker trade winds, deeper thermoclines, and abnormally-high SSTs in the equatorial EPO. El Niño's opposite phase, often called La Niña, is characterized by stronger trade winds, shallower thermoclines, and lower SSTs. Research has documented a connection between the ENSO and the rate of primary production, phytoplankton biomass, and phytoplankton species composition. Upwelling of nutrient-rich subsurface water is reduced during El Niño episodes, leading to a marked reduction in primary and secondary production. ENSO also directly affects animals at middle and upper trophic levels. Scientists 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,

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

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 meteorological and oceanographic data on a quarterly basis for the EPO, including a summary of current ENSO conditions. A weak El Niño event was in effect during the fourth quarter of 2004. The weak warm conditions, however, transitioned to neutral conditions during the first quarter of 2005, and continued neutral through the third quarter of 2005. Weak La Niña conditions developed during the fourth quarter of 2005.

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 scientists have reported another major shift in the North Pacific in 1989. Climate-induced variability in the ocean has often been described in terms of "regimes," characterized by relatively stable means and patterns in the physical and biological variables. Analyses by the IATTC staff have indicated that yellowfin tuna in the EPO have experienced a lower recruitment regime (1975-1983) and a higher recruitment regime (1984-present). The increased recruitment during the latter period is thought to be due to a shift to a higher productivity regime in the Pacific Ocean. Decadal fluctuations in upwelling and water transport are simultaneous to the higher-frequency ENSO pattern, and have basin-wide effects on the SSTs and thermocline slope that are similar to those caused by ENSO, but on longer time scales.

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 on marine ecosystems has stimulated considerable research in recent years. Numerous objectives have been proposed to evaluate fishery impacts on ecosystems and to define overfishing 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, catch trophic spectra, relative abundance of an indicator species or group, and numerous environmental indicators, have been proposed. Whereas there is general agreement that multiple system-level indicators should be used, there is concern over whether there is sufficient practical knowledge of the dynamics of such metrics and whether a theoretical basis for identifying precautionary or limit reference points based on ecosystem properties exists. Ecosystem-level metrics are not yet commonly used for managing fisheries.

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. Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms and to facilitate estimates of energy or mass flow through communities. A simplified food-web diagram, with approximate TLs, of the pelagic tropical EPO, is shown in Figure J-1. Toothed whales (Odontoceti, average TL 5.2), large squid predators (large bigeye tuna and swordfish, average TL 5.2) and sharks (average TL 5.0) are top-level predators. Other tunas, large piscivores, dolphins, and seabirds occupy slightly lower TLs. Smaller epipelagic fishes (*e.g. Auxis* spp. and flyingfishes), cephalopods, and mesopelagic fishes are the principal forage of many of the upper-level predators in the ecosystem. Small fishes and crustaceans prey on two zooplankton groups, and the herbivorous microzooplankton (TL 2) feed on the producers, phytoplankton and bacteria (TL 1).

In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as the ecosystem's apex predators. Over time, fishing can cause the overall size composition of the catch to decline, and, in general, the TLs of smaller organisms are lower than those of larger organisms. The mean TL of the organisms taken by a fishery is a potentially useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. There has been increasing attention to analyzing the mean TL of fisheries catches and discards since a study demonstrated that, according to FAO landings statistics, the mean TL of the fishes and invertebrates landed globally had declined between 1950 and 1994. 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 from 1993 to 2005 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The estimates were made by applying the TLs from the EPO ecosystem model (see Section 7), weighted by the catch data by fishery and year for all model groups from the IATTC tuna, bycatch, and discard data bases. The TLs of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year (Figure J-2: Average PS+LP). The TL of the floating-object sets varied more than those of the other fisheries, due to the interannual variability in the sizes of the tunas caught and the species compositions of the bycatches in those sets. No relationships between TL estimates and the frequency of different types of sets were observed.

The TLs were also estimated separately for the time series of retained and discarded catches by year for the purse-seine fishery from 1993 to 2005 (Figure J-3). The TLs of the retained catches were quite stable from year to year, while the TLs of the discarded catches varied considerably. The greatest variation occurred for sets on unassociated fish. The low TL of the discarded catches by sets on unassociated fish in 1998 was due to increased bycatches of rays, which feed on plankton and other small animals that occupy low TLs. From 1998 to 2001, the discarded catches of rays gradually declined and those of large sharks increased, resulting in a gradually increasing TL of the discarded catches over that interval. To a lesser degree, the average TLs of the discarded catches of sets on floating objects also increased from 1998 to 2001. That increase was due primarily to increasing bycatches of large wahoo and small dorado.

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 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 mortality of each stock of dolphins has 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. IATTC Resolution C-04-05, 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. In response to a request made by the Subsecretaría de Recursos Pesqueros of Ecuador, the IATTC began a program, supported by the World Wildlife Fund and the United States government, to mitigate the incidental capture of sea turtles, to reduce the mortality of sea turtles due to the coastal longline fisheries of North, Central, and South America, and to compare the catch rates of tunas, billfishes, and dorado using circle and J hooks of two sizes. Circle hooks do not hook as many turtles as the J hooks currently used in the longline fishery, and the chance of serious injury to the sea turtles that bite the hooks is reduced because they are wider and they tend to hook the lower jaw, rather than the more dangerous deep hookings in the esophagus and other areas, which are more common with the J hooks. Improved procedures and instruments to release hooked and entangled sea turtles have also been disseminated to the longline fleets of the region.

Observers have recorded data on almost 400 fishing trips of the vessels that are testing the different hooks. The program is actively running in, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Panama, and Peru, and plans are afoot in Nicaragua to initiate the program in 2006. Some activities are also being carried out in Mexico. 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 US agencies. Initial results show that, in the fisheries that target tunas, billfishes, and sharks (Figure J-4), 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. 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 (Figure J-4) 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 the countries participating in the program.

8.3. Other species

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

b. IATTC Resolution C-04-05 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.

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

d. A population model for black-footed albatross is being developed to assess whether past and present levels of bycatch are likely to affect significantly 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. 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 and topographic features, influences from the continent, *etc*., may generate heterogeneity that affects the distributions of the different species and their relative abundances in the catches. It would be desirable to increase our understanding of these ecological strata so that they can be used in our analyses.

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

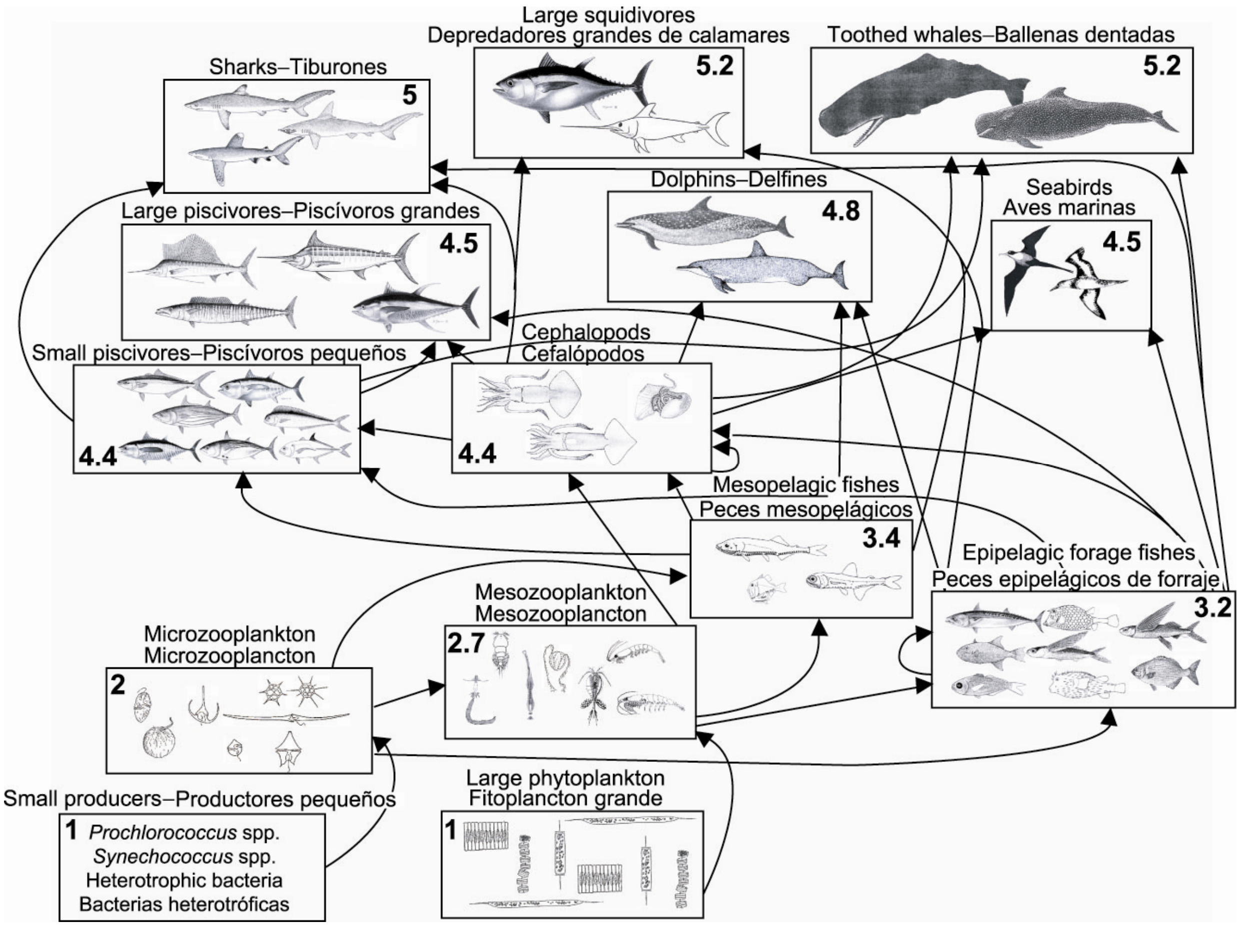


FIGURE J-1. Simplified food-web diagram of the pelagic ecosystem in the tropical eastern Pacific Ocean. The numbers inside the boxes indicate the approximate trophic levels of each group.
FIGURA J-1. Diagrama simplificado de la red trófica del ecosistema pelágico en el Océano Pacífico oriental tropical.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

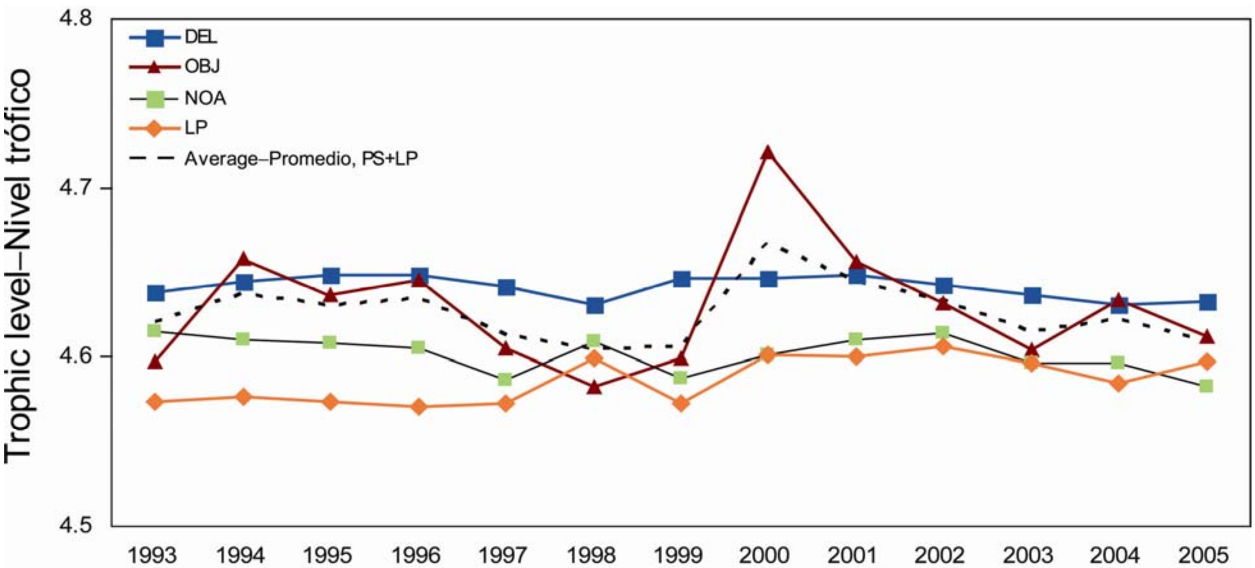


FIGURE J-2. Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine and pole-and-line fisheries in the tropical eastern Pacific Ocean, 1993-2004.
FIGURA J-2. Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de las pesquerías cerquera y cañera en el Océano Pacífico oriental tropical, 1993-2004.

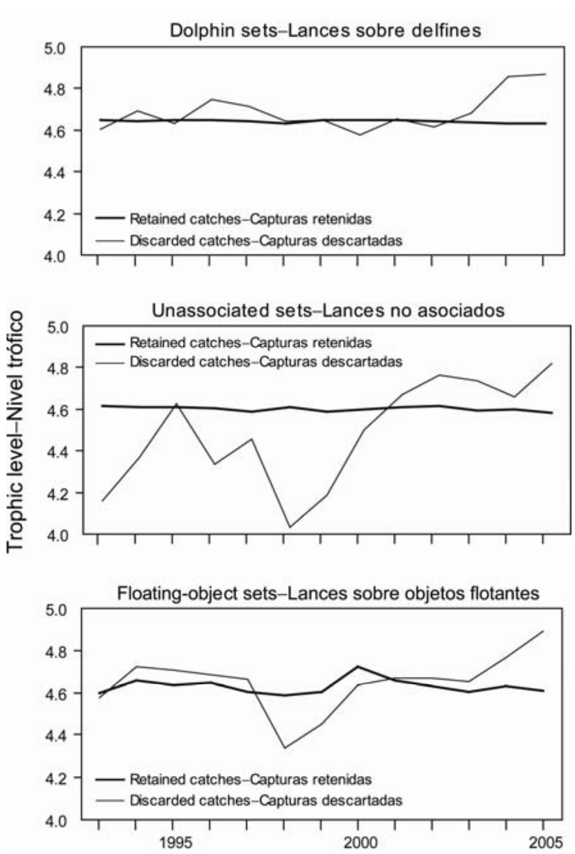


FIGURE J-3. Trophic level estimates of the retained catches and discarded catches by purse-seine fishing modes in the tropical eastern Pacific Ocean, 1993-2004.
FIGURA J-3. Estimaciones del nivel trófico de las capturas retenidas y descartadas por modalidad de pesca cerquera en el Océano Pacífico oriental tropical, 1993-2004.

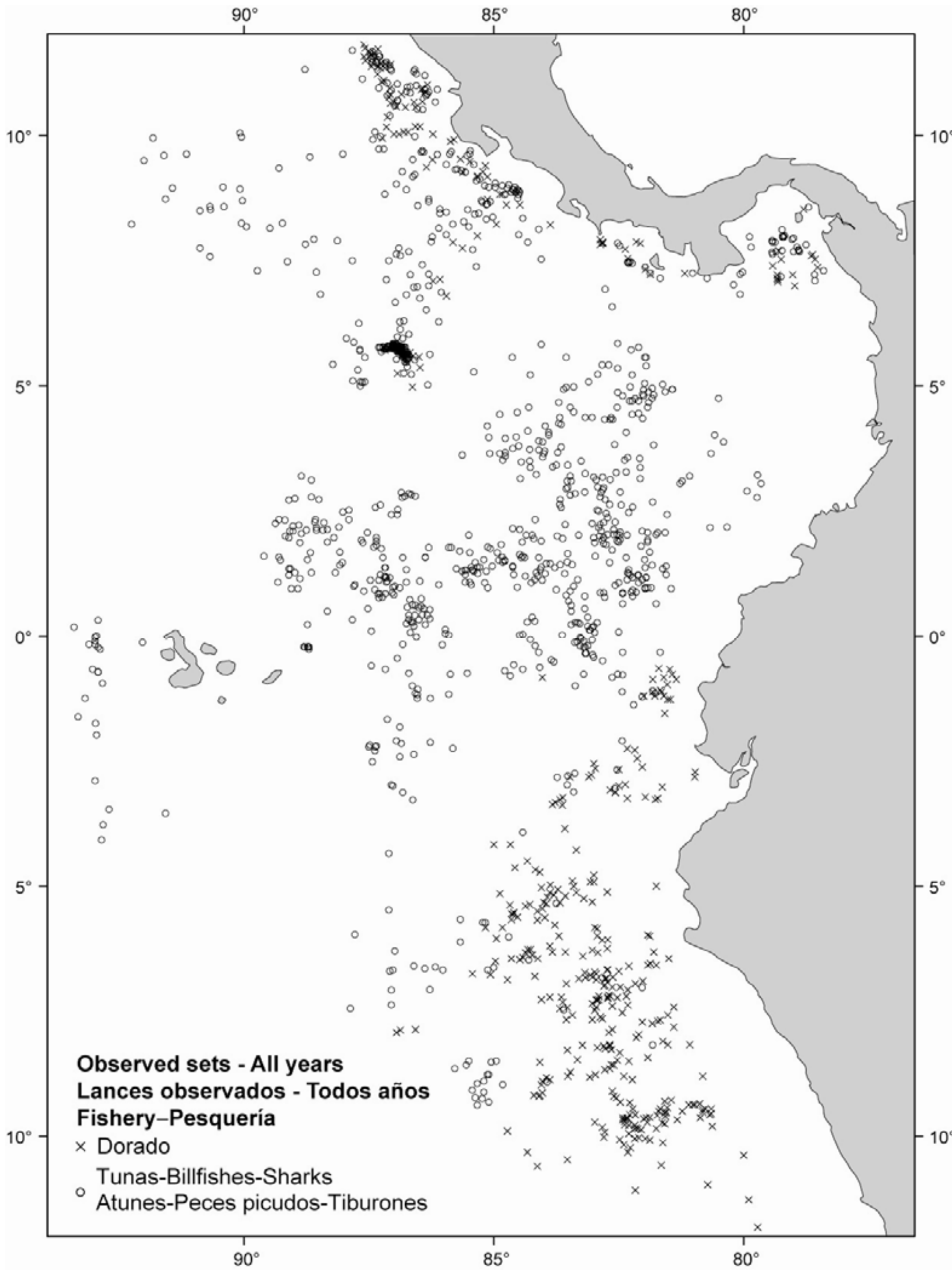


FIGURE J-4. Locations of longline sets by vessels from Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Panama and Peru (part), for which observers recorded data on the catches using different types of hooks.

FIGURA J-4. Posiciones de lances palangreros realizados por buques de Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Panamá y Perú (parte), para los cuales datos de las capturas con distintos tipos de anzuelo fueron registrados por observadores.