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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 May 2007. 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 4, published in 2006, except for updates of the figures.

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

Species:

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

[1] not elsewhere included

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

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

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

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

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

[2] Used to group known gear types

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

This section summarizes the fisheries for species covered by the IATTC Convention (tunas and other 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 (overall length >24 m) longline vessels of some nations that fish in the EPO and in other areas.

The data in this report are derived from various sources, including vessel logbooks, observer data, unloading records provided by canners and other processors, export and import records, 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 purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993, which allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the retained catch) are based principally on data from unloadings. Beginning with Fishery Status Report 3, which reports on the fishery in 2004, the unloading data for purse-seine and pole-and-line vessels have been adjusted, based on the species composition estimates for yellowfin, skipjack, and bigeye tunas. The current species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-2006 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 2000-2006 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 2006 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 2005 and 2006 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 1976-2006 are shown in Table A-2. The catches of tunas and bonitos by all gears during 2002-2006, 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 2005-2006 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 1998-2006. 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 1977-2006 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. The catch of yellowfin in the EPO, in 2002, 443 thousand t, was the greatest on record, but in 2004 and 2005 it decreased substantially, and the catch during 2006, 175 thousand t, was the lowest since 1984. In the WCPO, the catches of yellowfin reached 353 thousand t in 1990, peaked at 462 thousand t in 1998, and remained high through 2003; they fell to 367 thousand t in 2004, and in 2005 increased to 426 thousand t.

The annual retained catches of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1977-2006 are shown in Table A-2a. The average annual retained catch during 1991-2005 was 276 thousand t (range: 212 to 413 thousand t). The preliminary estimate of the retained catch in 2006, 167 thousand t, was 38% less than in 2005, and 39% less than the average for 1991-2005. 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 1977-2006 are shown in Table A-2a. During 1991-2005 they remained relatively stable, averaging about 21 thousand t (range: 10 to 31 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 1991-2005 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 1977-2006 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 1.5 million t, occurred in 2005, while the greatest reported catch in the EPO, 322 thousand t, occurred in 2006.

The annual retained catches of skipjack in the EPO by purse-seine and pole-and-line vessels during 1977-2006 are shown in Table A-2a. During 1991-2005 the annual retained catch averaged 157 thousand t (range 64 to 275 thousand t). The preliminary estimate of the retained catch in 2006, 309 thousand t, is 97% greater than the average for 1991-2005, and 12% greater than the previous 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 1977-2006 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 74 and 147 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 116 thousand t. Catches of bigeye in the WCPO increased significantly in 2004 and 2005, to 145 and 158 thousand t, respectively.

Prior to 1994, the average annual retained catch of bigeye taken by purse-seine vessels in the EPO was about 8 thousand t (range 1 to 22 thousand t) (Table A-2a). Following the development of fish-aggregating devices (FADs), placed in the water by fishermen to aggregate tunas, the annual retained catches of bigeye increased from 35 thousand t in 1994 between 44 and 94 thousand t during 1995-2000. A preliminary estimate of the retained catch in the EPO in 2006 is 71 thousand t. The average amount of bigeye discarded at sea during 1993-2005 was about 5% of the purse-seine catch of the species (range: 2 to 9%). Small amounts of bigeye have been caught by pole-and-line vessels, as shown in Table A-2a.

During 1977-1993, prior to the increased use of FADs and the resulting greater catches of bigeye by purse-seine vessels, the longline catches of bigeye in the EPO ranged from 46 to 104 thousand t (average: 74 thousand t) about 88%, on average, of the retained catches of this species from the EPO. During 1994-2005 the annual retained catches of bigeye by the longline fisheries ranged from about 36 to 74 thousand t (average: 54 thousand t), or an average of 46% of the total catch of bigeye in the EPO (Table A-2a). The preliminary estimate of the longline catch in the EPO in 2006 is 30 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 1977-2006, by gear, are shown in Table A-2. During 1991-2005 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 2006, 10 thousand t, is 7 thousand t greater than the average for 1991-2005. 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 1977-2006 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 6 thousand t in 2006, which is greater than the 1991-2005 annual average retained catch of about 2 thousand t (range: 500 t to 9 thousand t).

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

1.1.7. Billfishes

Catch data for billfishes (swordfish, blue marlin, black marlin, striped marlin, shortbill spearfish, and sailfish) are shown in Table A-2b 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 1991-2005 was 13 thousand t, but during 2001-2005 was about 17 thousand t. It is not clear whether this is due to increased abundance of swordfish or increased effort directed toward that species.

Other billfishes are caught with large-scale and artisanal longline gear and recreational gear. The average annual longline catches of blue marlin and striped marlin during 1991-2005 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 1996-2005, are shown in Figures A-1a, A-2a, and A-3a, and preliminary estimates for 2006 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 2006, as was the case in 2004 and 2005. Yellowfin catches off South America were also lower than the 1996-2005 average. Skipjack catches in 2006 were significantly greater than those of 1996-2005. Significant catches of skipjack were made throughout the year from about 5°N to 15°S. As was the case in 2004, and 2005, the catches of skipjack in the inshore areas off Mexico were greater, possibly due to changes in fishing strategy due to poor yellowfin fishing. Bigeye are not often caught north of about 7°N. The catches of bigeye have decreased in the Inshore areas off South America for several years. With the development of the fishery for tunas associated with FADs, the relative importance of the inshore areas has decreased, while that of the offshore areas has increased. Most of the bigeye catches are taken on FADs between 5°N and 5°S.

1.2.2. Longline catches

Data on the spatial and temporal distributions of the catches in the EPO by the distant-water longline fleets of China, Chinese Taipei, French Polynesia, Japan, the Republic of Korea, Spain, the United States, and Vanuatu are maintained in databases of the IATTC. Bigeye and yellowfin tunas make up the majority of the catches by most of these vessels. The distributions of the catches of bigeye and yellowfin tunas in the Pacific Ocean by 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 Reports 2 and 4. Briefly, the fish in a well of a purse-seine or pole-and-line vessel are selected for sampling only if all the fish in the well were caught during the same calendar month, in the same type of set (floating-object, unassociated school, or dolphin), and in the same sampling area. These data are then categorized by fishery (Figure A-5), based on the staff's most recent stock assessments.

Data for fish caught during the 2001-2006 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 2006, and the second shows the combined data for each year of the 2001–2006 period. For bluefin, the histograms show the 2001-2006 catches by commercial and recreational gear combined. For black skipjack, the histograms show the 2001-2006 catches by commercial gear. Only a small amount of catch was taken by pole-and-line vessels in 2006, and no samples were obtained from these vessels.

For stock assessments of yellowfin, nine purse-seine fisheries (four associated with floating objects, three associated with dolphins, and two unassociated) and one pole-and-line fishery are defined (Figure A-5). The last fishery includes all 13 sampling areas. Of the 1,053 wells sampled, 739 contained yellowfin. The estimated size compositions of the fish caught during 2006 are shown in Figure A-6a. The majority of the yellowfin catch was taken in sets associated with dolphins and in unassociated sets Most of the larger yellowfin (>100 cm) were caught during the third and fourth quarters in the Northern and Inshore dolphin fisheries, and during the first quarter in the Southern dolphin fishery. Larger fish were also caught in the Southern unassociated fishery, mostly during the fourth quarter. A small amount of large yellowfin was taken in the Southern floating-object fishery during the third quarter. A mode of smaller yellowfin (50 cm) was evident in all the floating-object fisheries during the year, and in the unassociated fishery in the South during the first and second quarters. 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 2001-2006 are shown in Figure A-6b. The average weights of the yellowfin caught in 2006 were significantly lower than those of the previous five years shown in the figure.

For stock assessments of skipjack, seven purse-seine fisheries (four associated with floating objects, two unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last two fisheries include all 13 sampling areas. Of the 1,053 wells sampled, 877 contained skipjack. The estimated size compositions of the fish caught during 2006 are shown in Figure A-7a. Large amounts of skipjack in the 40- to 50-cm size range were caught in all of the floating-object fisheries and in the Southern unassociated fishery during the first, second, and third quarters of 2006. Larger skipjack in the 60- to 70-cm size range were caught primarily during the third and fourth quarters in the North and Equatorial floating-object fisheries and in the Southern unassociated fishery. Lesser amounts of the larger skipjack were taken in the floating-object fishery during the first and second quarters and in the dolphin fishery throughout the year Negligible amounts of skipjack were caught by pole-and-line vessels.

The estimated size compositions of the skipjack caught by all fisheries combined during 2001-2006 are shown in Figure A-7b. The average weights of skipjack are considerably less than those of the previous five years.

For stock assessments of bigeye, six purse-seine fisheries (four associated with floating objects, one unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last three fisheries include all 13 sampling areas. Of the 1,053 wells sampled, 338 contained bigeye. The estimated size compositions of the fish caught during 2006 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 2006, as in 2004 and 2005, nearly equal amounts of bigeye were taken in the Northern, Equatorial, and Southern floating-object fisheries. Small amounts of bigeye were caught in unassociated sets, 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 2001-2006 are shown in Figure A-8b. The average weight of the fish was greatest in 2000, when the greatest catch of bigeye was taken. From 2002 to 2005 the average weights of bigeye were fairly constant, but in 2006 it was considerably less. The smaller bigeye (40-60 cm) were caught in floating-object sets throughout the year, while most of the larger fish (>80 cm) were caught in floating-object sets during the first, second and fourth quarters in the Equatorial area, and during most of the year in the Southern area.

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 2006 bluefin were caught between 26°N and 31°N from March through August. The majority of the catches of bluefin by both commercial and recreational vessels were taken during June, July, and August. In the past, commercial and recreational catches have been reported separately. In 2004, 2005, and 2006 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 2001-2006 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. Fourteen samples of black skipjack were taken in 2006; 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 2002-2006, 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 2005 and 2006, 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 2005 and 2006 (Tables A-4a-b, lower panels) indicate that, of the 569 thousand t of tunas and bonitos landed in 2006, 59% was landed in Ecuador and 18% in Mexico. Other countries with significant landings of tunas and bonitos caught in the EPO included Colombia and Venezuela (5% each). It is important to note that, when final information is available, the landings currently assigned to various countries may change due to exports from storage facilities to processors in other nations.

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

The total retained catch per cubic meter of well volume (C/m^3) for the purse-seine vessels that fish for tunas in the EPO are presented in Table A-7 for the EPO, by vessel size group and species, for 2001-2006. To provide more detail in this index, 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.

2. EFFORT

2.1. Purse seine

Estimates of the numbers of purse-seine sets of each type (associated with dolphins, associated with floating objects, and unassociated) in the EPO during the 1989-2006 period, and the retained catches of these sets, are shown in Table A-8 and in Figure 1. The estimates for vessels ≤363 t carrying capacity were calculated from logbook data in the IATTC statistical data base, and those for vessels >363 t carrying capacity were calculated from the observer data bases of the IATTC, Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, the United States, and Venezuela. The greatest numbers of sets associated with floating objects and unassociated sets were made from the mid-1970s to the early 1980s. Despite opposition to fishing for tunas associated with dolphins and the refusal of U.S. canners to accept tunas caught during trips during which sets were made on dolphin-associated fish, the numbers of sets associated with dolphins decreased only moderately during the mid-1990s, and in 2003 were the greatest recorded.

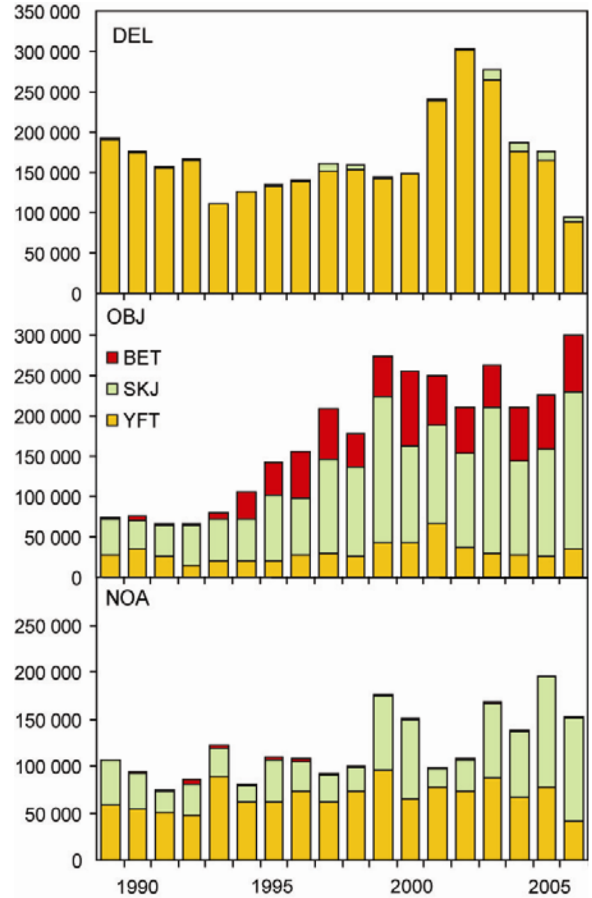

Figure 1. Purse-seine catches of tunas, by species and set type, 1989-2006

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 nominal fishing effort (in thousands of hooks) by longline vessels in the EPO, and their catches of the predominant tuna species, are shown in Table A-10.

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.

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.

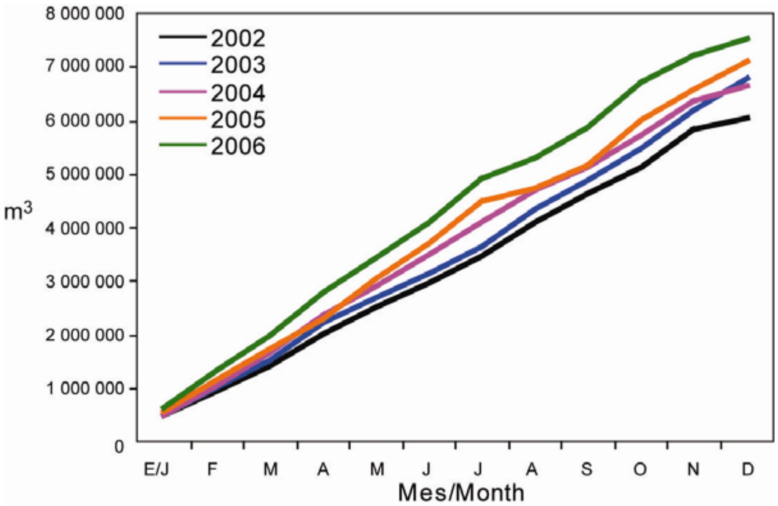

Figure 2. Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2002-2006

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 2006 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 225, and their total well volume from about 32 thousand to about 225 thousand m^3, an average of about 1,000 m^3 per vessel. An earlier peak in numbers and total well volume of purse seiners occurred from the mid-1970s to the early 1980s, when the number of vessels reached 282 and the total well volume about 195 thousand m^3, an average of about 691 m^3 per vessel (Table A-11; Figure 2).

The catch rates in the EPO were low during 1978-1981, due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume of purse-seine and pole-and-line vessels then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 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 2006 was 226 thousand m^3.

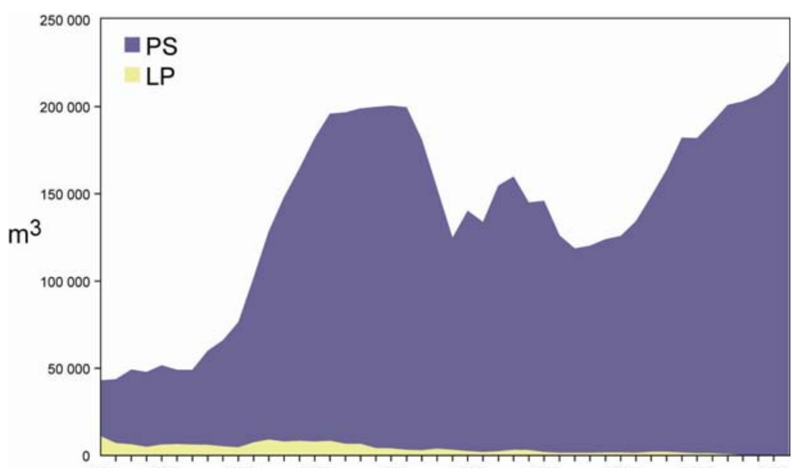

Figure 3. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2006

The 2005 and preliminary 2006 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 2006. The Ecuadorian fleet had about 26% and the Mexican fleet had about 25% of the total well volume during 2006, Panama about 15%, Venezuela about

14%, Colombia about 6%, Nicaragua and El Salvador about 4% each, and Spain about 3%.

The cumulative capacity at sea during 2006 is compared to those of the previous four years in Figure 3.

The monthly average, minimum, and maximum total well volumes at sea (VAS), in thousands of cubic meters, of purse-seine and pole-and-line vessels that fished for tunas in the EPO during 1996-2005, and the 2006 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 1998-2006, so the VAS values for September-December 2006 are not comparable to the average VAS values for those months of 1995-2005. The average VAS values for 1996-2005 and 2006 were 109 thousand m^3 (60% of total capacity) and 146 thousand m^3 (64% of total capacity), respectively.

3.2. Other fleets of the EPO

Information on other types of vessels that fish for tunas in the EPO is available on the IATTC's Regional Vessel Register, on the IATTC web site. The Register is incomplete for small vessels. In some cases, particularly for large longline vessels, the Register contains information for vessels authorized to fish not only in the EPO, but also in other oceans, and which may not have fished in the EPO during 2006, or ever.

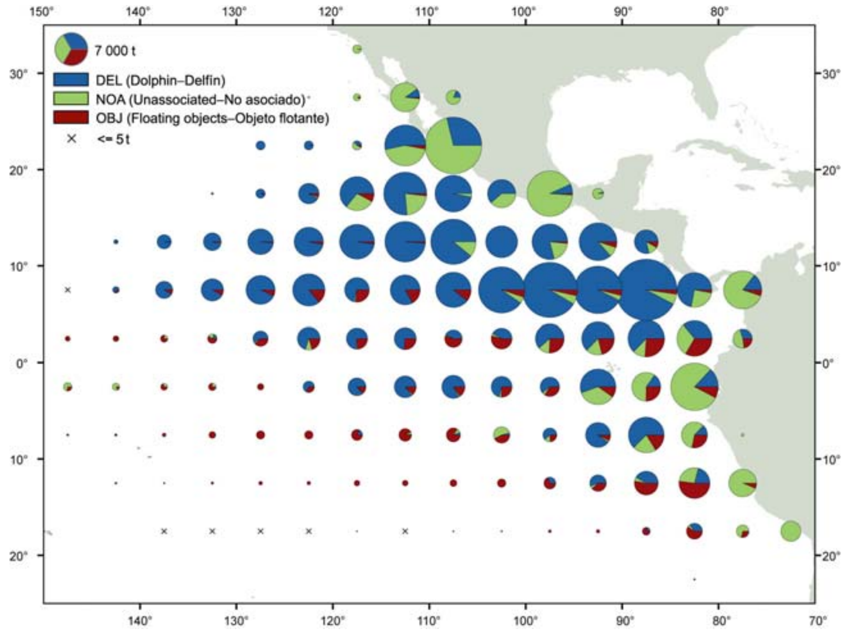

FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 1996-2005. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 1996-2005. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

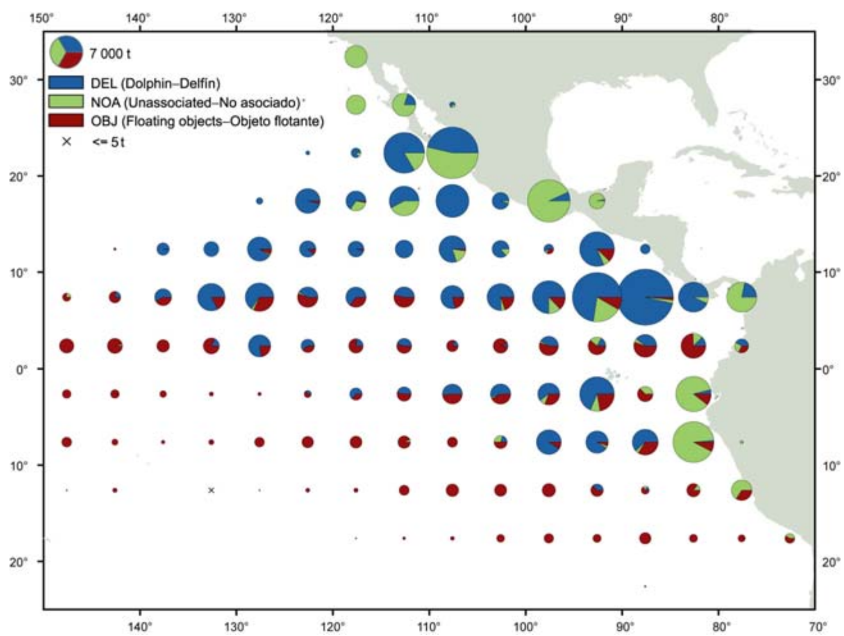

FIGURE A-1b. Annual distributions of the purse-seine catches of yellowfin, by set type, 2006. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2006. El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

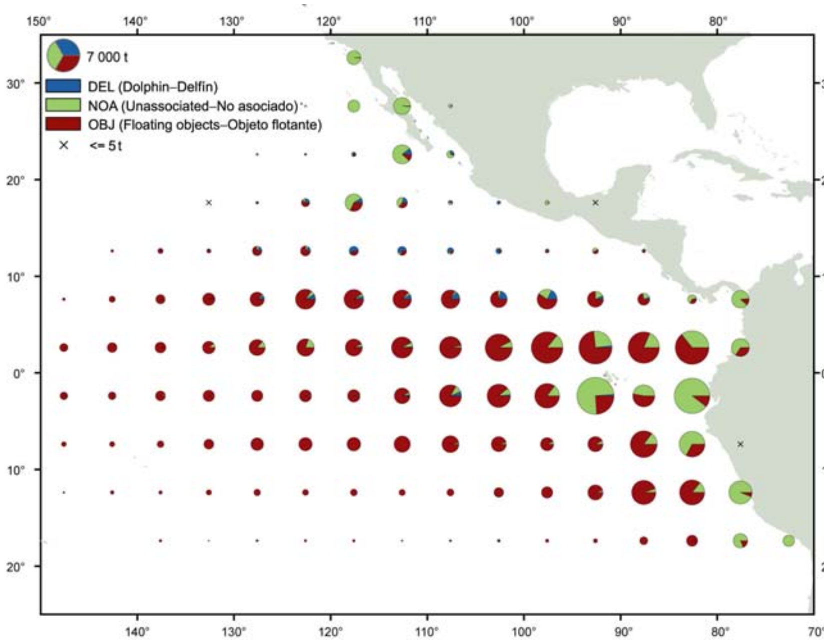

FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 1996-2005. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 1996-2005. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

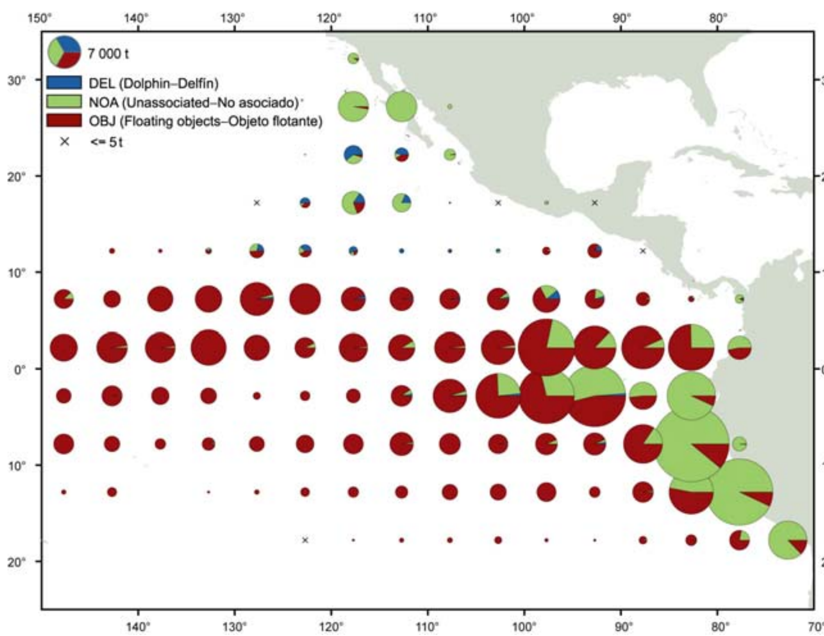

FIGURE A-2b. Annual distributions of the purse-seine catches of skipjack, by set type, 2006. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2b. Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2006. El tamaño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

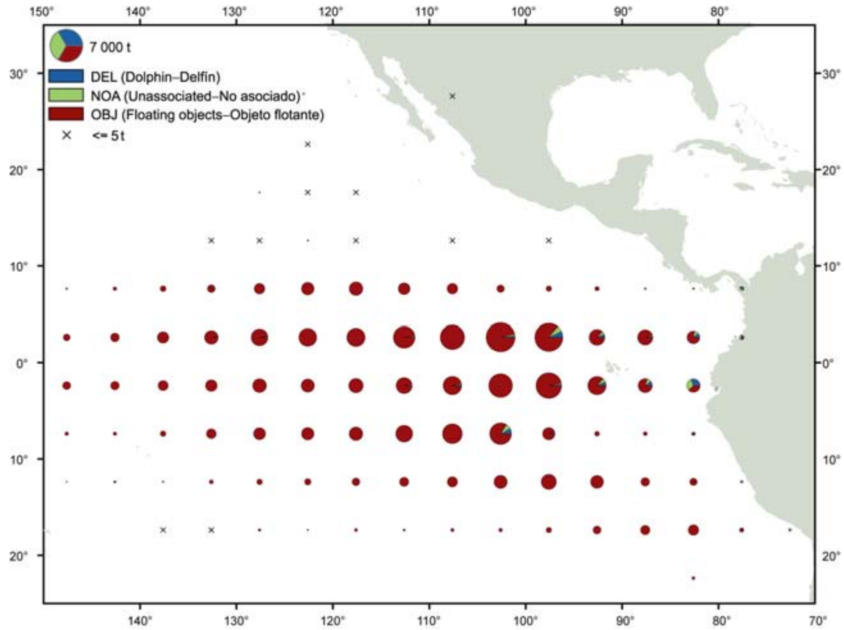

FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 1996-2005. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.

FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 1996-2005. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

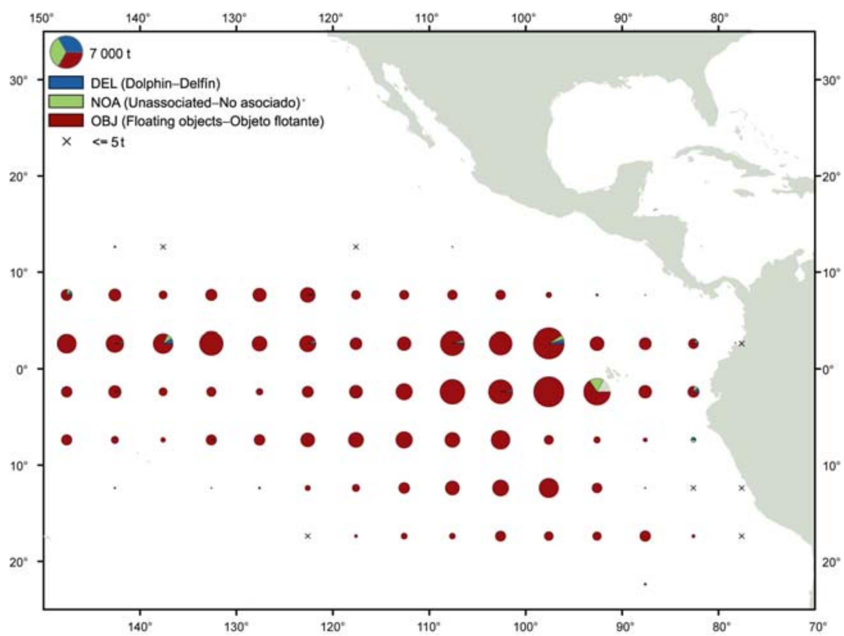

FIGURE A-3b. Annual distributions of the purse-seine catches of bigeye, by set type, 2006. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.

FIGURA A-3b. Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2006. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

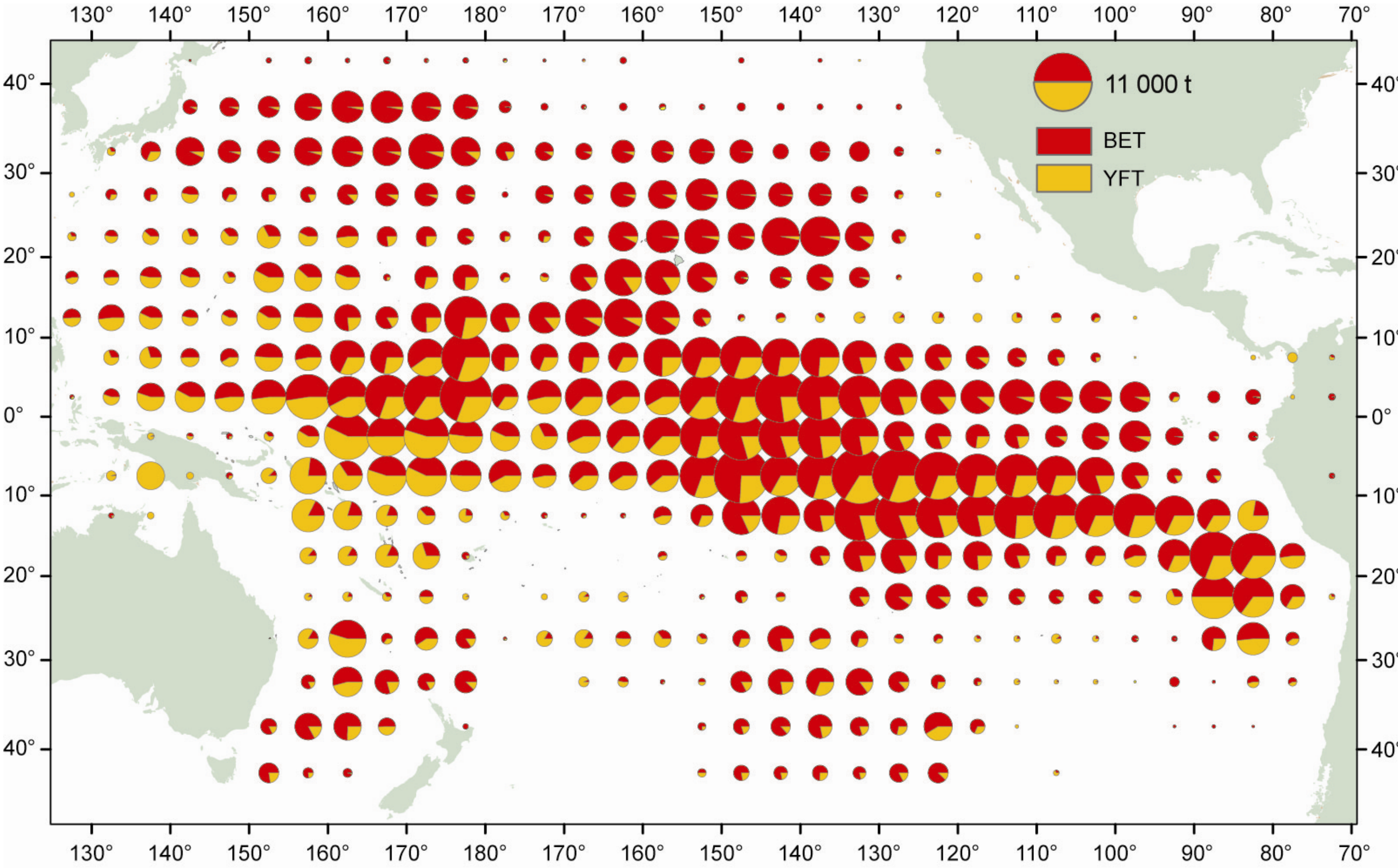

FIGURE A-4. Distributions of the catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by longline fleets, 2000-2004. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.

FIGURA A-4. Distribución de las capturas de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por las flotas palangreras, 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.

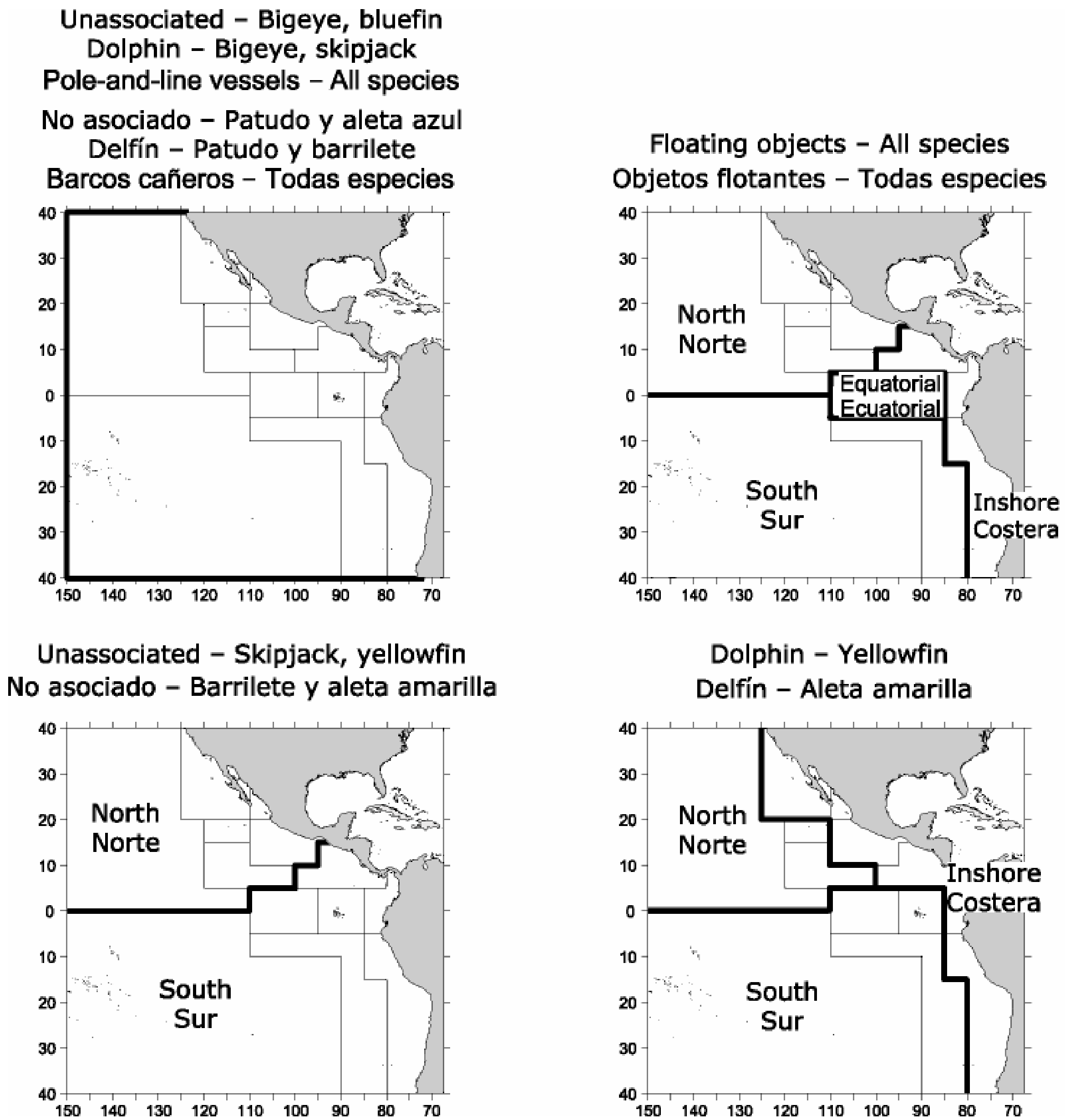

FIGURE A-5. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

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.

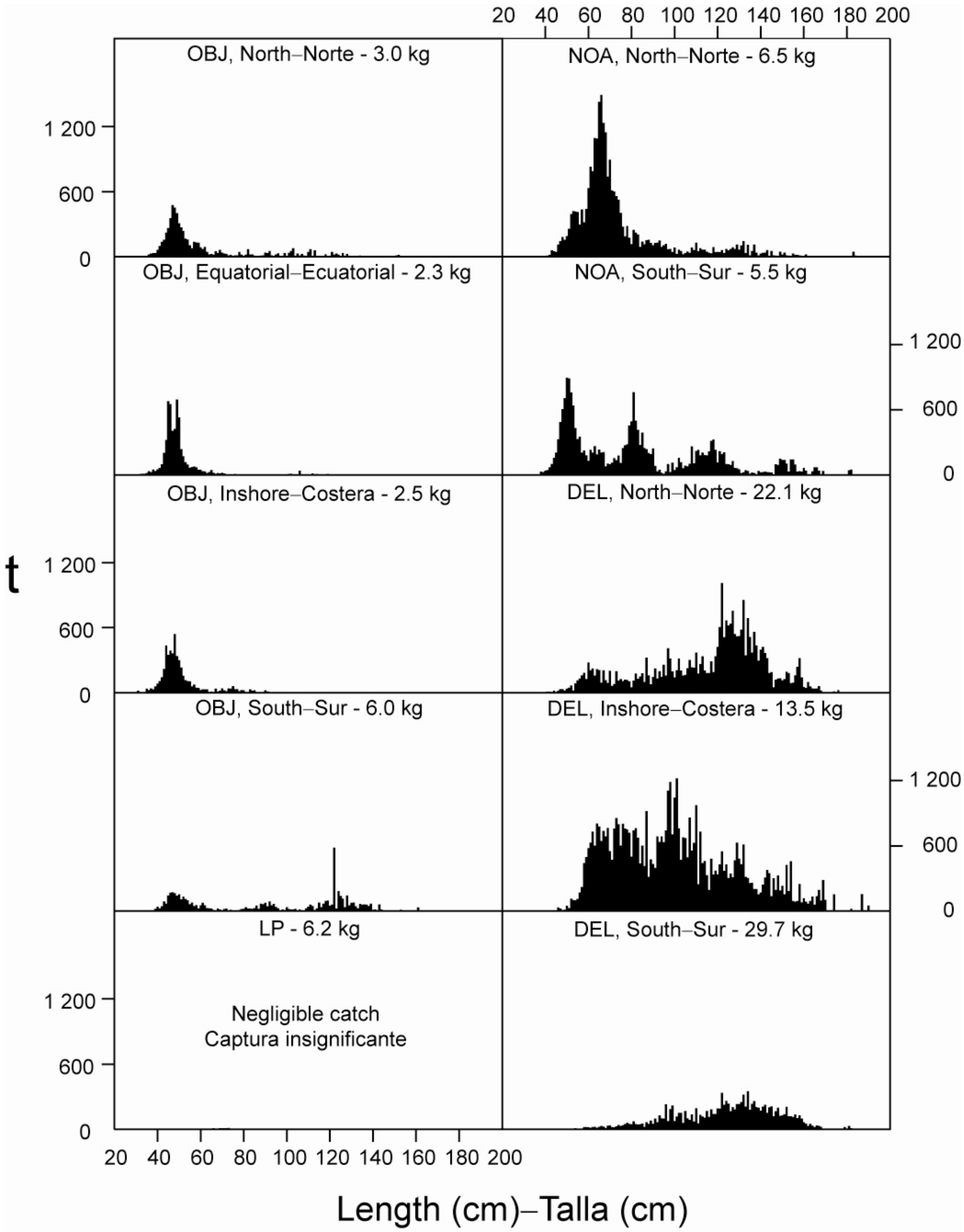

FIGURE A-6a. Estimated size compositions of the yellowfin caught in the EPO during 2006 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2006 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

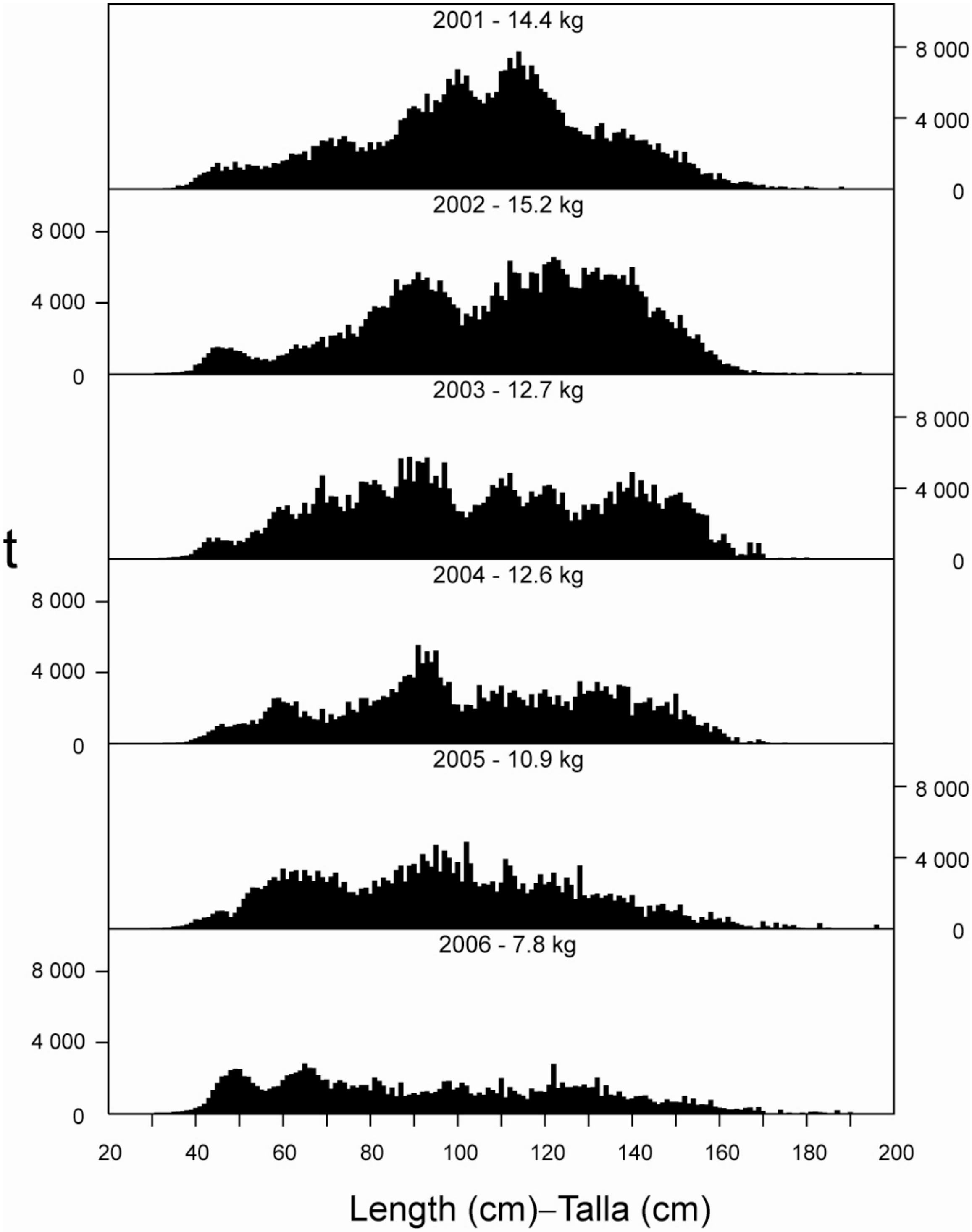

FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2001-2006. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2001-2006. En cada recuadro se detalla el peso promedio de los peces en las muestras.

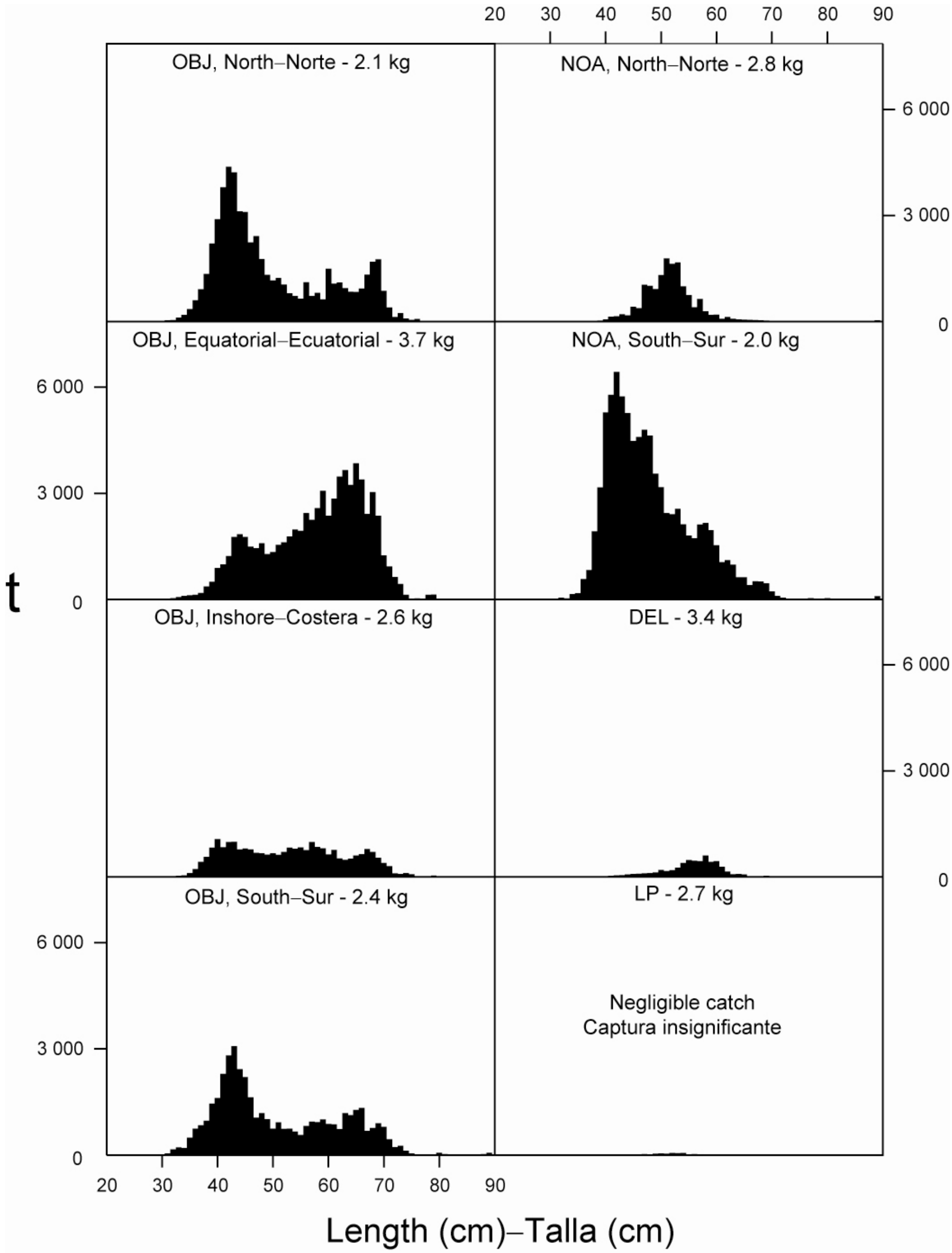

FIGURE A-7a. Estimated size compositions of the skipjack caught in the EPO during 2006 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7a. Composición por tallas estimada del barrilete capturado en el OPO durante 2006 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

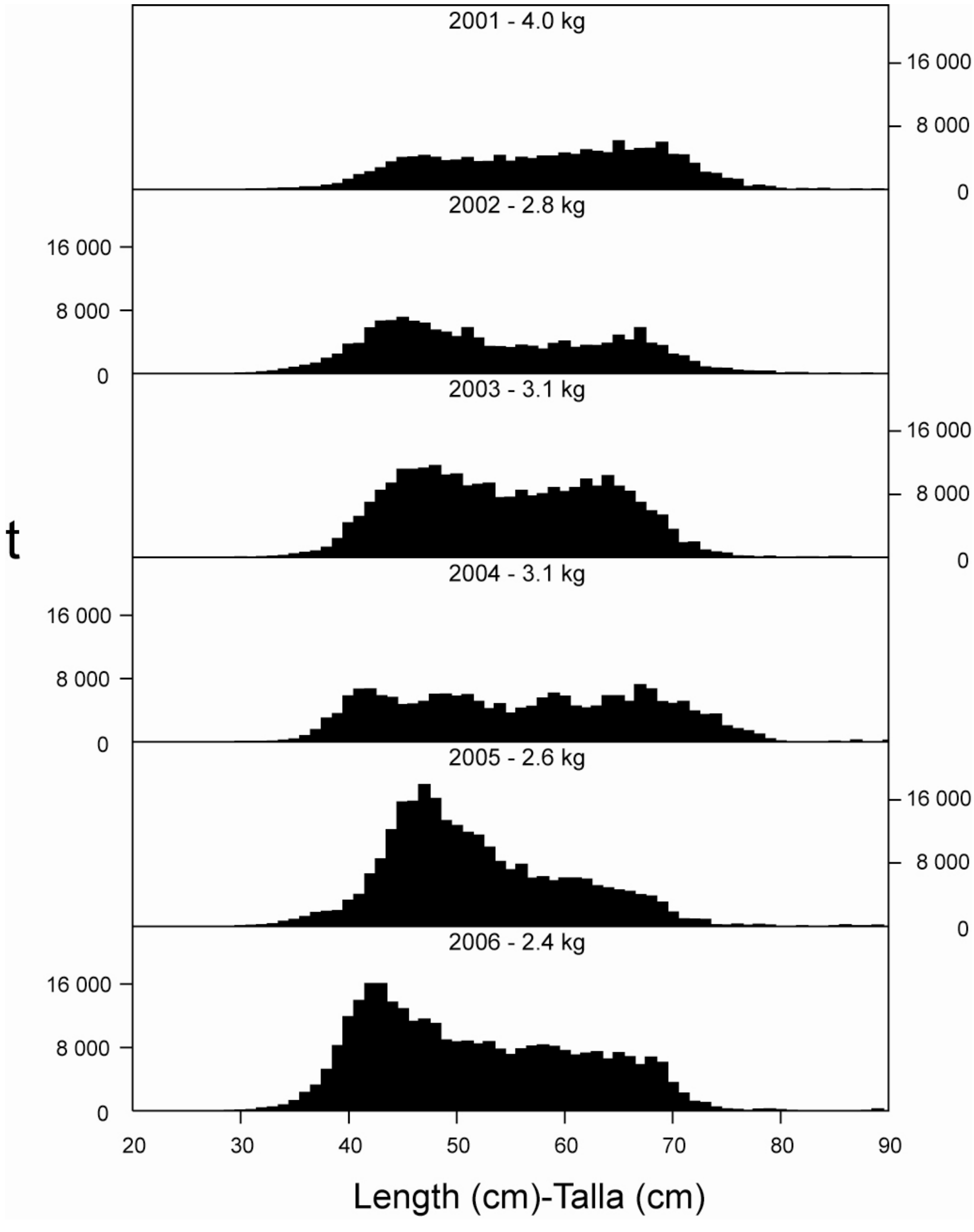

FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2001-2006. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2001-2006. En cada recuadro se detalla el peso promedio de los peces en las muestras.

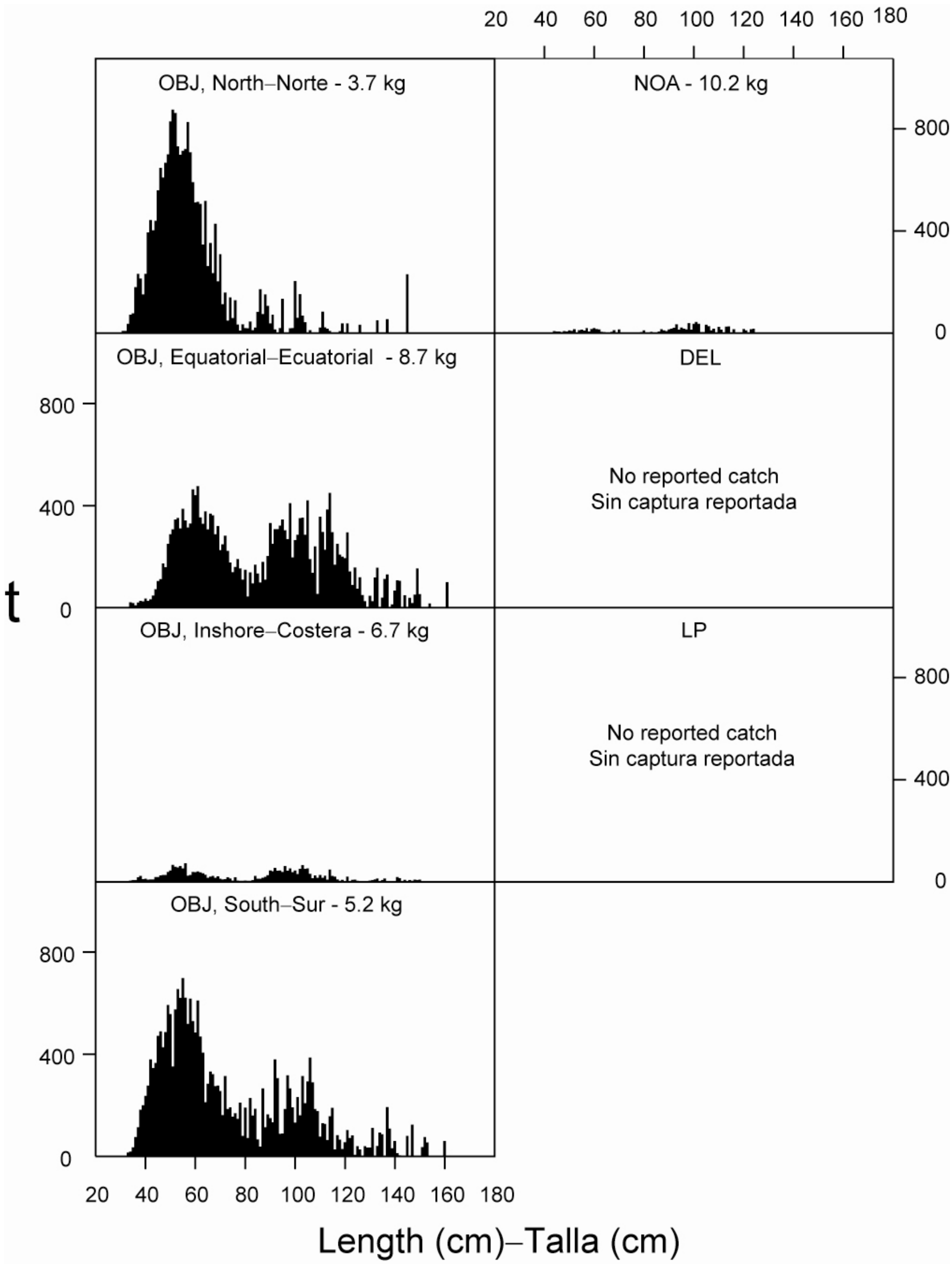

FIGURE A-8a. Estimated size compositions of the bigeye caught in the EPO during 2006 for each fishery designated in Figure A-5. The average weights of the fish in the samples are given at the tops of the panels.

FIGURA A-8a. Composición por tallas estimada del patudo capturado e en el OPO durante 2006 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

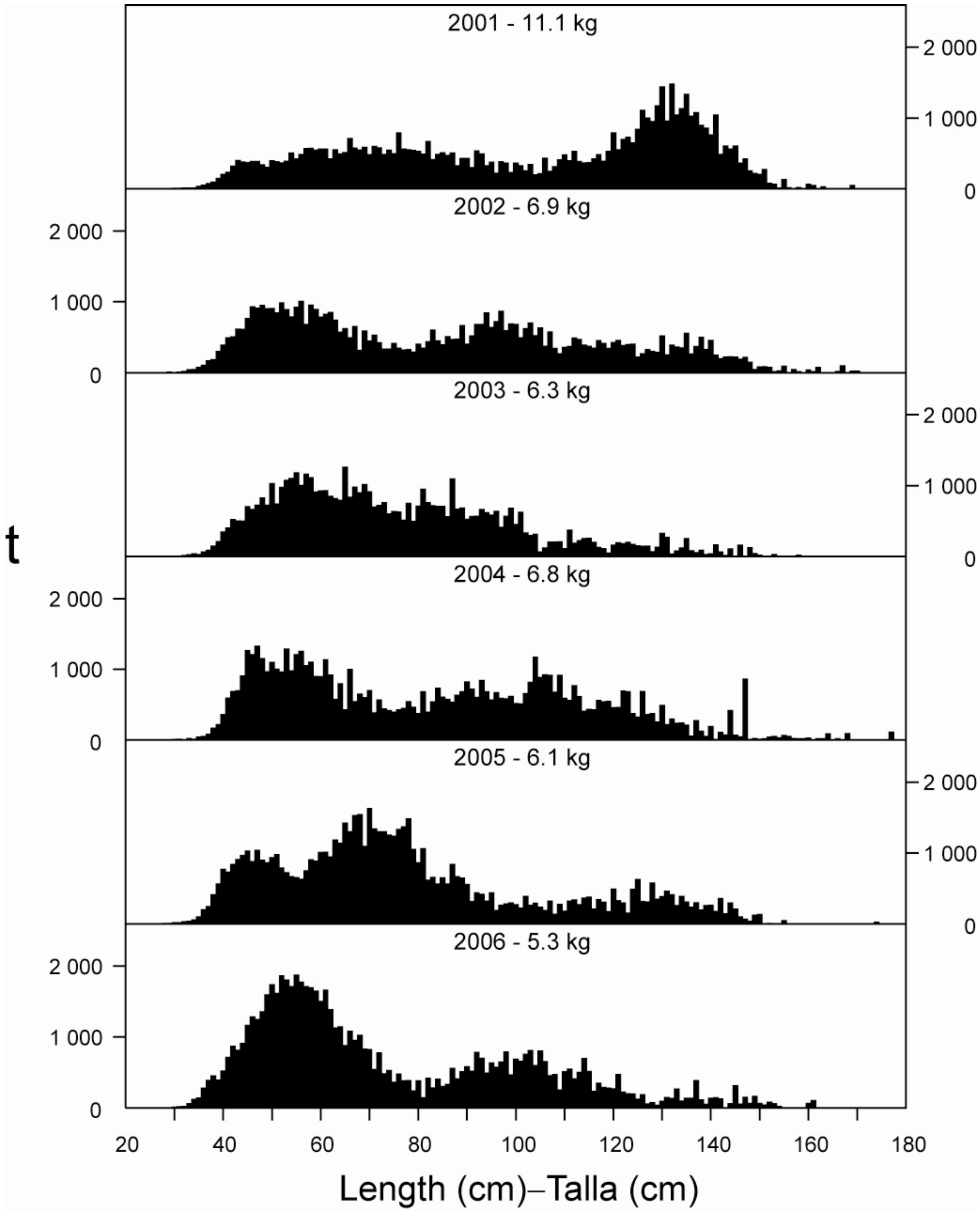

FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2001-2006. The average weights of the fish in the samples are given at the tops of the panels.
FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2001-2006. En cada recuadro se detalla el peso promedio de los peces en las muestras.

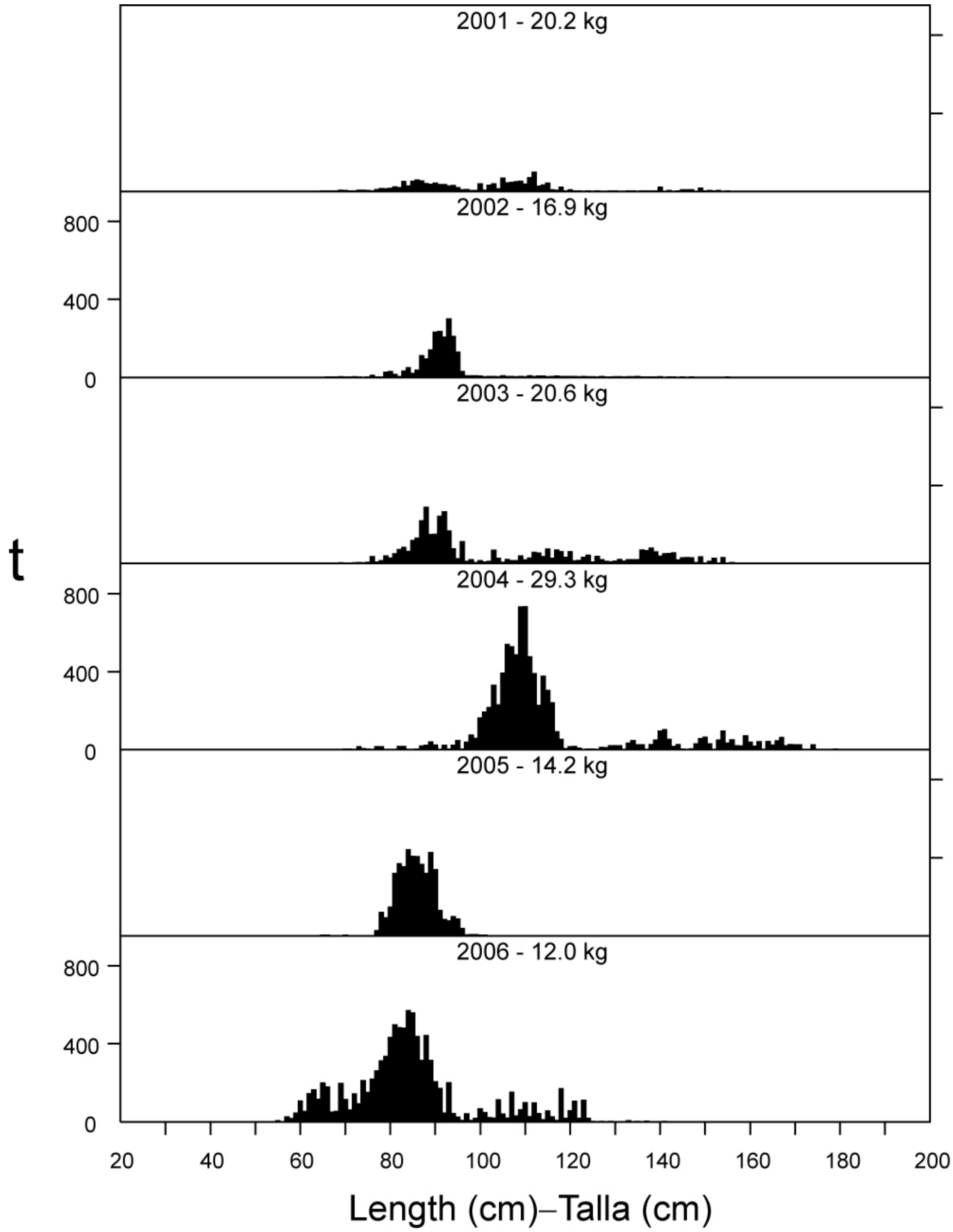

FIGURE A-9. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 2001-2006. The values at the tops of the panels are the average weights.
FIGURA A-9. Captura estimada de aleta azul del Pacífico con arte de cerco y deportiva en el OPO durante 2001-2006. El valor en cada recuadro representa el peso promedio.

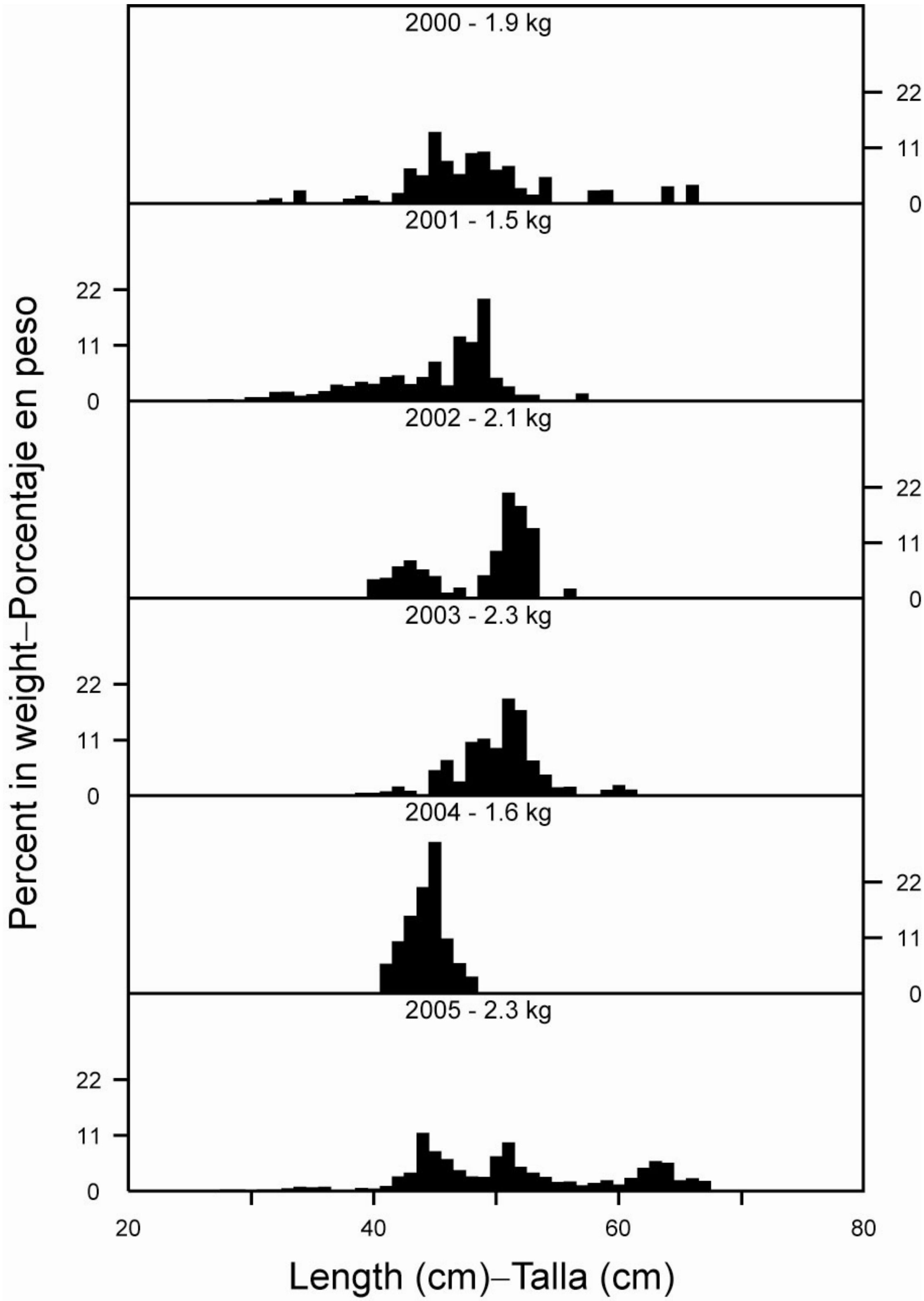

FIGURE A-10. Estimated size compositions of the catches of black skipjack by purse-seine vessels in the EPO during 2001-2006. The values at the tops of the panels are the average weights.

FIGURA A-10. Composición por tallas estimada del barrilete negro capturado por buques cerqueros en el OPO durante 2001-2006. El valor en cada recuadro representa el peso promedio.

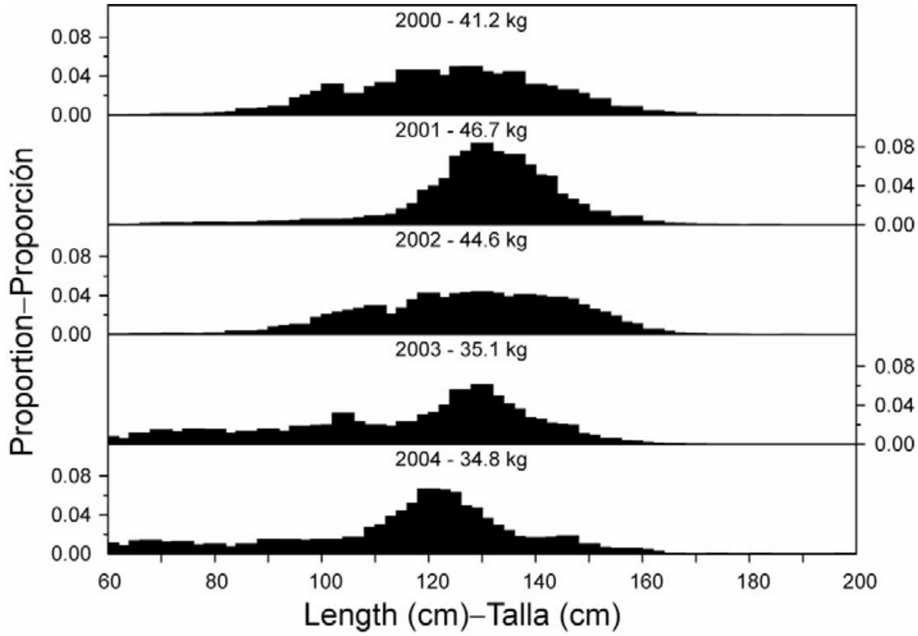

FIGURE A-11. Estimated size compositions of the catches of yellowfin tuna by the Japanese longline fishery in the EPO, 2000-2004.
FIGURA A-11. Composición por tallas estimada de las capturas de atún aleta amarilla por la pesquería palangrera japonesa en el OPO, 2000-2004.

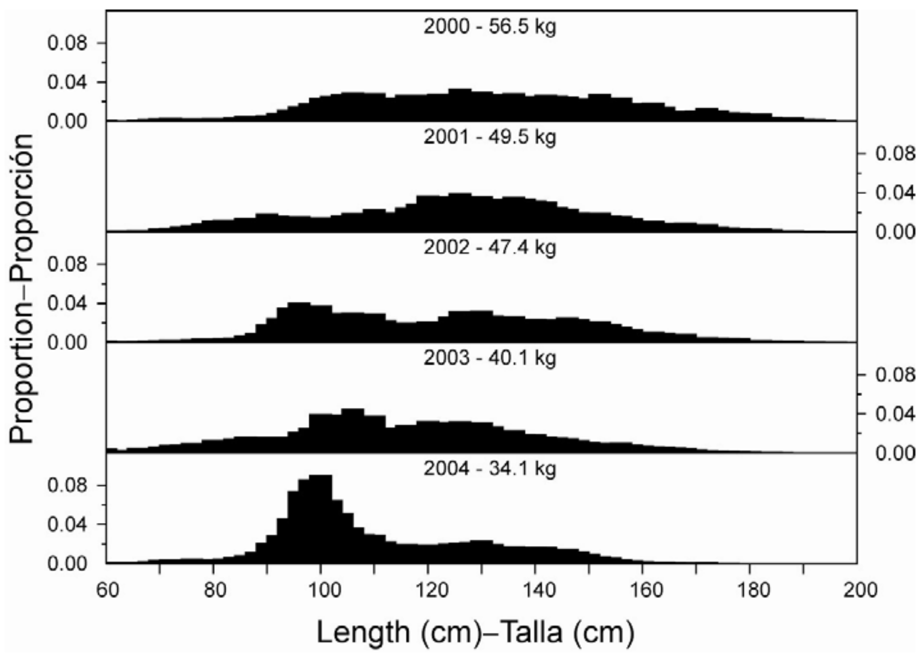

FIGURE A-12. Estimated size compositions of the catches of bigeye tuna by the Japanese longline fishery in the EPO, 2000-2004.
FIGURA A-12. Composición por tallas estimada de las capturas de atún patudo por la pesquería palangrera japonesa en el OPO, 2000-2004.

TABLE A-1. Annual catches of yellowfin, skipjack, and bigeye, by all types of gear combined, in the Pacific Ocean, 1977-2006. The EPO totals for 1993-2006 include discards from purse-seine vessels with a carrying capacity greater than 363 t.

TABLA A-1. Capturas anuales de aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico, 1977-2006. Los totales del OPO de 1993-2006 incluyen los descartes de buques cerqueros de más de 363 t de capacidad de acarreo.

	YFT			SKJ			BET			Total		
	EPO	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**
1977	199,380	181,538	380,918	94,108	397,147	491,255	85,249	76,788	162,037	378,737	655,473	1,034,210
1978	173,996	174,073	348,069	179,676	441,128	620,804	89,198	59,094	148,292	442,870	674,295	1,117,165
1979	187,137	194,442	381,579	141,504	405,327	546,831	67,533	66,372	133,905	396,174	666,141	1,062,315
1980	158,850	213,139	371,989	138,108	450,956	589,064	86,403	65,133	151,536	383,361	729,228	1,112,589
1981	178,514	225,922	404,436	126,001	430,522	556,523	68,339	53,346	121,685	372,854	709,790	1,082,644
1982	127,537	221,010	348,547	104,670	478,477	583,147	60,346	59,301	119,647	292,553	758,788	1,051,341
1983	100,013	256,532	356,545	62,150	669,602	731,752	64,755	59,896	124,651	226,918	986,030	1,212,948
1984	149,478	252,772	402,250	63,613	741,714	805,327	55,273	64,108	119,381	268,364	1,058,594	1,326,958
1985	226,036	259,164	485,200	52,000	595,086	647,086	72,404	68,706	141,110	350,440	922,956	1,273,396
1986	286,149	250,661	536,810	67,748	739,301	807,049	105,120	63,777	168,897	459,017	1,053,739	1,512,756
1987	286,359	303,346	589,705	66,464	675,053	741,517	101,314	79,269	180,583	454,137	1,057,668	1,511,805
1988	296,635	263,032	559,667	92,125	830,456	922,581	74,304	68,447	142,751	463,064	1,161,935	1,624,999
1989	299,739	313,793	613,532	98,930	808,902	907,832	72,993	77,237	150,230	471,662	1,199,932	1,671,594
1990	302,284	353,492	655,776	77,117	871,732	948,849	104,807	90,419	195,226	484,208	1,315,643	1,799,851
1991	266,091	394,712	660,803	65,895	1,097,899	1,163,794	109,116	73,768	182,884	441,102	1,566,379	2,007,481
1992	253,714	416,160	669,874	87,354	999,355	1,086,709	91,999	92,120	184,119	433,067	1,507,635	1,940,702
1993	256,675	386,142	642,817	100,521	904,841	1,005,362	82,834	79,885	162,719	440,030	1,370,868	1,810,898
1994	248,248	393,250	641,498	84,641	1,007,759	1,092,400	109,326	90,585	199,911	442,215	1,491,594	1,933,809
1995	244,601	372,482	617,083	150,670	1,042,219	1,192,889	108,209	82,932	191,141	503,479	1,497,633	2,001,112
1996	266,463	308,210	574,673	132,929	1,019,503	1,152,432	114,703	83,813	198,516	514,095	1,411,526	1,925,621
1997	278,264	429,336	707,600	188,530	966,501	1,155,031	122,348	109,403	231,751	589,142	1,505,240	2,094,382
1998	280,140	462,253	742,393	165,673	1,294,761	1,460,434	93,946	108,380	202,326	539,759	1,865,394	2,405,153
1999	304,939	412,789	717,728	292,070	1,150,572	1,442,642	93,300	116,830	210,130	690,309	1,680,191	2,370,500
2000	289,057	423,743	712,800	232,241	1,220,789	1,453,030	147,250	109,231	256,481	668,548	1,753,763	2,422,311
2001	423,767	425,102	848,869	159,160	1,121,695	1,280,855	131,475	105,943	237,418	714,402	1,652,740	2,367,142
2002	443,177	409,752	852,929	167,288	1,294,380	1,461,668	132,810	121,530	254,340	743,275	1,825,662	2,568,937
2003	413,612	449,450	863,062	301,882	1,288,418	1,590,300	116,474	107,332	223,806	831,968	1,845,200	2,677,168
2004	294,437	366,956	661,393	218,589	1,384,131	1,602,720	112,489	145,239	257,728	625,514	1,896,326	2,521,840
2005	288,019	425,692	713,711	284,329	1,451,906	1,736,235	114,151	157,534	271,685	686,498	2,035,132	2,721,630
2006	174,780	*	174,780	322,004		322,004	103,322	*	103,322	600,106	*	600,106

TABLE A-2a. Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with a carrying capacity greater than 363 t only, of tunas and bonitos, in metric tons, in the EPO, 1977-2006 The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary. The data for 2005-2006 are preliminary.
TABLA A-2a. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes, por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de atunes y bonitos, en toneladas métricas, en el OPO, 1977-2006. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares. Los datos de 2005-2006 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.				
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	255,025	6,796	2,431	22,772	2,034	289,057	205,459	26,415	231	68	67	232,241	93,753	5,649	0	47,579	269	147,250
2001	382,229	7,808	3,916	28,475	1,339	423,767	143,784	13,233	448	1,215	479	159,160	61,408	1,294	0	68,726	47	131,475
2002	412,407	4,019	950	24,002	1,799	443,177	153,398	12,625	616	261	388	167,288	57,437	937	0	74,405	31	132,810
2003	381,147	5,338	470	23,763	2,894	413,612	274,490	23,302	638	635	2,817	301,882	54,509	2,260	0	59,666	39	116,474
2004	269,463	2,967	1,884	16,970	3,153	294,437	198,678	17,555	528	712	1,116	218,589	67,337	1,588	0	43,354	210	112,489
2005	268,585	3,180	1,844	10,442	3,968	288,019	261,599	19,425	1,278	241	1,786	284,329	68,699	1,972	0	43,433	47	114,151
2006	166,739	1,494	693	3,976	1,878	174,780	308,148	13,155	429	184	89	322,004	71,195	1,848	0	30,271	8	103,322

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.				
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	10,143	20,618	188	834	-	-	40	1,062
1995	629	0	-	25	264	918	-	0	465	6,185	7,425	14,075	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	7,542	17,280	100	2,512	-	-	11	2,623
1998	1,772	0	0	94	504	2,370	42	0	81	12,635	13,155	25,913	488	1,876	39	-	0	2,403
1999	2,553	54	5.0	152	552	3,316	47	0.0	227	11,633	14,557	26,464	170	3,424	-	-	0	3,594
2000	3,712	0	61	46	374	4,193	71	0	86	9,663	13,455	23,275	294	1,877	-	-	0	2,170
2001	891	3	1	148	390	1,433	3	0	157	19,410	13,766	33,337	2,258	1,253	-	-	0	3,511
2002	1,708	6	3	70	358	2,146	31	0	381	15,289	14,453	30,155	1,459	2,207	8	-	-	3,674
2003	3,233	0	3	87	409	3,733	34	0	59	24,901	20,544	45,537	433	1,606	6	13	117	2,175
2004	8,880	19	0	15	59	8,974	105	0	126	18,444	22,159	40,834	883	351	-	27	862	2,123
2005	4,743	15	0	0	84	4,843	2	0	66	9,069	15,671	24,808	1,472	1,909	-	-	22	3,403
2006	9,795		0	-	96	9,891	109		-	6,390	6,402	12,901	2,000	-	-	-	-	2,000

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.				
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	3	692	1,068	359,810	-	3,945	140,093	8,883	512,734
1991	1,207	-	82	-	242	1,531	4	-	-	29	192	225	300,408	-	5,520	142,855	6,493	455,305
1992	977	-	-	-	318	1,295	120	-	-	27	1,071	1,218	322,712	-	6,001	120,453	11,636	460,827
1993	599	12	1	-	436	1,048	12	2,172	-	12	4,082	6,278	314,272	22,254	8,725	107,550	15,318	468,129
1994	8,331	147	362	-	185	9,025	9	969	-	1	464	1,442	322,930	19,373	7,312	111,380	14,480	475,464
1995	7,929	55	81	-	54	8,119	12	1,006	-	1	1,004	2,023	396,575	27,412	7,067	84,598	14,613	530,265
1996	647	1	7	-	16	671	36	1,300	-	1	1,038	2,375	413,514	40,444	6,396	71,085	13,157	544,596
1997	1,097	4	8	-	34	1,143	75	3,879	-	8	1,437	5,399	466,487	48,954	7,747	83,854	11,428	618,470
1998	1,330	4	7	-	588	1,929	15	1,633	-	26	18,158	19,832	442,366	33,940	6,896	73,608	35,396	592,207
1999	1,719	0	-	24	369	2,112	29	3,266	-	2,115	4,279	9,689	599,161	45,410	4,059	61,201	25,654	735,485
2000	636	0	0	75	56	767	190	1,795	-	1,994	1,468	5,447	559,139	42,532	2,809	82,197	17,723	704,402
2001	17	0	0	34	19	71	206	1,861	-	2,453	56	4,575	590,797	25,453	4,523	120,461	16,095	757,329
2002	0	0	0	42	1	43	576	2,709	-	3,278	1,422	7,985	627,017	22,503	1,958	117,348	18,452	787,279
2003	0	0	1	0	25	26	81	1,629	-	373	750	2,832	713,927	34,135	1,177	109,438	27,595	886,271
2004	15	47	1	8	3	73	259	1,426	-	504	258	2,447	545,620	23,982	2,539	80,034	27,820	679,996
2005	313	18	0	0	11	342	190	2,371	-	518	427	3,506	605,604	29,463	3,187	63,703	22,016	723,973
2006	3,477		12	0	0	3,488	99	2,507	-	5	192	2,803	561,562	20,876	1,133	40,826	8,665	633,062

TABLE A-2b. Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with a carrying capacity greater than 363 t only, of billfishes, in metric tons, in the EPO, 1977-2006. Data for 2005-2006 are preliminary. PS dis. = discards by purse-seine vessels.

TABLA A-2b. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes, por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de peces picudos, en toneladas métricas, en el OPO, 1977-2006. Los datos de 2005-2006 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**
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	5	6,167	4,434	10,606	103	6,279	292	6,674	92	217	-	309	71	3,332	243	3,646
1994	3	4,963	3,849	8,815	97	8,609	418	9,124	72	256	-	328	36	3,126	270	3,432
1995	4	4,466	3,003	7,473	99	6,944	344	7,387	76	158	-	234	24	2,943	306	3,273
1996	1	6,756	2,801	9,558	85	3,396	200	3,681	79	99	-	178	25	2,981	237	3,243
1997	4	9,508	2,853	12,365	150	5,468	340	5,958	101	153	-	254	28	4,201	272	4,501
1998	3	9,381	3,665	13,049	153	4,477	580	5,210	102	168	-	270	21	3,277	281	3,579
1999	2	7,470	2,064	9,536	214	3,010	680	3,904	117	94	-	211	37	2,287	334	2,658
2000	2	8,523	2,789	11,315	152	3,028	606	3,786	95	105	-	200	20	1,698	191	1,909
2001	4	15,354	2,617	17,974	175	3,554	643	4,371	122	123	-	245	23	1,687	274	1,984
2002	1	16,960	2,757	19,718	235	2,818	662	3,716	125	78	-	203	79	1,946	214	2,238
2003	5	17,879	641	18,526	209	3,140	876	4,225	144	72	-	216	35	1,773	138	1,947
2004	2	15,197	488	15,687	168	3,353	416	3,937	74	38	-	112	23	1,311	234	1,568
2005	3	8,797	4,490	13,290	236	2,619	820	3,676	103	41	-	145	39	1.278	328	1,645
2006	4	1,647	222	1,873	241	751	156	1,149	121	5	-	126	49	527	92	668

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
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	-	125	-	125	-	14,961	5,066	20,027
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	-	1,123	-	1,123	262	21,219	5,252	26,733
1993	0	1	-	1	57	1,145	1,121	2,323	96	1,650	-	1,746	424	18,791	6,090	25,305
1994	0	144	-	144	38	878	804	1,720	23	1,028	-	1,051	270	19,004	5,341	24,615
1995	1	155	-	156	28	237	1,114	1,379	12	232	-	244	243	15,135	4,767	20,145
1996	1	126	-	127	22	197	541	760	19	308	1	328	231	13,863	3,780	17,874
1997	1	141	-	142	24	799	418	1,241	8	1,324	-	1,332	316	21,594	3,883	25,793
1998	0	200	-	200	58	394	988	1,440	13	575	52	640	350	18,472	5,566	24,388
1999	1	278	-	279	40	107	1,109	1,256	16	1,135	-	1,151	427	14,381	4,187	18,995
2000	1	285	-	285	55	138	1,239	1,433	7	880	136	1,023	332	14,657	4,961	19,950
2001	1	304	-	304	34	189	1,614	1,837	6	1,741	204	1,951	364	22,952	5,352	28,668
2002	1	273	-	274	39	393	1,416	1,848	10	2,467	14	2,491	490	24,935	5,063	30,487
2003	4	289	-	293	96	162	1,012	1,269	11	1,387	-	1,398	504	24,702	2,668	27,874
2004	1	200	-	200	36	156	1,261	1,453	9	1,384	-	1,394	313	21,640	2,399	24,352
2005	1	276	-	278	40	37	782	859	10	896	-	906	432	13,945	6,420	20,797
2006	1	2	-	3	51	26	593	670	12	476	-	488	480	3,434	1,063	4,977

TABLE A-2c. Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with a carrying capacity greater than 363 t only, of other species, in metric tons, in the EPO, 1977-2006. Data for 2005-2006 are preliminary.

TABLA A-2c. Estimaciones de las capturas retenidas, por arte de pesca, y de los descartes, por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de otras especies, en toneladas métricas, en el OPO, 1977-2006. Los datos de 2005-2006 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.**				
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	-	-	280	1,095	1,375	240	-	-	260	13	513
1991	116	-	-	-	0	116	57	-	-	7	613	677	1	-	6	1,111	1,346	2,464	462	-	1	457	-	920
1992	116	-	-	-	0	116	69	-	-	37	708	814	-	-	-	2,293	1,190	3,483	445	-	-	182	-	627
1993	17	64	-	-	2	83	36	719	-	17	724	1,496	24	2,256	-	1,026	916	4,222	223	477	2	182	-	884
1994	7	40	-	-	16	63	279	1,237	-	46	3,459	5,021	113	2,353	-	1,234	1,314	5,015	10	354	-	251	-	615
1995	11	48	-	-	9	68	110	1,097	-	39	2,127	3,373	20	2,693	-	922	1,075	4,710	-	561	-	209	-	770
1996	55	217	-	-	57	329	119	1,332	-	43	183	1,677	3	2,453	-	1,121	2,151	5,728	5	354	-	455	-	814
1997	2	150	-	-	39	191	36	1,241	-	564	9,411	11,252	22	3,470	-	924	2,360	6,776	14	426	-	847	-	1,287
1998	57	178	-	-	4	239	15	836	-	39	11,656	12,546	6	3,228	-	2,008	4,484	9,726	65	983	-	1,338	-	2,386
1999	35	216	1	-	-	252	75	1,262	-	2,333	5,111	8,781		2,209	-	5,939	2,144	10,292	86	762	-	973	-	1,821
2000	57	121	-	4	4	186	109	1,547	-	3,537	1,041	6,233	3	1,691	-	8,621	406	10,720	1	287	-	1,487	0	1,775
2001	0	170	-	18	26	214	148	2,266	-	4,721	14,046	21,182	0	1,556	-	12,542	117	14,214	0	517	-	1,721	1	2,239
2002	0	135	-	15	20	171	45	1,849	-	3,974	11,969	17,837	0	683	-	11,043	3,751	15,476	0	517	-	1,895	0	2,412
2003	0	160	-	54	-	214	23	904	-	1,079	4,263	6,269	0	1,827	-	10,063	4,903	16,794	0	245	-	4,518	0	4,762
2004	0	161	-	-	-	161	99	1,005	-	1,649	6,965	9,718	0	1,455	9	9,014	2,190	12,668	14	684	-	515	0	1,213
2005	61	105	-	-	-	166	111	1,072	-	686	11,828	13,697	0	1,014	4	9,708	2,410	13,136	195	206	-	385	0	786
2006	133	474	-	-	-	607	132	1,295	-	227	13,583	15,237	0	1,306	-	4,186	881	6,373	494	396	-	0	0	890

TABLE A-3a. 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-3a. 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 la estimación de composición por especie, y son preliminares.

2002		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	1,447	0	1,459	67	438	0	0	0	3,411
CAN	LTL	0	0	0	0	4,753	0	0	0	4,753
CHL	NK	15	0	7	0	40	0	0	0	62
CHN	LL	1,457	0	7,614	0	1,327	0	0	0	10,398
COL	PS	29,725	2,613	300	0	0	0	0	284	32,922
CRI	NK	1,563	0	19	0	0	0	0	0	1,582
ECU	NK	0	0	5	0	0	0	0	0	5
	PS	30,930	80,806	26,934	0	0	877	0	84	139,631
ESP	LL								175	175
	PS	5,021	20,404	8,106	0	0	0	0	0	33,531
JPN	LL	8,513	66	34,193	2	2,627	0	0	0	45,401
KOR	LL	3,626	44	10,358	1	341	0	0	0	14,370
MEX	GN	1	0	0	0	0	0	0	0	1
	LL	4	0	0	1	0	0	0	0	5
	LP	950	616	0	1	0	8	0	0	1,575
	PS	153,172	6,312	2	1,708	28	358	0	0	161,581
PAN	LL	907	59	6	0	13	0	0	312	1,297
	PS	20,188	7,105	2,465	0	0	5	0	0	29,763
PER	NK	195	109	0	0	0	0	0	1,422	1,726
PYF	LL	278	27	388	0	2,545	0	0	0	3,238
SLV	PS	3,130	5,966	6,841	0	0	0	0	0	15,937
TWN	LL	7,360	64	17,253	0	7,096	0	0	0	31,773
USA	GN	1	0	0	7	0	0	1	0	9
	LL	5	1	132	0	0	0	0	1	139
	LP	0	0	0	2	381	0	0	0	383
	LTL	0	0	0	0	7,256	0	0	0	7,256
	PS	8,494	3,383	2,618	0	3	214	0	194	14,906
	RG	24	279	0	351	2,357	0	0	0	3,011
VEN	PS	121,919	2,631	0	0	0	0	0	0	124,550
VUT	LL	290	0	2,995	0	902	0	0	0	4,187
	PS	5,529	6,283	2,860	0	0	0	0	0	14,672
OTR[1]	LL[2]	115	0	7	0	47	0	42	2,790	3,002
	PS	34,299	17,895	7,311	0	0	5	0	14	59,524

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

TABLE A-3b. Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 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-3b. Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2003. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

2003		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	353	0	604	42	600	0	0	0	1,599
CAN	LTL	0	0	0	0	6,295	0	0	0	6,295
CHL	LL	0	0	0	0	0	13	0	0	13
	NK	73	0	14	0	1	0	24	0	112
CHN	LL	2,739	0	10,066	0	1,743	0	0	0	14,548
COL	PS	17,482	6,249	261	0	0	0	0	0	23,992
CRI	NK	1,418	0	18	0	0	0	0	0	1,436
ECU	LL	148	293	0	0	0	0	0	0	441
	NK	0	93	0	0	0	0	0	0	93
	PS	33,094	139,052	24,824	0	0	61	0	38	197,069
ESP	LL	0	0	58	0	0	0	0	186	244
	PS	3,760	28,606	7,983	0	0	0	0	0	40,349
JPN	LL	9,133	50	24,796	3	2,122	0	0	0	36,104
KOR	LL	4,911	25	10,272	0	343	0	0	0	15,551
MEX	LL	365	0	0	43	0	0	0	0	408
	LP	468	637	0	0	0	6	0	0	1,111
	PS	172,208	8,752	8	3,211	29	193	0	0	184,401
PAN	PS	25,042	13,473	4,674	0	0	3	0	10	43,202
PER	NK	806	2,575	0	0	0	117	0	750	4,248
PYF	LL	462	60	346	0	3,233	0	0	144	4,246
TWN	LL	3,477	172	12,016	0	12,663	0	0	0	28,328
USA	GN	0	9	6	14	16	0	1	0	46
	LL	5	1	232	0	24	0	0	4	266
	LP	2	1	0	3	59	0	1	0	66
	LTL	0	0	0	0	11,622	0	0	0	11,622
	PS	915	8,190	2,810	22	3	163	0	25	12,128
	RG	597	140	1	395	2,212	0	0	0	3,345
VEN	PS	95,137	7,913	439	0	0	0	0	0	103,489
VUT	LL	699	0	1,258	0	4,133	0	0	0	6,090
	PS	2,943	21,057	6,583	0	0	13	0	0	30,596
OTR[1]	LL[2]	1,472	33	18	0	438	0	0	39	2,000
	PS[3]	30,566	41,198	6,927	0	2	0	0	8	78,701

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

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

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

TABLE A-3c 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-3c. Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2004 Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

2004		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	190	26	120	*	296	*	*	*	632
CAN	LTL	*	*	*	*	7,676	*	*	*	7,676
CHL	LL	86	*	9	*	8	27	8	*	138
CHN	LL	798	*	2,645	*	590	*	*	*	4,034
CRI	NK	1,701	*	21	*	*	*	*	*	1,722
ECU	LL	*	*	312	*	*	*	*	*	312
	NK	*	*	185	*	*	*	*	*	185
	PS	40,501	88,470	30,647	*	*	97	7	12	159,733
ESP	LL	*	*	5	*	*	*	*	318	323
HND	PS	1,058	3,634	1,858	*	*	*	*	1	6,551
JPN	LL	7,240	96	21,132	1	2,264	*	*	*	30,733
KOR	LL	2,997	31	10,729	*	783	*	*	*	14,540
MEX	LL	32	*	*	14	*	*	*	*	46
	LP	1,882	528	*	*	*	*	*	*	2,410
	PS	90,897	24,972	*	8,880	104	418	8	54	125,332
NIC	LL	43	*	*	*	*	*	*	*	43
PAN	LL	2,802	148	48	*	143	*	*	11	3,152
	PS	31,308	20,365	11,434	*	*	25	*	2	63,134
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	*	*	*	126	*	1	*	129
	LTL	1	*	*	*	12,718	*	*	*	12,719
	PS	2,529	5,117	3,746	*	1	296	*	178	11,867
	RG	1,159	18	4	49	1,506	*	*	*	2,736
VEN	PS	54,220	13,058	1,056	*	*	47	*	1	68,382
VUT	LL	171	*	407	*	2,554	*	*	*	3,132
	PS	1,625	8,387	5,174	*	*	*	*	*	15,186
OTR[1]	LL	15	13	9	*	8	*	*	31	76
	PS[2]	47,325	34,675	13,422	*	247	1	*	12	95,682

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

2005		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	164	16	112	*	46	*	*	*	338
CAN	LTL	*	*	*	*	4,799	*	*	*	4,799
CHL	NK	110	*	24	*	7	22	11	*	174
CHN	LL	682	*	2,104	*	895	*	*	*	3,681
CRI	NK	1,791	*	23	*	*	*	*	*	1,814
ECU	LL	*	*	39	*	*	*	*	*	39
	PS	40,214	137,102	30,568	*	*	141	40	28	208,093
ESP	LL	*	*	*	*	*	*	*	362	362
HND	PS	2,246	5,498	3,714	*	*	*	*	*	11,458
JPN	LL	4,303	50	21,137	0	2,805	*	*	*	28,295
KOR	LL	532	*	11,580	*	172	*	*	*	12,284
MEX	LP	1,844	1,278	*	*	*	*	*	*	3,121
	PS	111,543	31,601	*	4,542	*	1,193	273	92	149,245
NIC	LL	18	*	*	*	*	*	*	*	18
	PS	7,008	2,511	34	*	*	*	*	*	9,553
PAN	LL	1,782	94	30	*	91	*	*	*	1,997
	PS	30,311	28,534	13,370	*	*	8	*	8	72,231
PER	NK	458	365	*	*	*	*	*	427	1,250
	OTR	708	1,398	*	*	*	*	*	*	2,106
PYF	LL	530	14	398	*	1,572	*	*	146	2,661
SLV	PS	7,001	5,347	1,016	*	*	73	*	60	13,497
TWN	LL	2,422	66	6,441	*	3,300	*	*	*	12,229
USA	GN	2	*	*	5	20	*	*	*	27
	LL	7	1	536	*	9	*	*	9	562
	LP	*	*	*	*	66	*	*	*	66
	LTL	*	*	*	*	9,069	*	*	*	9,069
	RG	899	23	*	79	1,719	*	*	*	2,720
VEN	PS	42,180	14,254	120	*	*	41	*	2	56,597
VUT	LL	*	*	1,056	*	179	*	*	*	1,235
OTR[1]	LL	2	*	*	*	57	*	*	1	60
	PS[2]	28,082	36,752	19,877	201	2	16	*	*	84,930

[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-3e. Estimates of the retained catches of tunas and bonitos, by flag, gear type, and species, in metric tons, in the EPO, 2006. The purse-seine and pole-and-line data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates and are preliminary.

TABLA A-3e. Estimaciones de las capturas retenidas de atunes y bonitos, por bandera, arte de pesca, y especie, en toneladas métricas, en el OPO, 2006. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías cerquera y cañera fueron ajustados a la estimación de composición por especie, y son preliminares.

2006		YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total
BLZ	LL	105	13	75	*	8	*	*	*	201
CAN	LTL	*	*	*	*	5,139	*	*	*	5,139
CHN	LL	36	*	709	*	13	*	*	*	758
CRI	NK	642	*	8	*	*	*	*	*	650
ECU	PS	26,152	143,094	34,176	*	*	79	*	67	203,568
HND	PS	1,694	6,483	3,061	*	*	*	*	*	11,238
JPN	LL	*	*	13,618	*	278	*	*	*	13,896
KOR	LL	*	*	8,694	*	58	*	*	*	8,752
MEX	LP	693	429	*	*	*	*	12	*	1,133
	PS	67,859	19,118	*	9,795	109	1,897	3,229	31	102,038
NIC	PS	7,257	5,371	1,878	*	*	*	*	1	14,507
PAN	LL	2,164	114	37	*	110	*	*	*	2,425
	PS	23,673	46,742	10,645	*	*	8	*	*	81,068
PER	NK	595	73	*	*	*	*	*	192	860
TWN	LL	1,671	57*	6,412	*	4,235	*	*	*	12,375
USA	LL	*	*	78	*	*	*	*	*	78
	RG	641	16	*	96	376	*	*	*	1,129
VEN	PS	17,226	25,725	4,135	*	*	11	248	*	47,345
VUT	LL	*	*	648	*	1,688	*	*	*	2,336
OTR[1]	LL	*	*	*	*	207	*	*	3	210
	PS[2]	22,878	61,615	17,300	*	*	5	*	2	101,800

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

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

TABLE A-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 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-4a. 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	40,214	137,102	30,568	*	*	141	40	28	208,093	34.0
HND	2,246	5,498	3,714	*	*	*	*	*	11,458	1.9
MEX	113,387	32,879	*	4,542	*	1,193	273	92	152,366	24.9
NIC	7,008	2,511	34	*	*	*	*	*	9,553	1.6
PAN	30,311	28,534	13,370	*	*	8	*	8	72,231	11.8
SLV	7,001	5,347	1,016	*	*	73	*	60	13,497	2.2
VEN	42,180	14,254	120	*	*	41	*	2	56,597	9.3
OTR	28,981	36,775	19,877	280	1,787	16	*	*	87,716	14.3
Total	271,328	262,900	68,699	4,822	1,787	1,472	313	190	611,511	
	Landings–Descargas									
COL	35,968	14,317	3,817	*	*	*	*	2	54,104	8.9
CRI	14,931	5,380	668	*	*	*	*	*	20,979	3.5
ECU	66,038	188,021	57,331	*	*	165	40	37	311,632	51.5
MEX	109,700	32,074	292	4,513	*	1,193	273	92	148,137	24.5
VEN	16,503	3,633	*	*	*	*	*	*	20,136	3.3
OTR	26,139	17,447	3,704	388	1,787	114	*	60	49,639	8.2
Total	269,279	260,872	65,812	4,901	1,787	1,472	313	191	604,627	

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

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

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

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

TABLE A-4b Preliminary estimates of the retained catches and landings, in metric tons, of tunas and bonitos caught by purse-seine, pole-and-line, and recreational vessels in the EPO in 2006, 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 2006, 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	26,152	143,094	34,176	*	*	79	*	67	203,568	36.1
HND	1,694	6,483	3,061	*	*	*	*	*	11,238	2.0
MEX	68,552	19,547	*	9,795	109	1,897	3,240	31	103,171	18.3
NIC	7,257	5,371	1,878	*	*	*	*	1	14,507	2.6
PAN	23,673	46,742	10,645	*	*	8	*	*	81,068	14.4
VEN	17,226	25,725	4,135	*	*	11	248	*	47,345	8.4
OTR	23,519	61,631	17,300	96	376	5	*	*	102,927	18.3
Total	168,073	308,593	71,195	9,891	485	2,000	3,488	99	563,824	
	Landings–Descargas									
COL	11,549	15,416	2,845	*	*	8	*	*	29,818	5.2
ECU	52,921	223,969	57,252	*	*	81	248	67	334,538	58.8
MEX	68,209	18,733	*	9,795	109	1,897	3,240	31	102,014	17.9
VEN	12,116	15,623	1,500	*	*	11	*	*	29,250	5.1
OTR	33,068	31,750	8,362	96	376	3	*	1	73,656	12.9
Total	177,863	305,491	69,959	9,891	485	2,000	3,488	99	569,276	

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

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

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

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

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

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

[1] Source: International Scientific Committee, Report of the Fifth ISC Pacific Bluefin Tuna Working Group—Fuente: Comité Científico Internacional, Informe del Quinto Grupo de Trabajo sobre el Atún Aleta Azul del Pacífico.

TABLE A-6a. Annual retained catches of North Pacific albacore by region and gear, in metric tons. Compiled from IATTC data (EPO) and SPC data (WCPO). Data for 2005 and 2006 are preliminary.
TABLA A-6a. Capturas retenidas anuales de atún albacora del Pacífico Norte por región, en toneladas métricas. Compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2005 y 2006 son preliminares.

ALB (N)	Eastern Pacific Ocean Océano Pacífico oriental						Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LP	LTL	PS	OTR	Subtotal	LL	LP	LTL	OTR	Subtotal	
1977	811	1,960	9,968	15	543	13,298	16,347	34,822	54	2,336	53,558	66,856
1978	790	1,577	16,613	156	821	19,957	12,610	57,018	23	10,419	80,070	100,027
1979	1,394	179	4,955	148	74	6,750	13,163	45,635	2,347	6,970	68,115	74,865
1980	1,268	407	5,421	194	168	7,459	14,245	43,495	2,347	7,511	67,597	75,056
1981	2,040	608	12,039	99	227	15,013	16,517	26,375	798	21,597	65,287	80,300
1982	1,971	198	3,303	355	257	6,084	15,693	29,744	3,410	26,154	75,001	81,085
1983	1,572	449	7,751	7	87	9,866	14,416	20,155	1,833	14,337	50,741	60,607
1984	2,592	1,441	8,343	3,910	1,427	17,713	12,972	25,928	1,011	26,266	66,177	83,890
1985	1,312	877	5,308	42	1,176	8,715	13,252	21,967	1,163	24,878	61,260	69,975
1986	698	86	4,282	47	196	5,309	12,349	14,525	456	18,603	45,933	51,242
1987	1,114	320	2,300	1	171	3,906	14,171	19,103	570	18,242	52,086	55,992
1988	899	271	4,202	17	64	5,454	14,417	7,839	165	27,923	50,343	55,797
1989	957	21	1,852	1	160	2,991	12,921	11,241	148	26,789	51,099	54,090
1990	1,139	170	2,440	39	24	3,812	15,034	13,944	465	32,154	61,597	65,409
1991	1,514	834	1,783	-	6	4,137	15,984	5,729	201	15,052	36,966	41,103
1992	1,635	255	4,515	-	2	6,407	17,788	14,774	419	19,952	52,933	59,340
1993	1,772	1	4,331	-	25	6,129	28,777	12,844	2,417	3,132	47,170	53,299
1994	2,356	85	9,574	-	106	12,121	28,386	30,439	3,560	3,804	66,189	78,310
1995	1,381	465	7,306	-	102	9,254	31,496	22,619	3,452	1,981	59,548	68,802
1996	1,675	72	8,195	11	88	10,041	37,614	22,551	13,654	720	74,539	84,580
1997	1,365	59	6,057	1	1,018	8,500	46,528	35,056	12,617	2,056	96,257	104,757
1998	1,730	81	11,936	42	1,208	14,996	46,101	27,797	8,138	1,663	83,700	98,696
1999	2,701	227	10,831	47	3,621	17,427	43,360	54,817	3,022	7,476	108,675	126,102
2000	1,880	86	10,874	71	1,798	14,710	38,989	21,767	4,371	2,956	68,082	82,792
2001	1,822	157	11,597	3	1,635	15,215	34,468	29,254	5,141	1,472	70,334	85,549
2002	1,226	381	11,906	31	2,357	15,900	21,852	49,575	4,417	3,904	79,749	95,649
2003	1,125	59	17,786	34	2,228	21,232	28,662	34,648	4,100	1,465	68,876	90,107
2004	919	126	20,196	105	1,518	22,864	21,832	34,911	1,977	7,597	66,317	89,181
2005	2,595	66	13,744	2	1,739	18,146	22,625	34,971	5,397	873	63,866	82,012
2006	4,245	*	5,977	109	376	10,707	*	*	*	*	*	10,707

TABLE A-6b. Annual retained catches of South Pacific albacore by region, in metric tons. Compiled from IATTC data (EPO) and SPC data (WCPO). Data for 2005 and 2006 are preliminary.

TABLA A-6b. Capturas retenidas anuales de atún albacora del Pacífico Sur por región, en toneladas métricas. Compiladas de datos de la CIAT (OPO) y la SPC (WCPO). Los datos de 2005 y 2006 son preliminares.

ALB (S)	Eastern Pacific Ocean Océano Pacífico oriental				Western and central Pacific Ocean Océano Pacífico occidental y central					Total
	LL	LTL	OTR	Subtotal	LL	LP	LTL	OTR	Subtotal	
1977	9,767	-	960	10,727	28,247	100	621	-	28,968	39,695
1978	11,149	-	2	11,151	21,739	100	1,686	-	23,525	34,676
1979	4,189	-	14	4,203	21,968	100	814	-	22,882	27,085
1980	4,050	-	60	4,110	26,917	101	1,468	-	28,486	32,596
1981	5,235	-	35	5,270	27,458	-	2,085	-	29,543	34,813
1982	6,436	-	2	6,438	21,911	1	2,434	4	24,350	30,788
1983	5,862	-	2	5,864	18,447	-	744	37	19,228	25,092
1984	4,120	-	24	4,144	16,220	2	2,773	1,565	20,560	24,704
1985	5,955	-	170	6,125	21,183	-	3,253	1,767	26,203	32,328
1986	5,752	74	149	5,975	26,885	-	1,929	1,797	30,611	36,586
1987	8,880	188	3	9,071	13,089	9	1,946	927	15,971	25,042
1988	9,035	1,282	0	10,317	19,249	-	3,014	5,283	27,546	37,863
1989	5,828	593	90	6,510	12,396	-	7,777	21,878	42,052	48,562
1990	5,397	1,336	306	7,038	13,969	245	5,639	7,232	27,086	34,124
1991	6,380	795	170	7,345	17,005	14	7,010	1,319	25,348	32,693
1992	15,446	1,205	18	16,668	15,146	11	5,373	47	20,578	37,246
1993	9,423	35	19	9,476	20,807	74	4,261	51	25,194	34,670
1994	8,034	441	22	8,498	26,252	67	6,723	67	33,108	41,606
1995	4,804	2	15	4,821	24,576	139	7,706	89	32,510	37,331
1996	5,956	94	21	6,071	17,906	57	7,273	135	25,371	31,442
1997	8,313	466	-	8,779	18,821	21	4,213	133	23,188	31,967
1998	10,905	11	-	10,916	26,941	47	6,247	85	33,320	44,236
1999	8,932	98	7	9,036	23,021	138	3,293	67	26,520	35,556
2000	7,783	780	3	8,565	26,197	102	5,340	136	31,776	40,341
2001	17,589	528	5	18,122	31,095	37	4,523	194	35,849	53,971
2002	14,064	150	40	14,254	46,932	18	4,345	112	51,407	65,661
2003	23,776	529	1	24,306	31,937	12	4,767	137	36,853	61,159
2004	17,525	445	-	17,970	42,810	110	3,793	124	46,837	64,807
2005	6,475	181	7	6,663	47,886	109	3,400	130	51,525	58,188
2006	2,145	49	*	2,193	*	*	*	*	*	2,193

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
2001	YFT	2.3	1.4	1.4	3.0	2.0	2.6	0.8	0.6	2.0
	SKJ	1.2	1.0	0.9	0.2	0.6	0.4	1.3	1.2	0.7
	BET	0.0	0.3	0.3	0.1	0.3	0.1	0.6	0.5	0.2
	All	3.7	2.8	2.6	3.3	3.1	3.0	2.8	2.2	3.0
2002	YFT	1.7	1.6	1.1	3.3	2.6	2.3	0.7	0.5	2.0
	SKJ	1.3	1.3	0.9	0.3	0.7	0.2	1.3	1.4	0.8
	BET	0.0	0.1	0.2	0.1	0.3	0.1	0.5	0.5	0.2
	All	3.2	3.1	2.2	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	3.2	3.0	2.7	2.6	2.6	1.8	2.4	2.7	2.6
2005	YFT	1.2	1.2	0.8	1.7	1.4	1.5	0.8	0.7	1.3
	SKJ	3.0	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	2.5	2.4	3.4	3.3	2.9
2006	YFT	0.9	0.7	0.6	1.0	0.9	0.9	0.5	0.6	0.8
	SKJ	2.4	2.1	1.6	0.8	0.8	1.1	2.3	1.3	1.4
	BET	0.1	0.3	0.3	0.1	0.2	0.2	0.6	0.6	0.3
	All	3.8	3.3	2.7	2.0	2.1	2.2	3.4	2.5	2.5

TABLE A-8. Estimated numbers of sets, by set type and vessel capacity category, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna in the EPO, by purse-seine vessels. The data for 2006 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 categoría de capacidad de buque, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo en el OPO. Los datos de 2006 son preliminares. Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a la estimación de composición por especie, y son preliminares.

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Vessel capacity-Capacidad del buque		Total	YFT	SKJ	BET
	≤ 363 t	> 363 t				
DEL	**Sets on fish associated with dolphins Lances sobre peces asociados con delfines**					
1989	33	12,827	12,860	191,623	1,728	26
1990	31	10,997	11,028	173,894	1,350	0
1991	0	9,661	9,661	155,283	1,332	0
1992	26	10,398	10,424	165,647	1,262	0
1993	34	6,953	6,987	110,893	587	51
1994	5	7,804	7,809	125,345	1,106	1
1995	0	7,185	7,185	132,710	2,548	1
1996	14	7,472	7,486	138,466	1,761	57
1997	43	8,977	9,020	152,240	8,160	0
1998	0	10,645	10,645	154,528	4,998	6
1999	0	8,648	8,648	143,166	1,705	5
2000	0	9,235	9,235	147,618	542	15
2001	0	9,823	9,823	238,094	1,805	6
2002	0	12,446	12,446	301,401	3,180	2
2003	0	13,839	13,839	264,599	13,323	1
2004	0	11,783	11,783	175,792	10,824	3
2005	0	12,173	12,173	165,131	11,716	4
2006	0	8,923	8,923	89,183	4,942	0
OBJ	**Sets on fish associated with floating objects Lances sobre peces asociados con objetos flotantes**					
1989	974	2,339	3,313	28,377	44,664	1,527
1990	719	2,558	3,277	35,527	35,552	3,995
1991	819	2,165	2,984	25,501	39,036	2,747
1992	868	1,763	2,631	15,010	49,144	2,048
1993	493	2,063	2,556	19,614	53,009	6,141
1994	668	2,770	3,438	20,843	51,125	33,960
1995	707	3,521	4,228	21,146	80,010	41,873
1996	1,230	4,007	5,237	27,842	69,614	58,371
1997	1,699	5,653	7,352	30,009	116,806	62,704
1998	1,198	5,481	6,679	26,286	110,297	41,909
1999	630	4,620	5,250	43,052	181,547	49,330
2000	504	3,916	4,420	42,688	121,036	91,474
2001	801	5,744	6,545	66,353	122,752	60,627
2002	857	5,781	6,638	37,797	116,656	55,916
2003	704	5,497	6,201	29,798	181,326	52,705
2004	615	5,083	5,698	27,595	117,669	65,829
2005	641	5,122	5,763	26,238	132,483	67,510
2006	1,086	7,140	8,226	35,642	194,679	69,564

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

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Vessel capacity-Capacidad del buque		Total	YFT	SKJ	BET
	≤ 363 t	> 363 t				
NOA	**Sets on unassociated schools Lances sobre cardúmenes no asociados**					
1989	2,955	5,878	8,833	57,996	48,542	477
1990	3,683	5,397	9,080	53,832	37,467	1,926
1991	3,571	3,612	7,183	50,473	21,860	2,123
1992	4,010	4,079	8,089	47,463	33,876	5,131
1993	5,739	6,267	12,006	88,985	30,234	3,465
1994	5,440	5,064	10,504	62,220	17,895	938
1995	6,120	4,782	10,902	61,578	44,489	3,447
1996	5,807	5,118	10,925	72,299	32,598	2,883
1997	5,334	4,693	10,027	62,629	28,490	1,568
1998	5,700	4,631	10,331	73,145	25,336	2,214
1999	5,632	6,143	11,775	95,702	78,313	1,823
2000	5,439	5,482	10,921	64,719	83,881	2,264
2001	3,958	3,030	6,988	77,782	19,227	775
2002	4,923	3,409	8,332	73,209	33,562	1,519
2003	7,284	5,083	12,367	86,750	79,841	1,803
2004	4,935	5,698	10,633	66,076	70,185	1,505
2005	6,099	7,857	13,956	77,216	117,400	1,185
2006	6,003	8,463	14,466	41,914	108,527	1,631
ALL	**Sets on all types of schools Lances sobre todos tipos de cardumen**					
1989	3,962	21,044	25,006	277,996	94,934	2,030
1990	4,433	18,952	23,385	263,253	74,369	5,921
1991	4,390	15,438	19,828	231,257	62,228	4,870
1992	4,904	16,240	21,144	228,121	84,283	7,179
1993	6,266	15,283	21,549	219,492	83,830	9,657
1994	6,113	15,638	21,751	208,408	70,126	34,899
1995	6,827	15,488	22,315	215,434	127,047	45,321
1996	7,051	16,597	23,648	238,607	103,973	61,311
1997	7,076	19,323	26,399	244,878	153,456	64,272
1998	6,898	20,757	27,655	253,959	140,631	44,129
1999	6,262	19,411	25,673	281,920	261,565	51,158
2000	5,943	18,633	24,576	255,025	205,459	93,753
2001	4,759	18,597	23,356	382,229	143,784	61,408
2002	5,780	21,636	27,416	412,407	153,398	57,437
2003	7,988	24,419	32,407	381,147	274,490	54,509
2004	5,550	22,564	28,114	269,463	198,678	67,337
2005	6,740	25,152	31,892	268,585	261,599	68,699
2006	7,089	24,526	31,615	166,739	308,148	71,195

TABLE A-9. Types of floating objects on which sets were made. The 2006 data are preliminary.
TABLA A-9. Tipos de objetos flotantes sobre los que se hicieron lances. Los datos de 2006 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
1992	1,087	61.7	556	31.5	120	6.8	1,763
1993	1,138	55.2	825	40.0	100	4.8	2,063
1994	773	27.9	1,899	68.6	98	3.5	2,770
1995	729	20.7	2,704	76.8	88	2.5	3,521
1996	537	13.4	3,447	86.0	23	0.6	4,007
1997	832	14.7	4,768	84.3	53	0.9	5,653
1998	752	13.7	4,627	84.4	102	1.9	5,481
1999	833	18.0	3,758	81.4	29	0.6	4,620
2000	488	12.5	3,381	86.3	47	1.2	3,916
2001	567	9.9	5,076	88.4	102	1.8	5,744
2002	756	13.1	4,953	85.7	72	1.2	5,781
2003	713	13.0	4,744	86.3	40	0.7	5,497
2004	590	11.6	4,469	87.9	24	0.5	5,083
2005	593	11.6	4,421	86.3	108	2.1	5,122
2006	740	10.4	6,339	88.8	61	0.8	7,140

TABLE A-10. Reported nominal longline fishing effort (E; 1000 hooks), and catch (C; metric tons) of yellowfin, skipjack, bigeye, Pacific bluefin, and albacore tunas only, by flag, in the EPO.

TABLA A-10. Esfuerzo de pesca palangrero nominal reportado (E; 1000 anzuelos), y captura (C; toneladas métricas) de atunes aleta amarilla, barrilete, patudo, aleta azul del Pacífico, y albacora solamente, por bandera, en el OPO.

LL	CHN		JPN		KOR		PYF		TWN		USA		OTR[1]
	E	C	E	C	E	C	E	C	E	C	E	C	C
1977	0	0	132,875	83,725	10,958	5,628	0	0	11,973	7,789	0	0	0
1978	0	0	140,006	79,320	8,571	7,012	0	0	8,743	6,525	0	0	0
1979	0	0	137,769	67,932	5,021	2,305	0	0	3,138	2,293	0	0	0
1980	0	0	138,141	75,639	11,788	5,907	0	0	3,000	1,611	0	0	0
1981	0	0	131,275	59,226	19,731	6,539	0	0	5,952	2,949	0	0	0
1982	0	0	116,200	61,370	18,612	7,488	0	0	8,117	3,910	0	0	0
1983	0	0	127,176	69,563	14,675	6,479	0	0	4,850	2,311	0	0	49
1984	0	0	119,635	57,261	11,767	4,491	0	0	3,730	1,734	0	0	0
1985	0	0	106,758	74,348	19,785	10,508	0	0	3,126	1,979	0	0	2
1986	0	0	160,553	111,672	30,765	17,432	0	0	4,874	2,569	0	0	68
1987	0	0	188,393	104,053	36,436	19,405	0	0	12,267	5,335	0	0	273
1988	0	0	182,694	82,383	43,056	10,172	0	0	9,567	4,590	0	0	234
1989	0	0	170,373	84,961	43,365	4,879	0	0	16,360	4,962	0	0	9
1990	0	0	178,419	117,923	47,167	17,415	0	0	12,543	4,755	0	0	0
1991	0	0	200,365	112,337	65,024	24,644	0	0	17,969	5,862	43	12	0
1992	0	0	191,284	93,011	45,634	13,104	500	89	33,025	14,142	325	106	0
1993	0	0	159,955	87,977	46,375	12,843	2,605	79	18,064	6,566	417	81	2
1994	0	0	163,976	92,606	44,788	13,250	3,410	574	12,588	4,883	302	25	41
1995	0	0	129,598	69,435	54,979	12,778	3,452	559	2,910	1,639	823	180	7
1996	0	0	103,653	52,298	40,290	14,121	4,219	931	5,830	3,553	507	182	0
1997	0	0	96,383	59,325	30,493	16,663	5,490	1,941	8,720	5,673	462	215	28
1998	0	0	106,569	50,167	51,817	15,089	6,415	2,858	10,586	5,039	1,020	406	24
1999	0	0	80,958	32,886	54,269	13,294	9,190	4,446	23,247	7,865	1,680	469	100
2000	0	0	79,311	45,216	33,585	18,759	10,230	4,382	18,152	7,809	1,076	204	3,758
2001	13,056	5,162	102,219	54,775	72,261	18,201	11,200	5,086	53,224	20,060	1,400	238	14,452
2002	36,756	10,398	103,919	45,401	96,273	14,370	10,700	3,238	77,051	31,773	236	139	8,710
2003	43,289	14,548	101,242	36,104	71,006	15,551	14,048	4,101	74,322	28,328	1,314	262	10,159
2004	15,889	4,034	76,739	30,733	55,861	14,540	17,865	3,030	51,697	19,535	1,040	166	7,458
2005	16,895	3,681	71,679	28,295	16,828	12,284	13,359	2,515	38,345	12,229	2,601	553	3,629

[1] Includes the catch of—Incluye la captura de: Belize, Chile, Ecuador, El Salvador, Guatemala, Honduras, México, Nicaragua, Panamá, Vanuatu

TABLE A-11. Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet, 1976-2006. The data for 2006 are preliminary.
TABLA A-11. Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO, 1976-2006. Los datos de 2006 son preliminares.

	PS		LP		Total	
	No.	**Vol. (m^3)**	**No.**	**Vol. (m^3)**	**No.**	**Vol. (m^3)**
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	220	213,005	4	498	224	213,503
2006	225	225,397	4	498	229	225,895

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 2005, by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

TABLA A-12a. 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 y arte de pesca. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag Bandera	Gear Arte	Well volume — Volumen de bodega (m^3)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m^3)
		Number—Número						
COL	PS	2	1	7	3	-	13	14,439
ECU	PS	36	18	16	4	7	81	55,075
ESP	PS	-	-	-	-	3	3	6,955
GTM	PS	-	-	-	1	-	1	1,475
HND	PS	-	1	2	-	-	3	2,810
MEX	PS	10	12	20	17	-	59	56,163
	LP	4	-	-	-	-	4	498
NIC	PS	-	-	4	2	-	6	8,060
PAN	PS	2	4	9	6	4	25	32,320
SLV	PS	-	1	1	-	2	4	6,324
USA	PS	1	-	1	-	-	2	1,365
VEN	PS	-	-	19	7	-	26	33,839
VUT	PS	-	-	1	1	-	2	2,163
UNK	PS	1	-	-	-	-	1	222
Grand total—Total general	PS	52	37	76	39	16	220	
	LP	4	-	-	-	-	4	
	PS + LP	56	37	76	39	16	224	
		Well volume—Volumen de bodega (m^3)						
Grand total—Total general	PS	13,345	22,271	85,251	58,025	34,113		213,005
	LP	498	-	-	-	-		498
	PS + LP	13,843	22,271	85,251	58,025	34,113		213,503

- : 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 2006 by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore the grand total may not equal the sums of the individual flags.

TABLA A-12b. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2006, por bandera y arte de pesca. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el "Total general"; por consiguiente, los totales generales no equivalen necesariamente a las sumas de las banderas individuales.

Flag Bandera	Gear Arte	Well volume — Volumen de bodega (m^3)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m^3)
		Number—Número						
BOL	PS	1	-	-	-	-	1	222
COL	PS	2	1	7	3	-	13	14,439
ECU	PS	36	19	17	4	8	84	58,087
ESP	PS	-	-	-	-	3	3	6,955
GTM	PS	-	-	-	1	-	1	1,475
HND	PS	-	1	2	-	-	3	2,729
MEX	PS	8	11	22	16	-	57	55,830
	LP	4	-	-	-	-	4	498
NIC	PS	-	1	4	2	-	7	8,308
PAN	PS	2	4	9	6	5	26	34,624
SLV	PS	-	1	1	-	3	5	8,184
USA	PS	-	-	-	1	-	1	1,593
VEN	PS	-	-	11	9	2	22	30,788
VUT	PS	-	-	1	1	-	2	2,163
Grand total—Total general	PS	49	38	74	43	21	225	
	LP	4	-	-	-	-	4	
	PS + LP	53	38	74	43	21	229	
		Well volume—Volumen de bodega (m^3)						
Grand total—Total general	PS	12,539	22,428	82,451	62,694	45,285		225,397
	LP	498	-	-	-	-		498
	PS + LP	13,037	22,428	82,451	62,694	45,285		225,895

- : 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 l996-2005 and in 2006, 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 1996-2005 y en 2006 por mes.

Month Mes	1996-2005			2006
	Min	Max	Ave-Prom	
1	67.0	144.3	103.9	157.7
2	67.9	150.8	113.5	175.3
3	70.3	149.8	110.8	159.4
4	75.9	143.0	114.9	164.2
5	65.3	147.9	111.0	164.4
6	78.2	162.9	113.9	161.4
7	73.3	155.5	117.1	167.6
8	62.2	140.2	105.3	96.6
9	78.9	137.7	109.2	137.7
10	75.1	172.2	119.3	168.2
11	76.6	145.0	111.2	127.4
12	33.1	116.4	75.0	66.2
Ave-Prom	68.7	147.1	108.8	145.5

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 cannot be estimated with currently-available tagging data.

The stock assessment requires a substantial amount of information. This includes data on retained catch, discards, fishing effort, and the size compositions of the catches from several different fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality, and stock structure. Several inputs into the latest assessment differ from those used for 2005 (IATTC Fishery Status Report 4). Recent catch and effort data have been incorporated, and earlier data have been updated. The catches are shown in Figure B-1.

Significant levels of fishing mortality have been observed in the yellowfin tuna fishery in the EPO (Figure B-2). These levels are greatest for middle-aged yellowfin. Both recruitment (Figure B-3) and exploitation have had substantial impacts on the yellowfin biomass trajectory (Figure B-4). Most of the yellowfin catch is taken in sets associated with dolphins, and, accordingly, this fishery has the greatest impact on the yellowfin population (Figure B-4), although it has almost the least impact per weight captured of all fisheries. It appears that the yellowfin population has experienced two, or possibly three, different recruitment regimes (1975-1982, 1983-2001, and possibly 2002-2006) corresponding to low, high, and intermediate recruitments The recruitment regimes correspond to regimes in biomass, with higher-recruitment regimes producing greater biomasses. The spawning biomass ratio (the ratio of the current spawning biomass to that for the unfished stock; SBR) of yellowfin in the EPO was below the level corresponding to the average maximum sustainable yield (AMSY) during the lower productivity regime of 1975-1982 (which corresponds to SBR levels in 1977-1984), but above that level during the following years, except for the most recent period (2004-2007, Figure B-5). The 1984 increase in the SBR is attributed to the regime change, and the recent decrease may be a reversion to an intermediate recruitment regime. The two different productivity regimes may support two different AMSY levels and associated SBR levels.

The current SBR is estimated to be below the SBR level at AMSY (Figure B-5). However, there is substantial uncertainty in the most recent estimate of SBR, so there is a moderate probability that the current SBR is above the level that would support the AMSY. The effort levels are estimated to be above those capable of supporting the AMSY (Table B-1 based on the recent (2004-2006) distribution of effort among the different fisheries). However, there is substantial uncertainty in these estimates, so there is a moderate probability that the effort levels are less than those capable of supporting the AMSY (Figure B-8). Future projections under the current effort levels and average recruitment indicate that the population will remain at approximately the same level over the next five years (Figure B-6). These simulations were carried out using the average recruitment for the 1975-2006 period. Both the purse-seine and longline catches of 2007 are expected to be greater than those of 2006 (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, these have been followed by weaker recruitments, so the size of the spawning stock decreased during 2002-2006. The biomass in 2005-2007 was at levels similar to those prior to 1985.

The overall average weights of yellowfin tuna that are caught have consistently been much less than those that would maximize the 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.

It is predicted that, with the 2006 level of fishing effort, the conservation measures imposed in 2004 under Resolution C-04-09 would maintain the stock at about the AMSY level, slightly higher than would otherwise have been the case.

Catches during 2006 and the first quarter of 2007 have been markedly less than those of the same period in 2004 and 2005. The most likely cause of lesser catches is a decline in recruitment.

A sensitivity analysis was carried out to estimate the effect of a stock-recruitment relationship and alternative average maximum lengths of yellowfin. The results suggest that the model with a stock-recruitment relationship fits the data slightly better than the base case, but this result could also be explained by a regime shift, since spawning biomass is low during the period of low recruitment and high during that of high recruitment. The results from the analysis with a stock-recruitment relationship are more pessimistic, suggesting that the effort level is greater than that corresponding to the 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 results are similar to those of the previous assessments, except that the current SBR is less than that corresponding to the AMSY.
2. There is uncertainty about recent and future recruitment and biomass levels.
3. The recent fishing mortality rates are about equal to those required to produce AMSY.
4. Increasing the average weight of the yellowfin caught could increase AMSY.
5. There have been two, and possibly three, different recruitment regimes, and the levels of AMSY and the biomasses corresponding to the AMSY may differ between the regimes. The population may have recently switched from the high to an intermediate recruitment regime.
6. The results are more pessimistic if a stock-recruitment relationship is assumed.

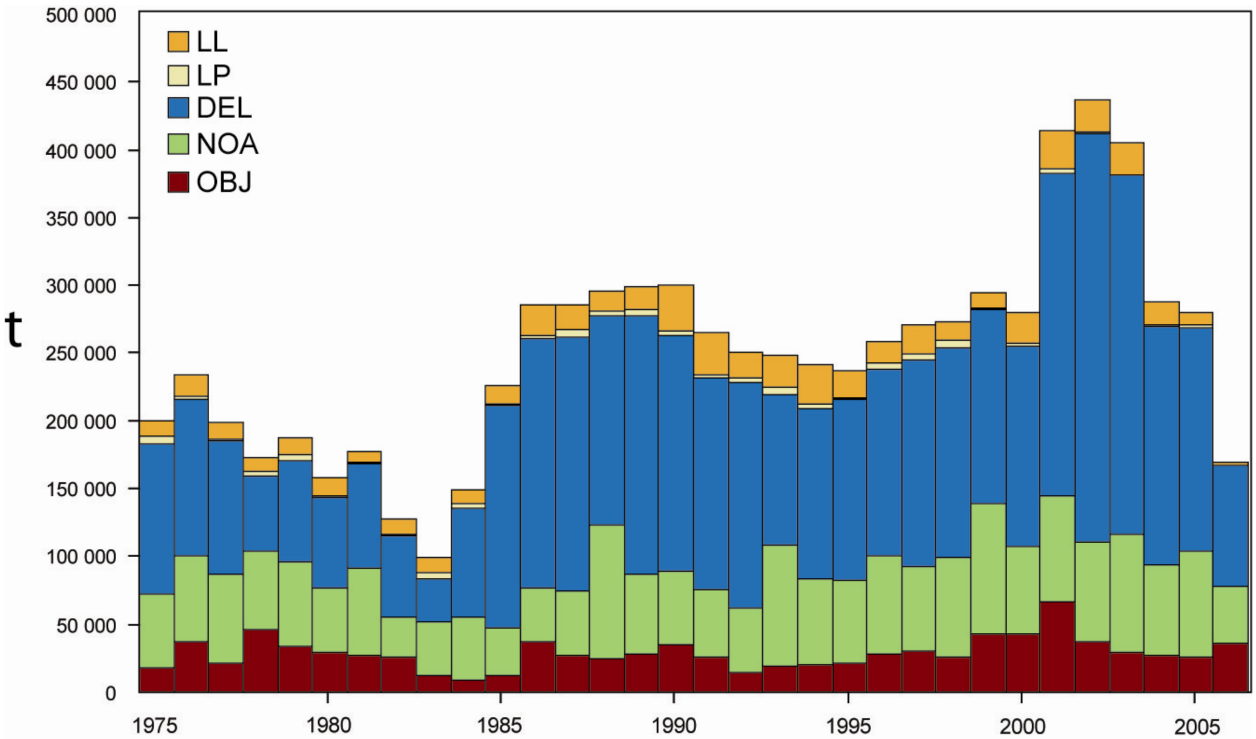

FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2006. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. 2006 catches are provisional.

FIGURA B-1. Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco, y capturas retenidas de las pesquerías cañera y palangreras, de atún aleta amarilla en el Océano Pacífico oriental, 1975-2006. Las capturas cerqueras están ajustadas a la estimación de la composición por especie obtenida del muestreo de las capturas. Las capturas de 2006 son provisionales.

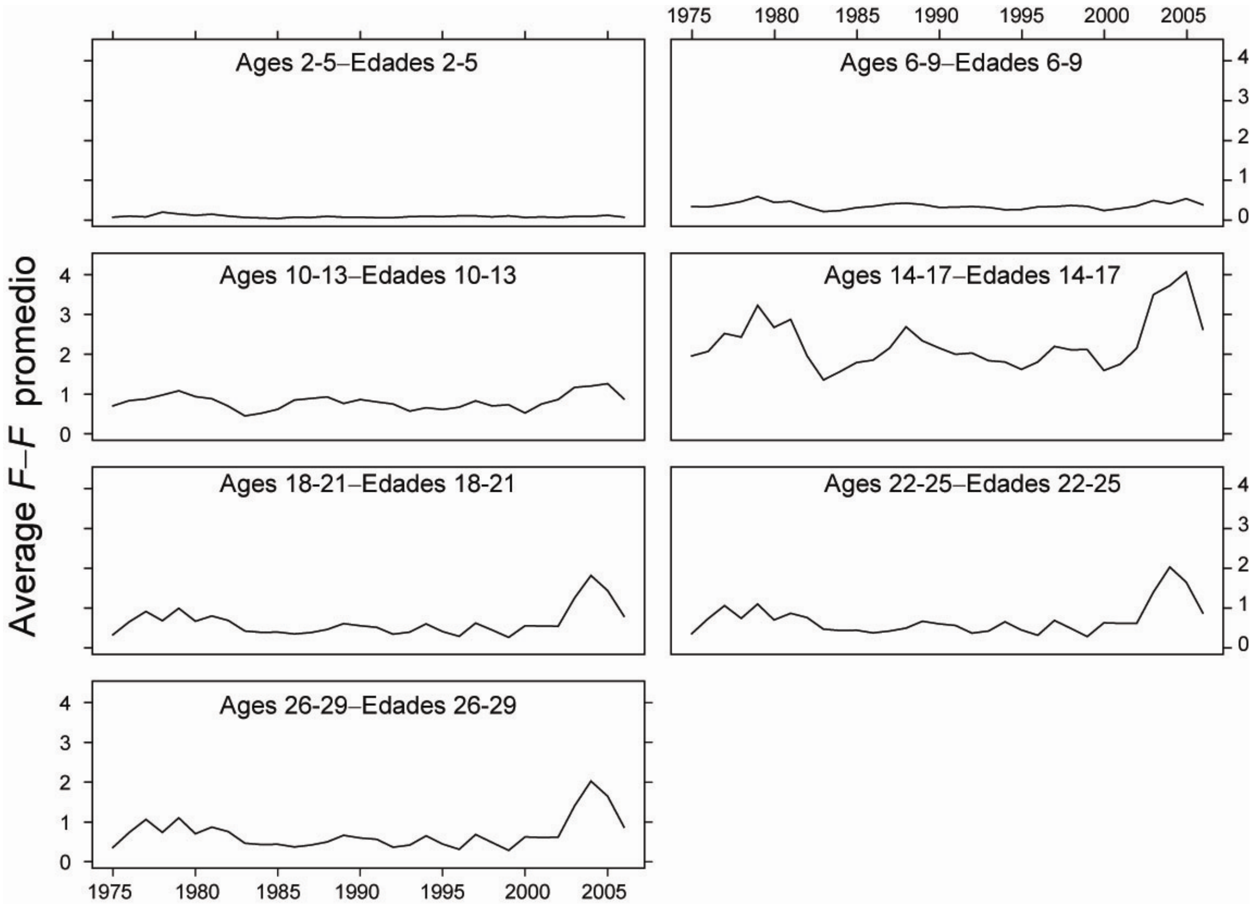

FIGURE B-2. Average total annual fishing mortality of yellowfin tuna that have been recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish of the age range indicated in the title of each panel. For example, the trend illustrated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

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

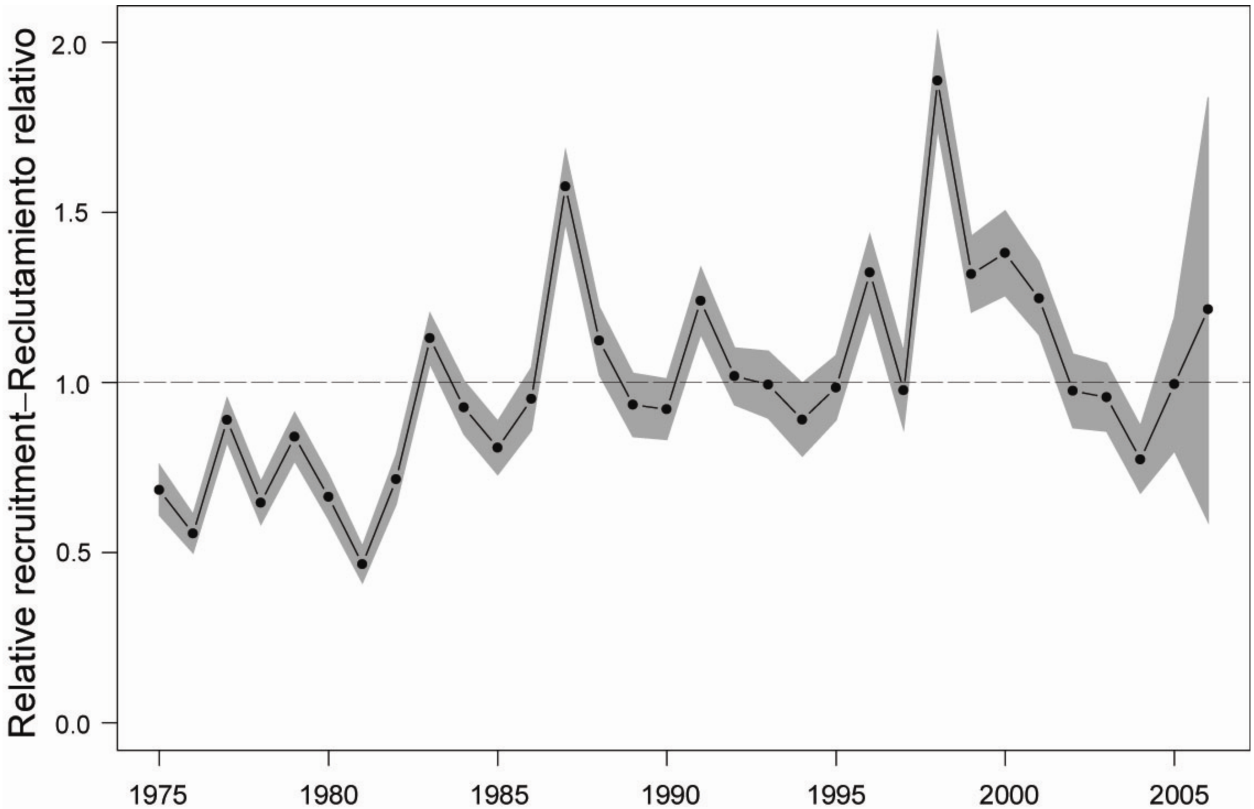

FIGURE B-3. Estimated recruitment of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The bold line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.
FIGURA B-3. Reclutamiento estimado de atún aleta amarilla a las pesquerías del OPO. Se escalan las estimaciones para que el reclutamiento medio equivalga a 1,0. La línea gruesa ilustra las estimaciones de probabilidad máxima del reclutamiento, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

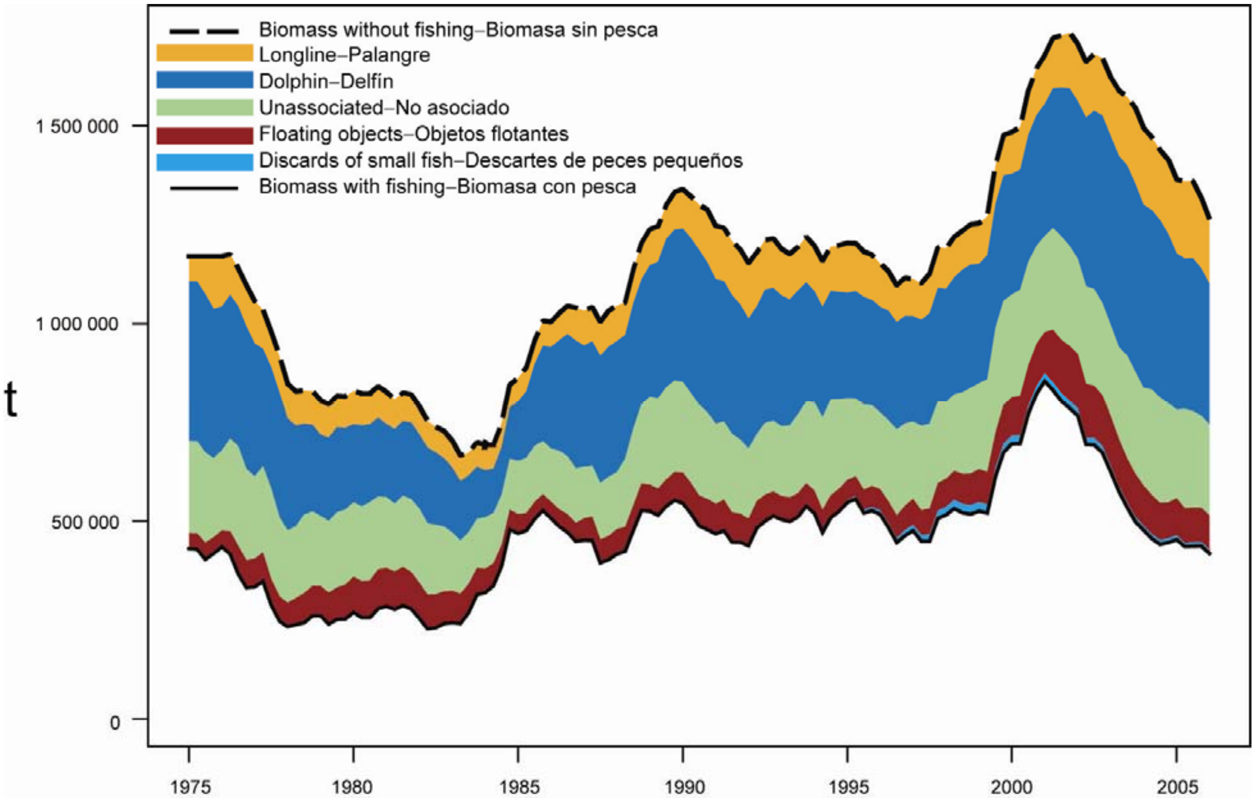

FIGURE B-4. Biomass trajectory of a simulated population of yellowfin tuna that was not exploited during 1975-2006 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing method.
FIGURA B-4. Trayectoria de la biomasa de una población simulada de atún aleta amarilla no explotada durante 1975-2006 (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.

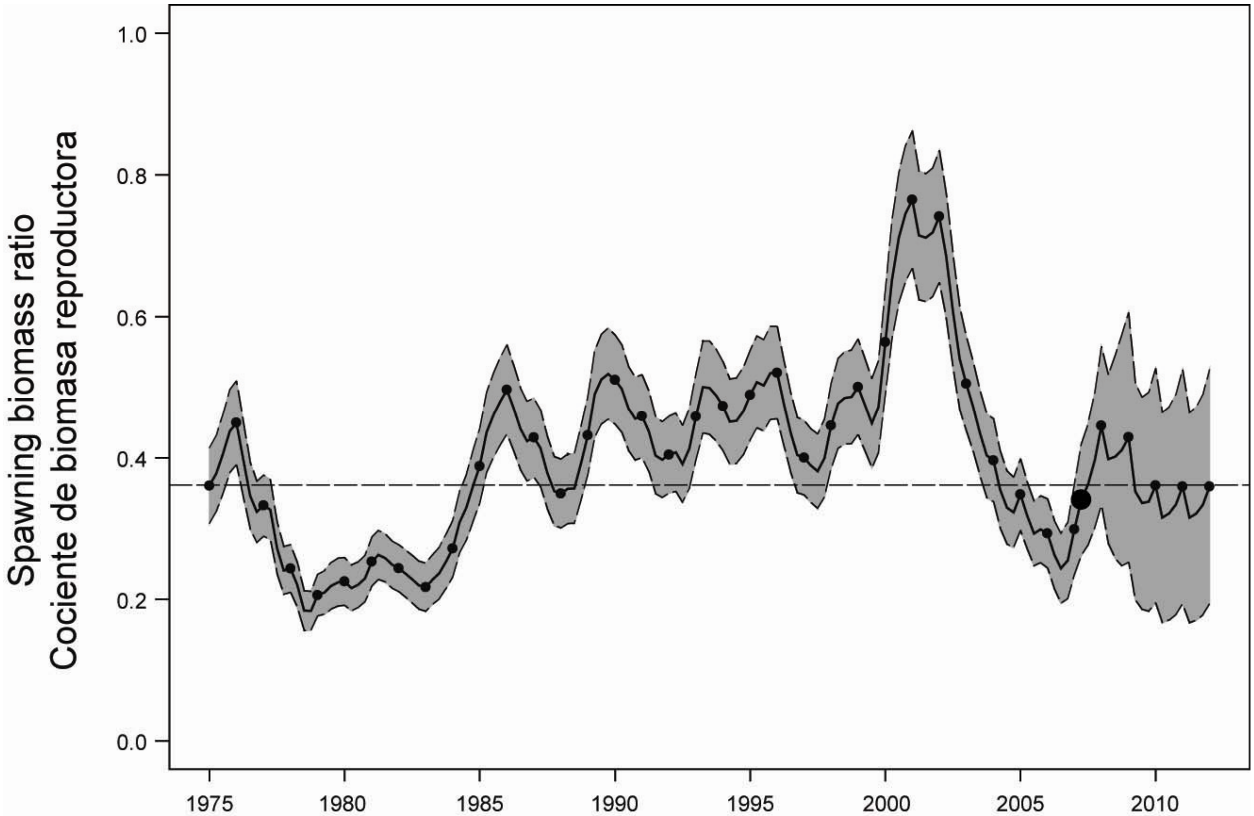

FIGURE B-5. Spawning biomass ratios (SBRs) for 1975-2006 and SBRs projected during 2007-2012 for yellowfin tuna in the EPO. The dashed horizontal line (at 0.37) identifies SBR_{AMSY}. The shaded area represents the 95% confidence limits of the estimates. The estimates after 2007 (the large dot represents the start of the second quarter of 2007) indicate the SBR predicted to occur if effort continues at the level of 2006, catchability (with effort deviates) continues at the average for 2004 and 2005, and average environmental conditions occur during the next five years.

FIGURA B-5. Cocientes de biomasa reproductora (SBR) de 1975-2006 y SBR proyectados durante 2007-2012 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 2007 (el punto grande representa el principio del segundo trimestre de 2007) señalan el SBR predicho si el esfuerzo continúa en el nivel observado en 2006, la capturabilidad (con desvíos de esfuerzo) continúa en el promedio de 2004 y 2005, y ocurren condiciones ambientales medias en los cinco años próximos.

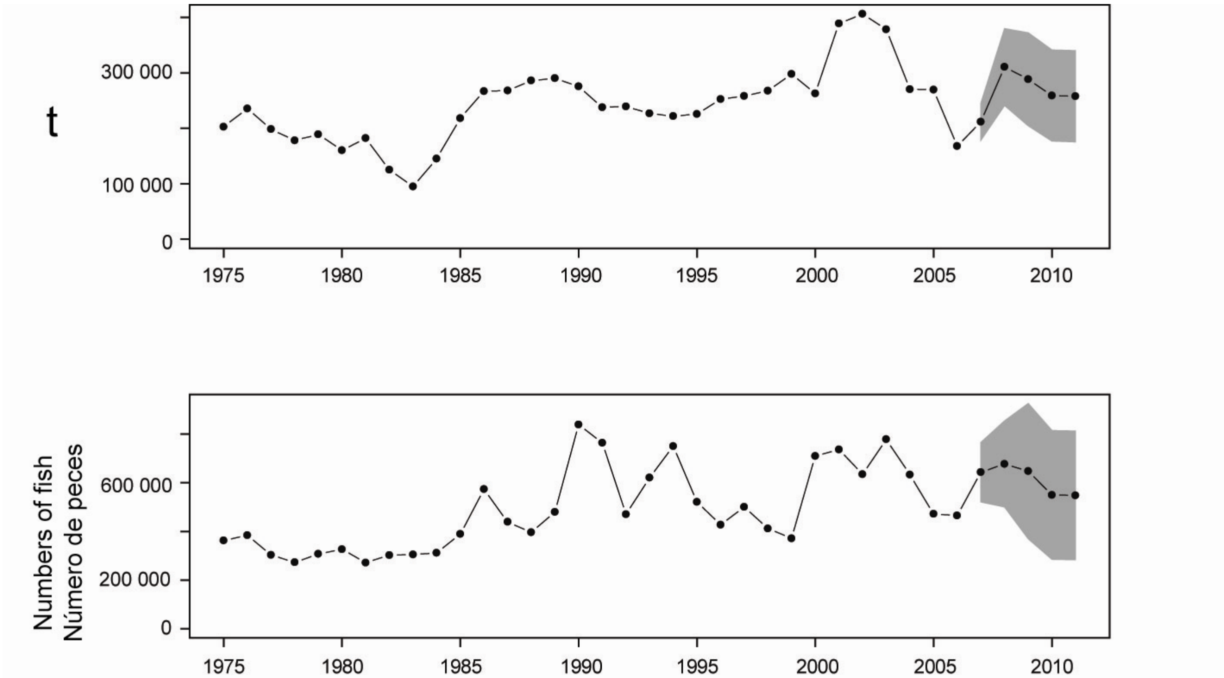

FIGURE B-6. Catches of yellowfin tuna during 1975-2006 and simulated catches of yellowfin tuna during 2007-2011 taken by the purse-seine and pole-and-line fleets (upper panel) and the longline fleet (lower panel). The shaded area represents the 95% confidence limits of the estimates.

FIGURA B-6. Capturas de atún aleta amarilla durante 1975-2006 y capturas simuladas de aleta amarilla durante 2007-2011 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.

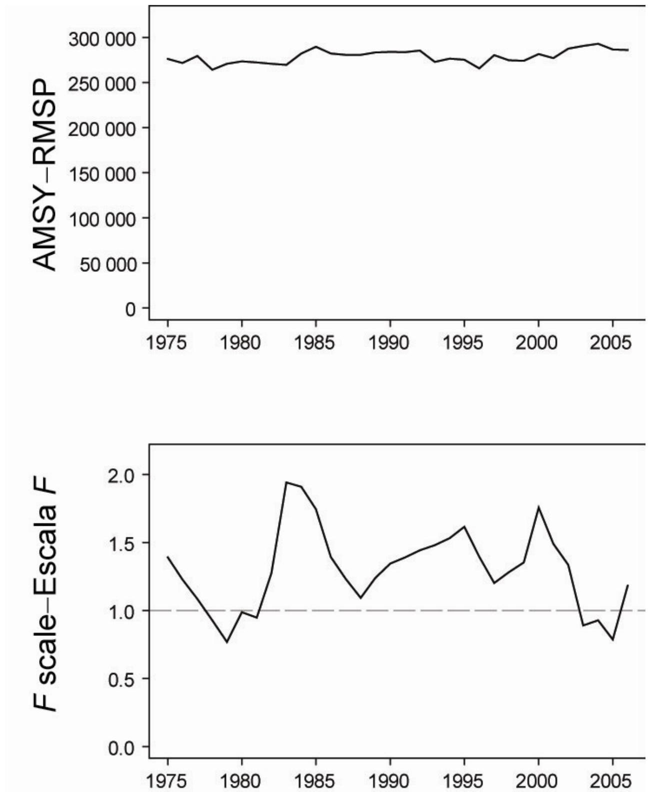

FIGURE B-7. AMSY (upper panel), 1975-2006, and the change (increase or reduction) in the effort corresponding to the AMSY (lower panel), estimated separately for each year, using the average age-specific fishing mortality for that year.
FIGURA B-7. RMSP (recuadro superior), 1975-2006, y cambio (aumento 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.

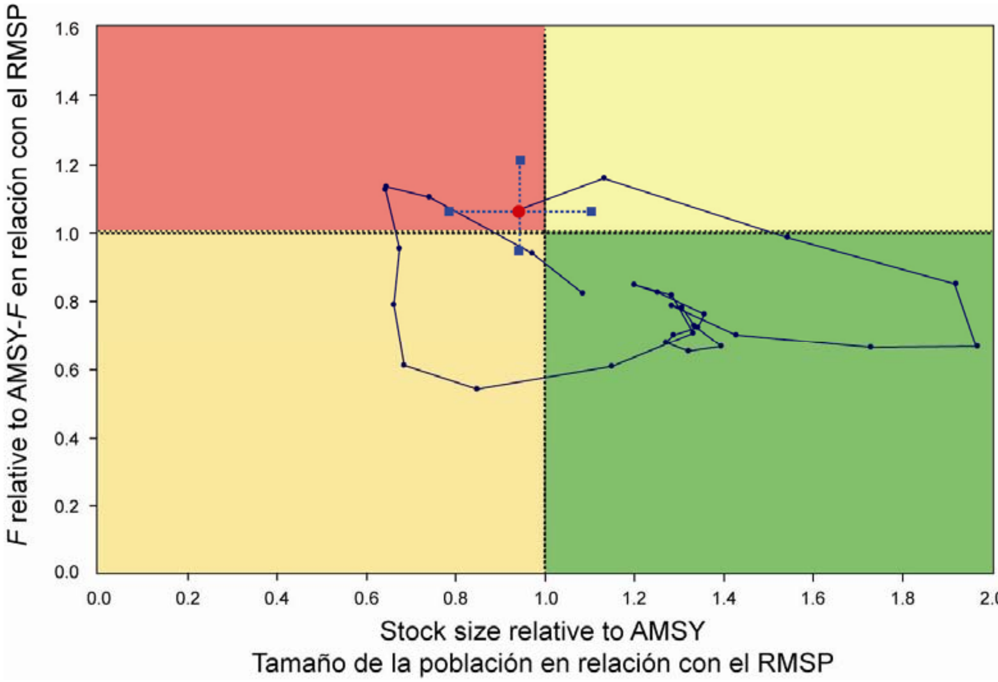

FIGURE B-8. Phase plot of the time series of estimates for stock size and fishing mortality relative to their AMSY reference points. Each dot is a running average of three years; the large red dot indicates the most recent estimate. The squares represent approximate 95% confidence intervals.
FIGURA B-8. Gráfica de fase de la serie de tiempo de las estimaciones del tamaño de la población y la mortalidad por pesca en relación con sus puntos de referencia de RMSP. Cada punto representa un promedio móvil de tres años; el punto rojo grande indica la estimación valor más reciente. Los puntos cuadrados representan los intervalos de confianza de 95% aproximados.

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 2004 to 2006. B_{recent} and B_{AMSY} are the biomass of yellowfin tuna 2+ quarters old at the start of the second quarter of 2007 and at AMSY, respectively, and S_{2007}, S_{AMSY}, and S_0 are indices of spawning biomass (relative number of eggs) at the start of 2007, at AMSY, and without fishing, respectively. C_{2006} is the estimated total catch in 2006.
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 2004-2006. $B_{reciente}$ y B_{RMSP} son la biomasa de peces de 2+ trimestres de edad al principio del segundo trimestre de 2007 y en RMSP, respectivamente, y S_{2007},S_{RMSP}, y S_0 son índices de la biomasa reproductora (número relativo de huevos) al principio de 2007, en RMSP, y sin pesca, respectivamente. C_{2006} es la captura total estimada en 2006.

	Base case Caso base	**h = 0.75**
AMSY–RMSP	288,569	300,990
B_{AMSY} –B_{RMSP}	416,324	549,570
S_{AMSY} —S_{RMSP}	4,712	6,519
C_{2006}/AMSY—C_{2006}/RMSP	0.59	0.56
B_{recent}/B_{AMSY} –$B_{reciente}/B_{RMSP}$	0.96	0.73
S_{2007}/S_{AMSY} –S_{2007}/S_{RMSP}	0.95	0.68
$S_{AMSY}/S_{F=0}$ –$S_{RMSP}/S_{F=0}$	0.36	0.42
F multiplier—Multiplicador de *F*	0.96	0.65

C. SKIPJACK TUNA

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

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 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 fish-aggregating devices (FADs) in the early 1990s, which was associated with a southward expansion of the fishery (Figure C-2). The fishing mortality (Figure C-3) was 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 that 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 about 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 (weight at which the gain to the total weight of a cohort due to growth is equal to the weight loss to that cohort due to natural mortality) is less than the average weight at recruitment to the fishery. However, this 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 an analysis described in IATTC Stock Assessment Report 7, in which an index of relative abundance was developed from the ratio of skipjack to bigeye tuna in the floating-object fishery, were consistent with previous assessments, and suggest that there is no management concern for skipjack tuna, apart from the associated catch of bigeye in floating-object sets.

In 2007, trends in several indicators of stock status were examined (Figure C-6). Recent increases in catch per unit effort (CPUE), which suggested a healthy stock, contrasted with increased fishing effort and decreased average weight, suggesting high exploitation rates. A simple population model fitted to CPUE and catch data showed that the inconsistency could be explained by increases in both exploitation rate and abundance. Alternatively, it is possible that the vunerability of skipjack to purse-seine fishing is increasing. Further work is needed for this analysis to provide clear information about the state of the stock.

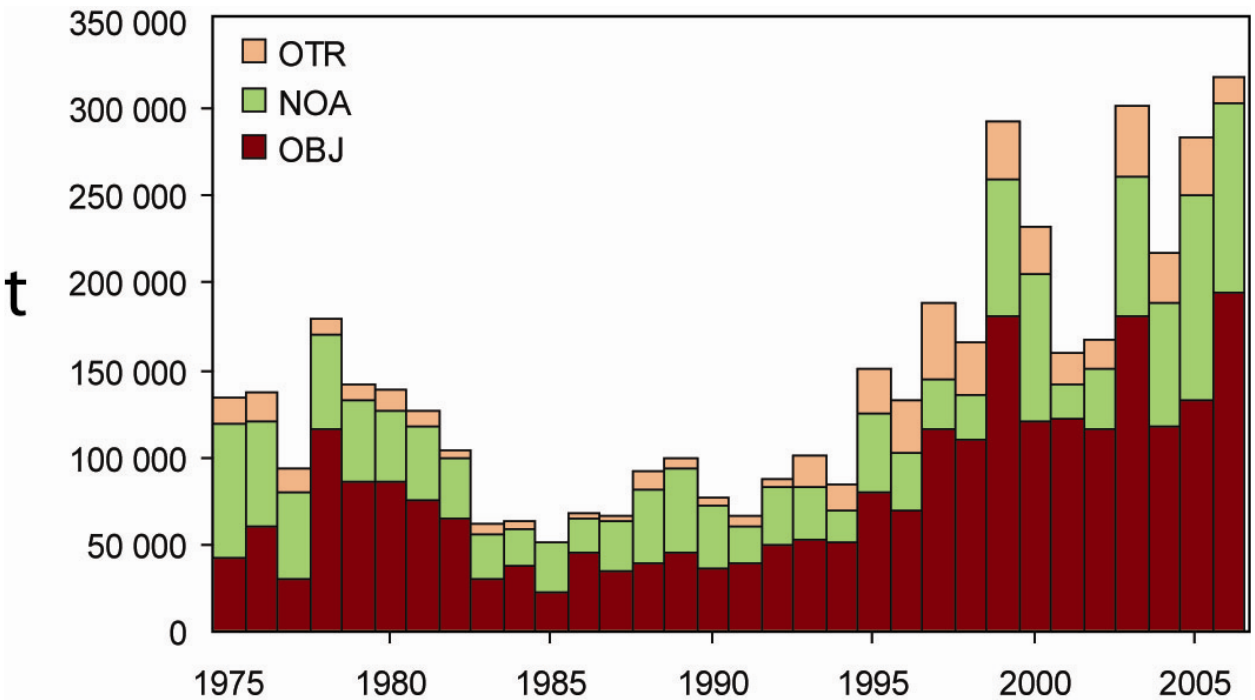

FIGURE C-1. Total catches (retained catches plus discards) of skipjack tuna by the purse-seine fisheries on floating objects and unassociated schools, and by other fisheries combined, in the eastern Pacific Ocean, 1975-2006. The purse-seine catches for 1975-2006 are adjusted to the species composition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

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

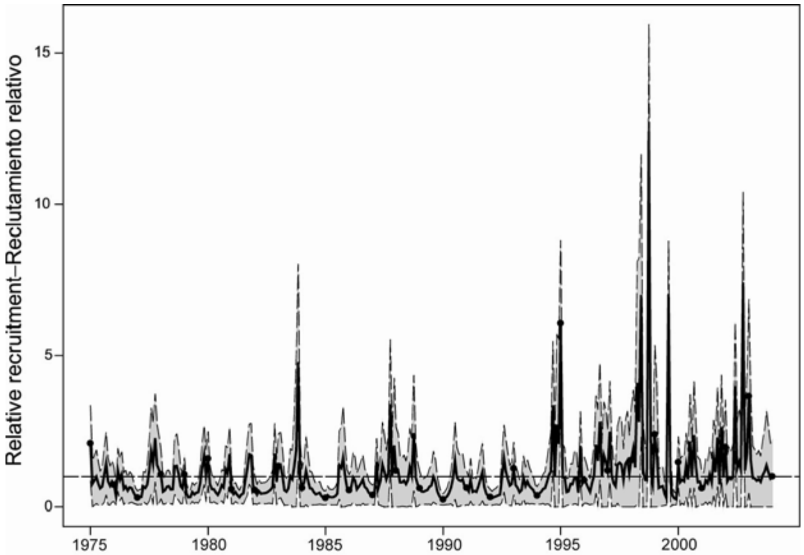

FIGURE C-2. Estimated recruitment of skipjack tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0. The solid line illustrates the maximum-likelihood estimates of recruitment, and the shaded area the 95% confidence intervals. The labels on the time 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.

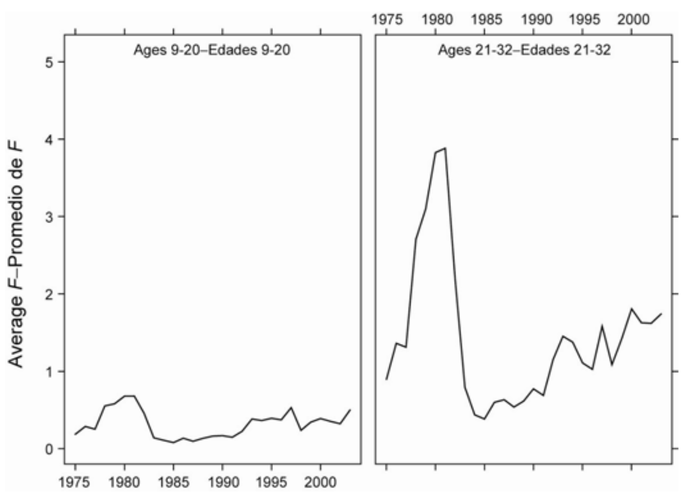

FIGURE C-3. Average total monthly fishing mortality of skipjack tuna recruited to the fisheries of the EPO. Each panel illustrates an average of 12 monthly fishing mortality vectors that affected fish of the age range indicated in the title of each panel. For example, the trend illustrated in the left 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.

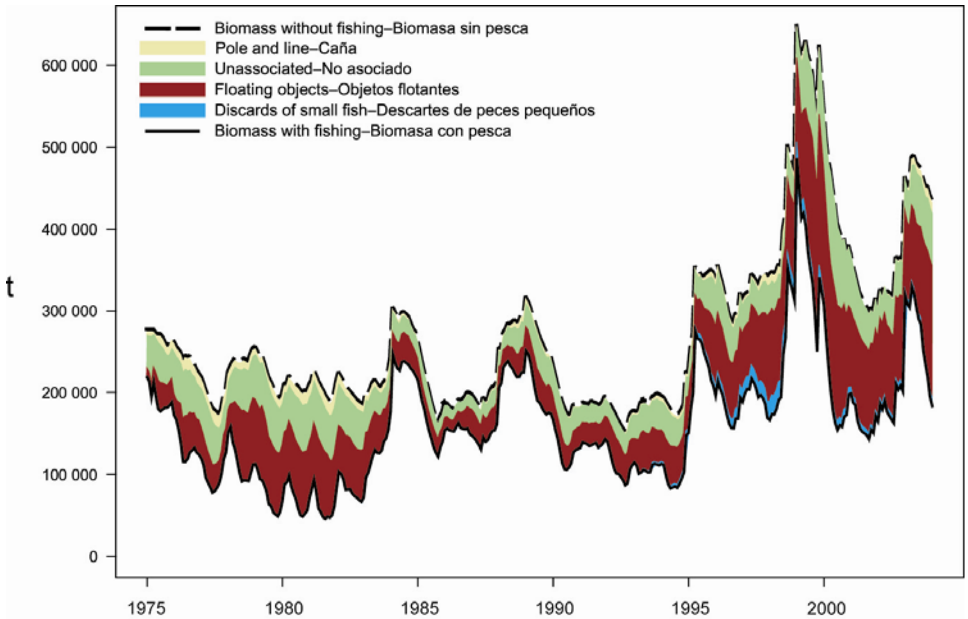

FIGURE C-4. Biomass trajectory of a simulated population of skipjack tuna that was not exploited during 1975-2004 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines represent the portion of the fishery impact attributed to each fishing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

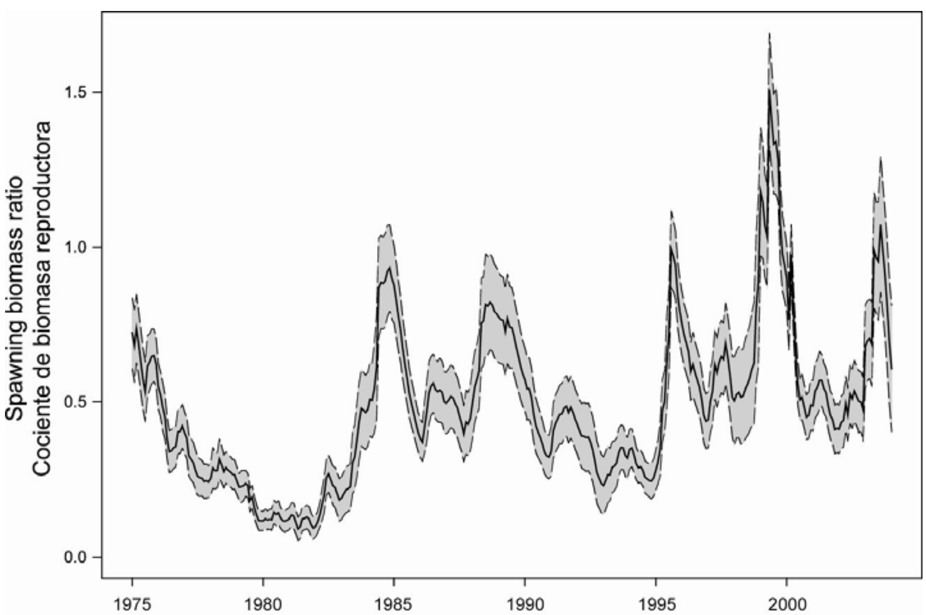

FIGURE C-5. Estimated spawning biomass ratios (SBRs) for skipjack tuna in the EPO, from the monotonic selectivity assessment. The shaded area represents the 95% confidence limits of the estimates.
FIGURA C-5. Series de tiempo estimadas de los cocientes de biomasa reproductora (SBR) de atún barrilete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

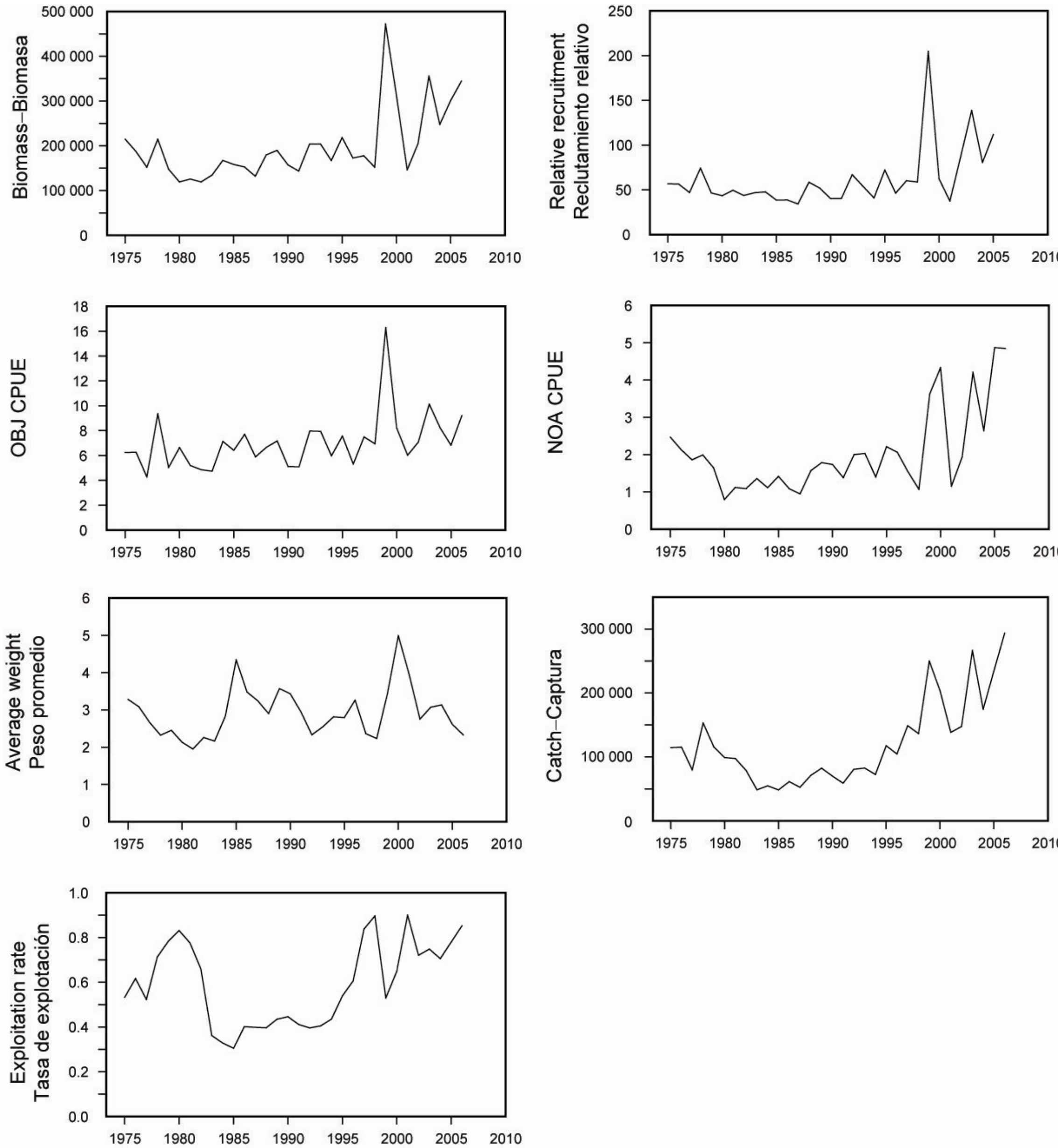

FIGURE C-6. Indicators of stock status based on data and/or a simple stock assessment model.
FIGURA C-6. Indicadores de condición de la población basados en datos y/o en un modelo sencillo de evaluación de población.

D. BIGEYE TUNA

There have been substantial changes in the bigeye tuna fishery in the eastern Pacific Ocean (EPO) over the last 15 years. Initially, the majority of the bigeye catch was taken by longline vessels, but with the expansion of the fishery on fish associated with fish-aggregated devices (FADs) since 1993, the purse-seine fishery has taken an increasing proportion of the bigeye catch (Figure D-1). The FAD fishery captures smaller bigeye, and has therefore reduced the yield per recruit and the 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-2).

An age-structured catch-at-length model, Stock Synthesis II (SS2), was used in this assessment of the bigeye stock of the EPO. Previous assessments were conducted with the A-SCALA model. There are several differences between the two models, but their general structure and the data used are the same (see Report of Workshop on Stock Assessment Methods[1]). The details of the stock assessment are available on the IATTC web site[2].

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 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 are not often caught by purse seiners in the EPO north of 10ºN (Figure A-3), but a substantial portion of the longline catches of bigeye in the EPO is made north of that parallel (Figure A-4). Bigeye tuna do not move long distances (95% of tagged bigeye showed net movements of less than 1000 nautical miles), and current information indicates little exchange between the eastern and western Pacific Ocean (Figure D-3). This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at 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 Ocean.

Several inputs into the current assessment differ from that for 2005. Recent catch and CPUE data have been incorporated, and earlier data have been updated.

There are several important features in the estimated time series of bigeye recruitment (Figure D-4). The estimates of recruitment before 1993 are very uncertain, as the 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. Recruitment has been above average since 2000. The most recent recruitment is very uncertain, due to the fact that recently-recruited bigeye are represented in only a few length-frequency data sets. The extended period of relatively high recruitment during 1995-1998 coincided with the expansion of the fisheries that catch bigeye in association with floating objects.

The biomass of 3+-quarter-old bigeye increased during 1983-1984, and reached its peak of about 615,000 t in 1986, after which it decreased to an historic low of about 279,000 t at the beginning of 2005. Spawning biomass has generally followed a trend similar to that for the biomass of 3+-quarter-olds, but lagged by 1-2 years. The biomasses of both 3+-quarter-old fish and spawners are estimated to have increased slightly after 2005.

The estimated trajectory of the spawning biomass that would have occurred without fishing and that projected by the assessment model, together with an estimate of the impacts attributed to each fishing

[1] http://www.iattc.org/PDFFiles2/Assessment-methods-WS-Nov05-ReportENG.pdf
[2] http://www.iattc.org/StockAssessmentReportsENG.htm

gear, are shown in Figure D-5.

At the beginning of 2007, the spawning biomass of bigeye in the EPO (Figure D-6) had recovered slightly from the lowest level previously seen. At that time the spawning biomass ratio (the ratio of current spawning biomass to biomass of spawners in the absence of fishing mortality; SBR) was estimated to be about 0.20, about 10% less than the level corresponding to the AMSY (SBR_{AMSY}).

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

In the base case assessment, recent catches are estimated to have been at about the AMSY level (Table D-1). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the AMSY is about 83% of the current (2004-2006) level of effort. 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 that are close to the critical weight. Before the expansion of the floating-object fishery, beginning in 1993, the AMSY was greater than the current AMSY and the fishing mortality (F) was less than F_{AMSY} (Figure D-8). The historical status of the stock is shown in Figure D-9. The two most recent estimates indicate that the bigeye stock in the EPO is overfished ($S < S_{AMSY}$) and that overfishing is taking place ($F>F_{AMSY}$).

Analyses were carried out to assess the sensitivity of the stock assessment results to: 1) incorporating a stock–recruitment relationship; 2) using the CPUE data from the southern longline fishery only; 3) either estimating the growth parameters or assuming estimates for the asymptotic length parameter of the von Bertalanffy growth curve; 4) fitting to initial equilibrium catch; 5) iterative reweighing of the data; 6) using two time blocks for selectivity and catchability of the southern longline fishery; and 7) including the new Japanese longline data.

Of the ten analyses conducted, seven estimated that at the start of 2007 the spawning biomass was below the level corresponding to the AMSY. 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 eight of the scenarios considered, fishing mortality is above the level corresponding to the AMSY.

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

Summary:

1. Recent fishing mortality levels are about 20% 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 two alternative models and data formulations considered in this and previous analyses.

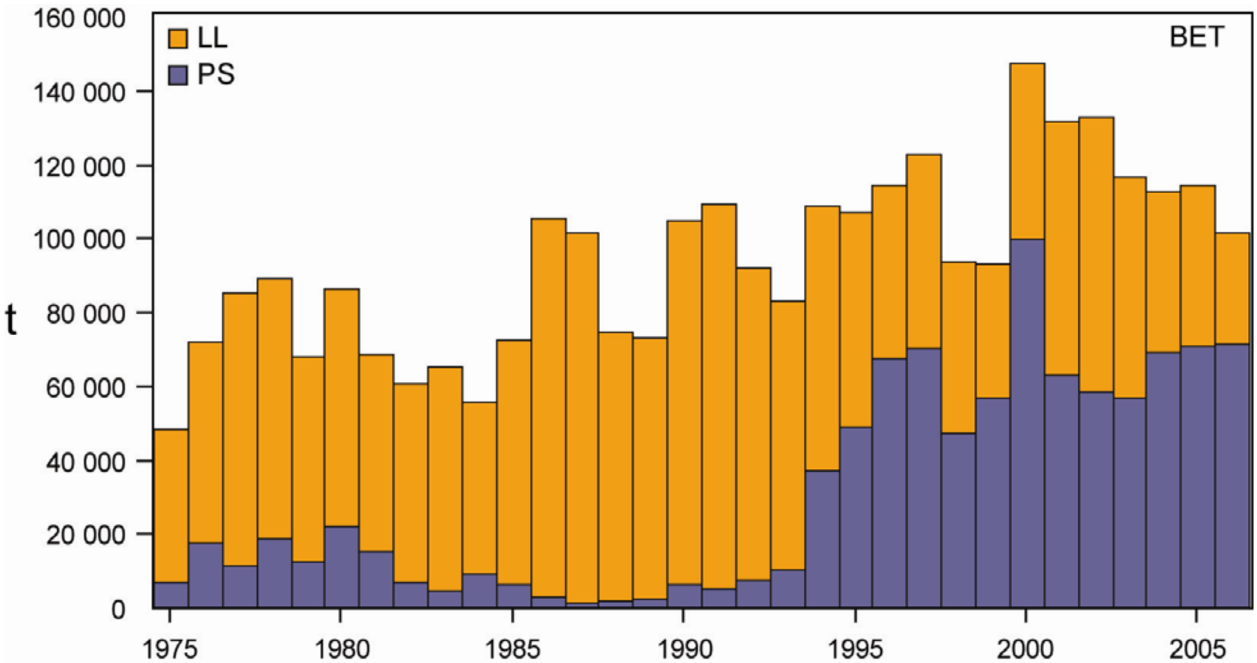

FIGURE D-1. Total catches (retained catches plus discards) of bigeye tuna by the purse-seine fisheries, and retained catches for the longline fisheries, in the eastern Pacific Ocean, 1975-2006. The purse-seine catches are adjusted to the species composition estimate. 2006 catches are provisional.

FIGURA D-1. Capturas totales (capturas retenidas más descartes) de atún patudo por las pesquerías de cerco y capturas retenidas de las pesquerías palangreras en el Océano Pacífico oriental, 1975-2006. Las capturas cerqueras están ajustadas a la estimación de la composición por especie. Las capturas de 2006 son provisionales.

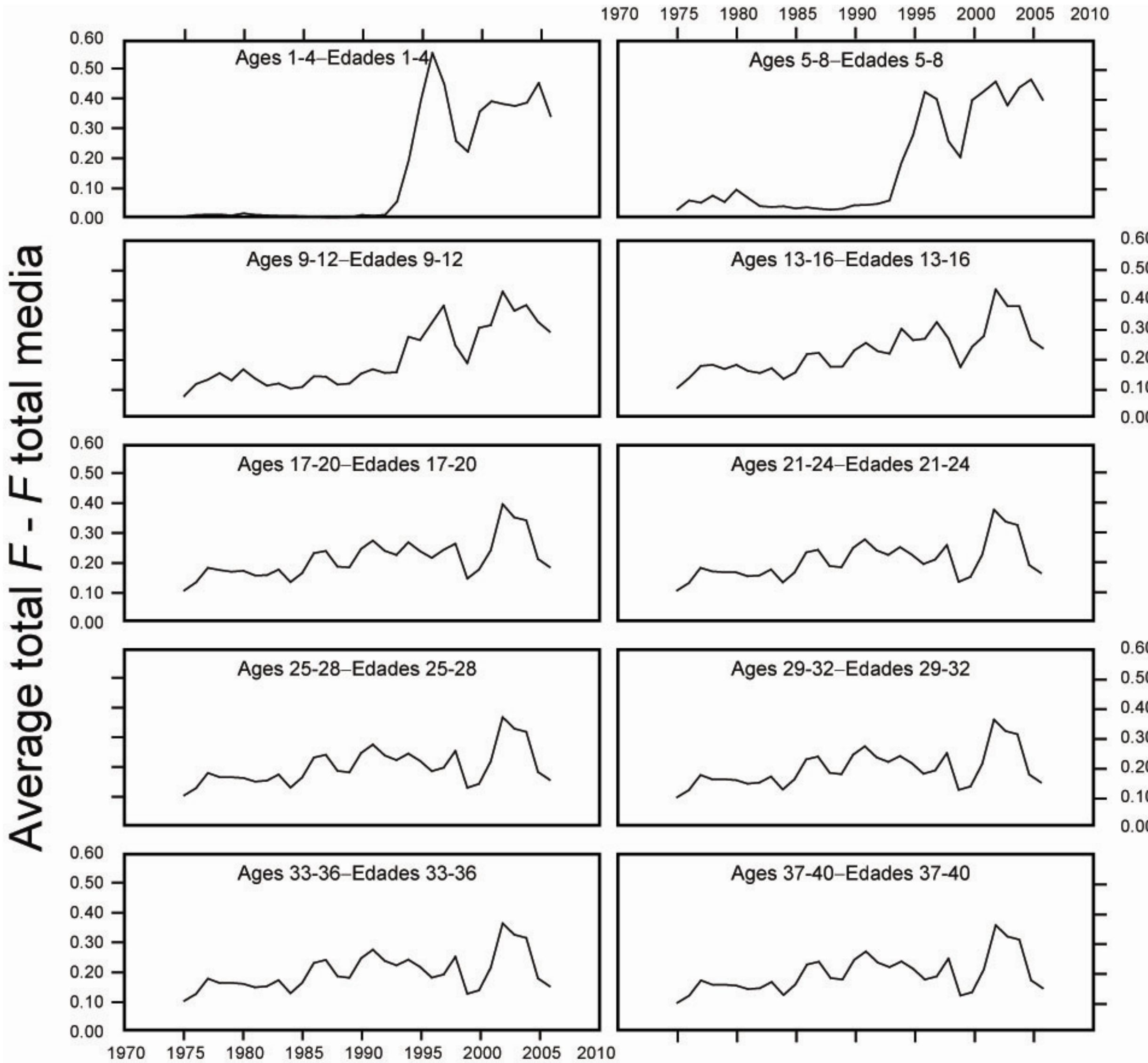

FIGURE D-2. Average annual fishing mortality, by all gears, of bigeye tuna recruited to the fisheries of the EPO. Each panel illustrates an average of four annual fishing mortality vectors that affected the fish in the range of ages indicated in the title of each panel. For example, the trend illustrated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

FIGURA D-2. Mortalidad por pesca anual media, por todas las artes, de atún patudo reclutado a las pesquerías del OPO. Cada recuadro ilustra un promedio de cuatro vectores anuales de mortalidad por pesca que afectaron los peces de la edad indicada en el título de cada recuadro. Por ejemplo, la tendencia ilustrada en el recuadro superior izquierdo es un promedio de las mortalidades por pesca que afectaron a peces de entre 1-4 trimestres de edad.

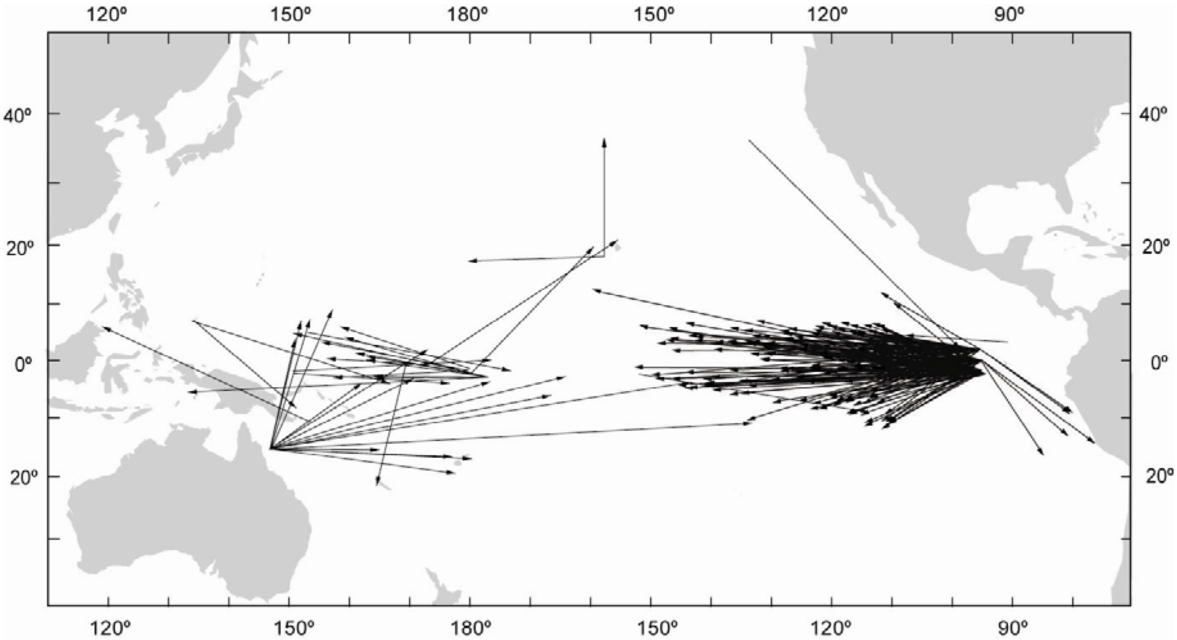

FIGURE D-3. Movements of more than 1000 nm by tagged bigeye tuna in the Pacific Ocean.
FIGURA D-3. Desplazamientos de más de 1000 mn de atunes patudo marcados en el Océano Pacífico.

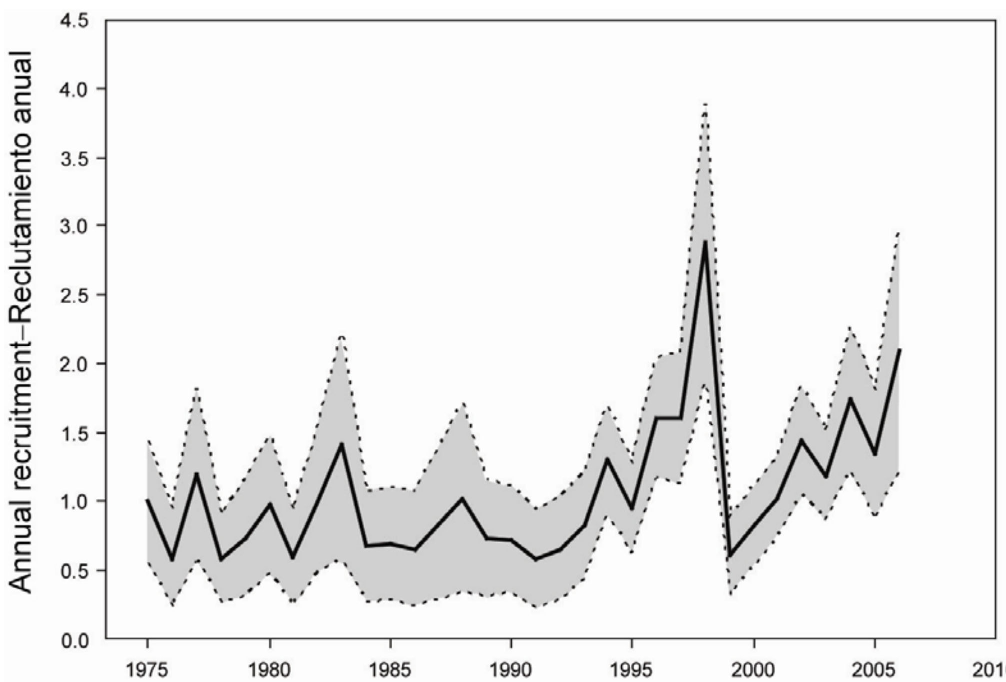

FIGURE D-4. Estimated recruitment of bigeye tuna to the fisheries of the EPO. The estimates are scaled so that the estimate of virgin recruitment is equal to 1.0. The solid line shows the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.
FIGURA D-4. Reclutamiento estimado de atún patudo a las pesquerías del OPO. Se escalan las estimaciones para que la estimación de reclutamiento virgen equivalga a 1,0. La línea sólida indica las estimaciones de reclutamiento de verosimilitud máxima, y el área sombreada indica los intervalos de confianza de 95% aproximados de esas estimaciones.

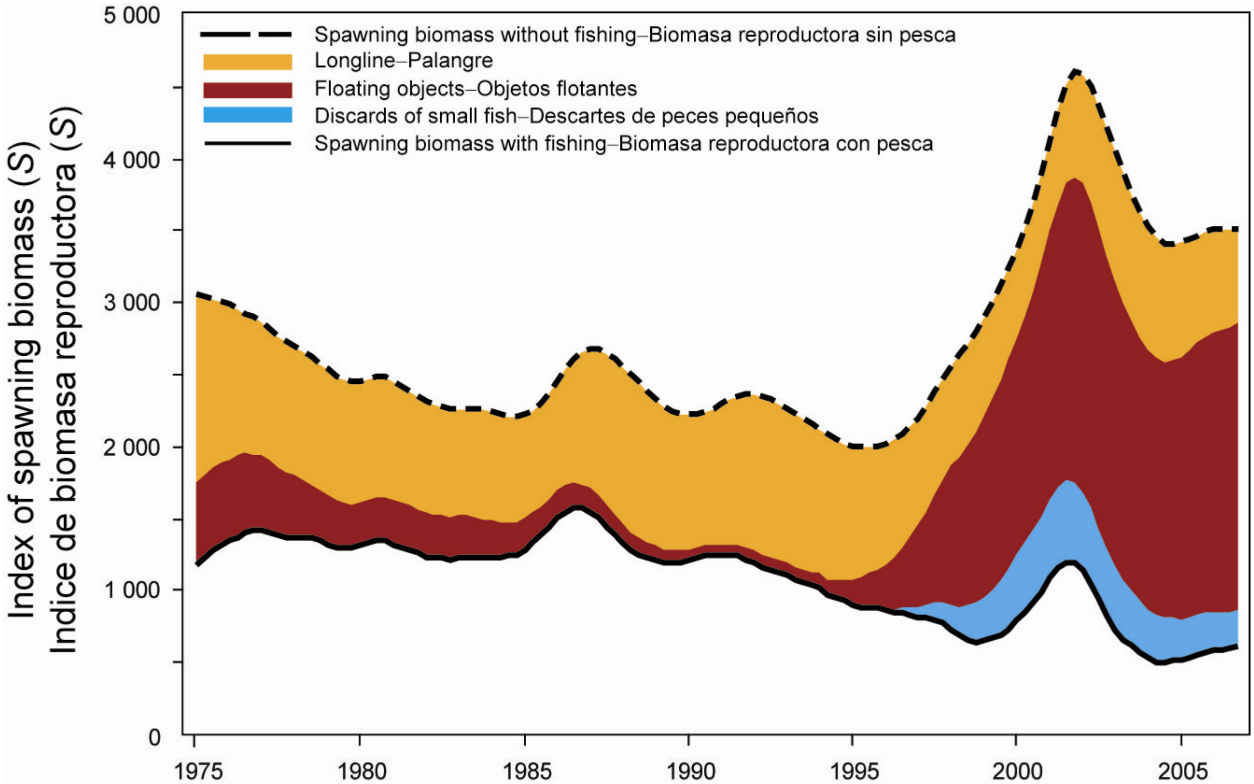

FIGURE D-5. Trajectory of the index of spawning biomass (*S*) of a simulated population of bigeye tuna that was not exploited during 1975-2006 (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishery.

FIGURA D-5. Trayectoria del índice de biomasa reproductora (*S*) de una población simulada de atún patudo no explotada durante 1975-2006 (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.

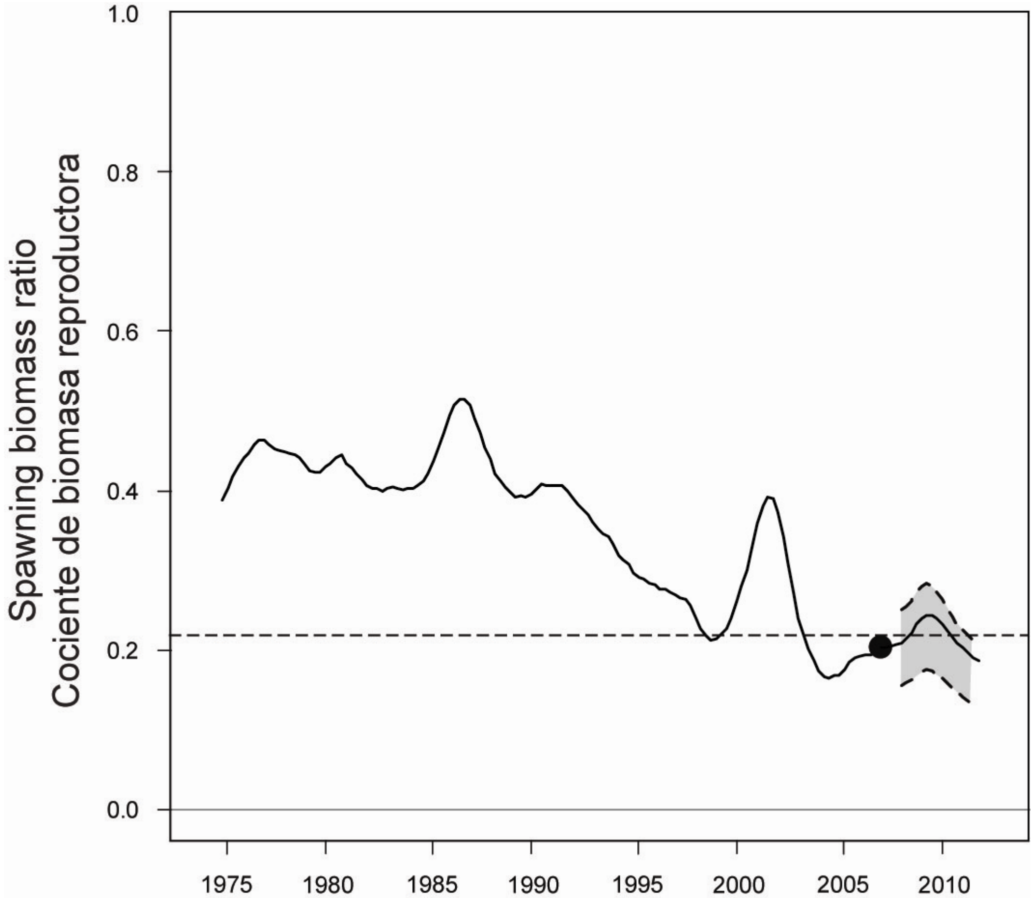

FIGURE D-6. Estimated time series of spawning biomass ratios (SBRs) for bigeye tuna in the EPO. The dashed horizontal line (at about 0.22) identifies the SBR at AMSY. The solid line shows the maximum likelihood estimates,. The estimates after 2007 (the large dot) indicate the SBR predicted to occur if fishing mortality continues at the average for 2004-2006, and average environmental conditions occur during the next five 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. Las estimaciones a partir de 2007 (el punto grande) señalan el SBR predicho si la mortalidad por pesca continúa en el promedio de 2004-2006, y con condiciones ambientales promedio en los cinco próximos años.

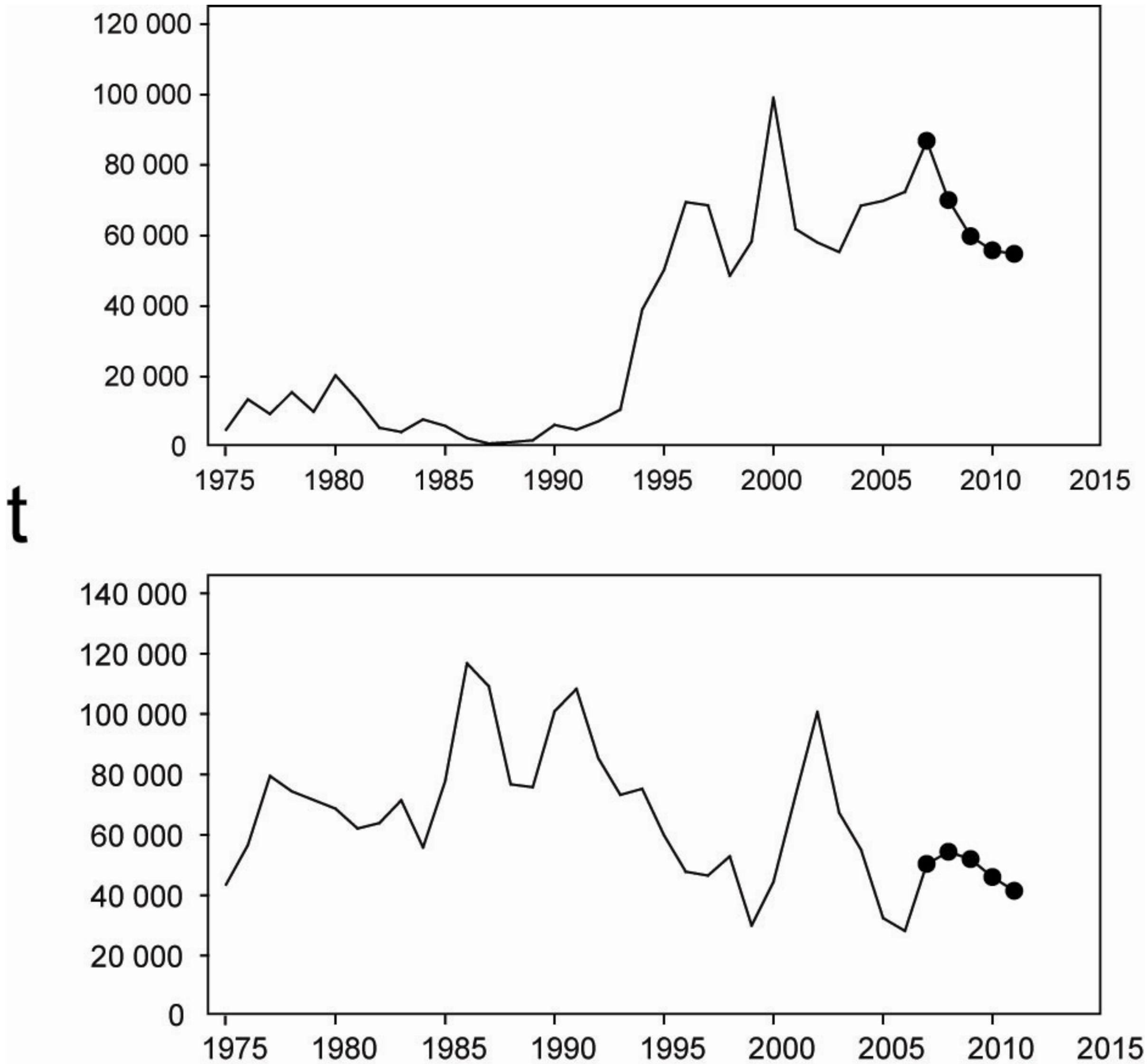

FIGURE D-7. Catches for 1975-2006, and predicted catches for 2007-2012, of bigeye tuna by the purse-seine and pole-and-line (upper panel) and longline (lower panel) fisheries. The predicted catches are based on average fishing mortality for 2004 and 2005

FIGURA D-7. Capturas de patudo durante 1975-2006, y predichas para 2007-2012, por las pesquerías de cerco y de caña (recuadro superior) y de palangre (recuadro inferior). Las capturas predichas se basan en la mortalida por pesca promedio de 2004 y 2005

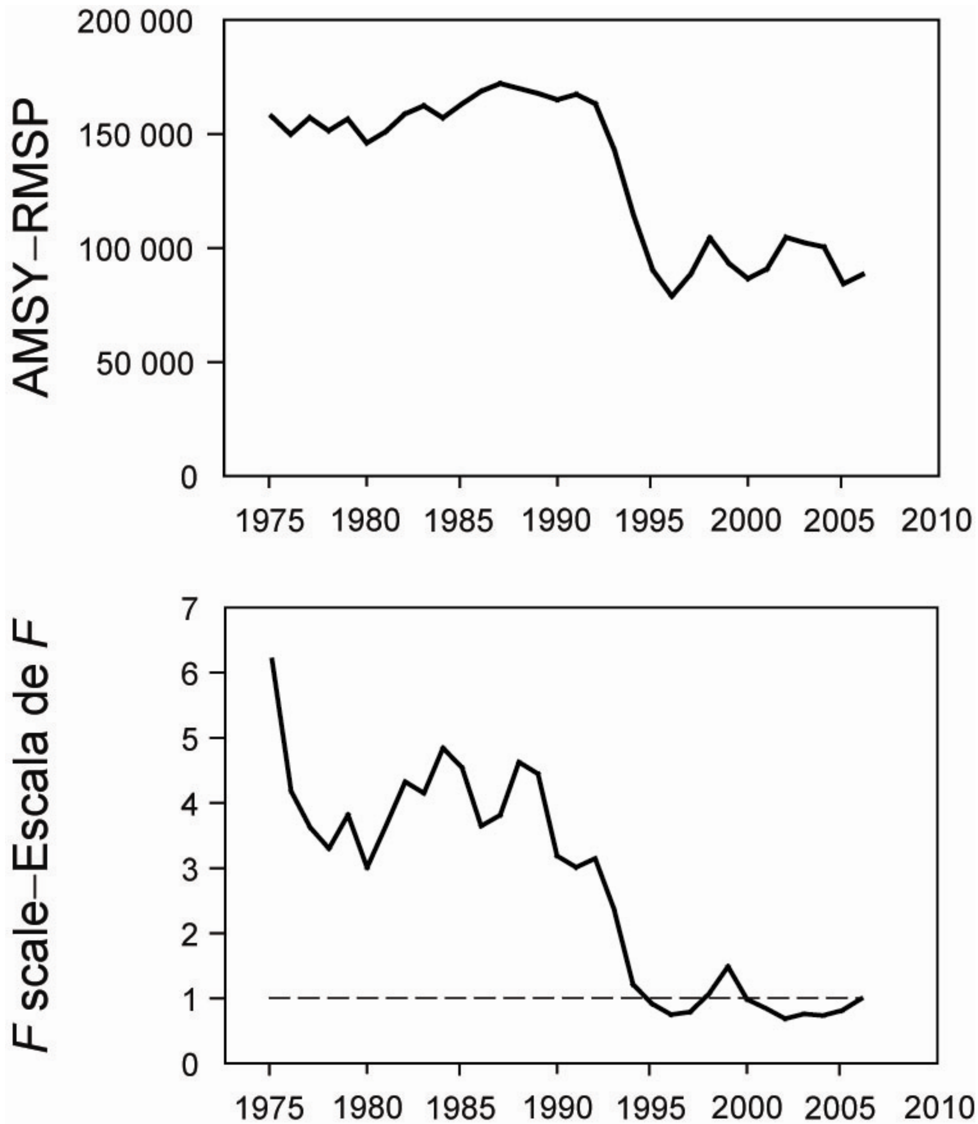

FIGURE D-8. AMSY (upper panel), 1975-2006, and the change (increase or reduction) in the effort required to produce the AMSY (lower panel) for bigeye tuna, estimated separately for each year, using the average age-specific fishing mortality for that year.
FIGURA D-8. RMSP (recuadro superior), 1975-2006, 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.

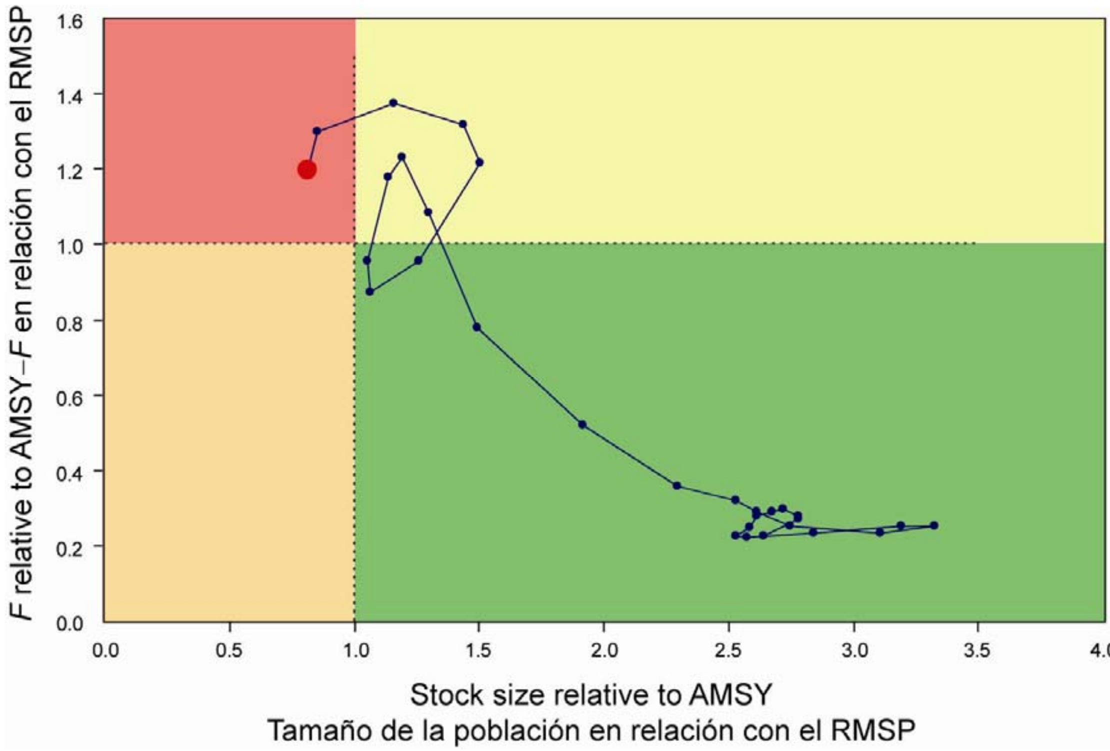

FIGURE D-9. Phase plot of the time series of estimates of stock size and fishing mortality relative to their AMSY reference points. Each dot is a running average of three years. The large red dot indicates the most recent estimate.

FIGURA D-9. Gráfica de fase de la serie de tiempo de las estimaciones del tamaño de la población y la mortalidad por pesca en relación con sus puntos de referencia de RMSP. Cada punto representa un promedio móvil de tres años. El punto rojo grande indica la estimación más reciente.

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 steepness (*h*) of 0.75. All analyses are based on average fishing mortality for 2004-2006. B_{2007}, B_{AMSY}, and B_0 are the biomass of bigeye 3+ quarters old at the start of 2007, at AMSY, and without fishing, respectively, and S_{2007}, S_{AMSY}, and S_0 are the relative number of eggs (index of spawning biomass) at the start of 2007, at AMSY, and without fishing, respectively. C_{2006} is the estimated total catch in 2006.

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 2004-2006. B_{2007}, B_{RMSP}, y B_0 son la biomasa de patudo de edad 3+ trimestres al principio de 2006, en RMSP, y sin pesca, respectivamente, y S_{2007}, S_{RMSP}, y S_0 son el número relativo de huevos (índice de biomasa relativa) al principio de 2007, en RMSP, y sin pesca, respectivamente. C_{2006} es la captura total estimada en 2006.

	Caso base **Basecase**	**Inclinación = 0.75** **Steepness = 0.75**
AMSY—RMSP	91,519	87,013
B_{AMSY}—B_{RMSP}	309,473	490,423
S_{AMSY}—S_{RMSP}	678	1,175
B_{AMSY}/B_0—B_{RMSP}/B_0	0.27	0.34
S_{AMSY}/S_0—S_{RMSP}/S_0	0.22	0.31
C_{2006}/AMSY—C_{2006}/RMSP	1.11	1.18
B_{2007}/B_{AMSY}—B_{2007}/B_{RMSP}	1.10	0.76
S_{2007}/S_{AMSY}—S_{2007}/S_{RMSP}	0.92	0.61
F multiplier—Multiplicador de *F*	0.83	0.59

E. PACIFIC BLUEFIN TUNA

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

Most of the catches of bluefin in the EPO are taken by purse seiners. Nearly all of the purse-seine catch is made west of Baja California and California, within about 100 nautical miles of the coast, between about 23°N and 35°N. Ninety percent of the catch is estimated to have been between 60 and 100 cm, representing mostly fish 1 to 3 years old. 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 to sashimi markets. Lesser amounts of bluefin are caught by recreational, gillnet, and longline gear. Bluefin have been caught during every month of the year, but most of the fish are taken during May through October.

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

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

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

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

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

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

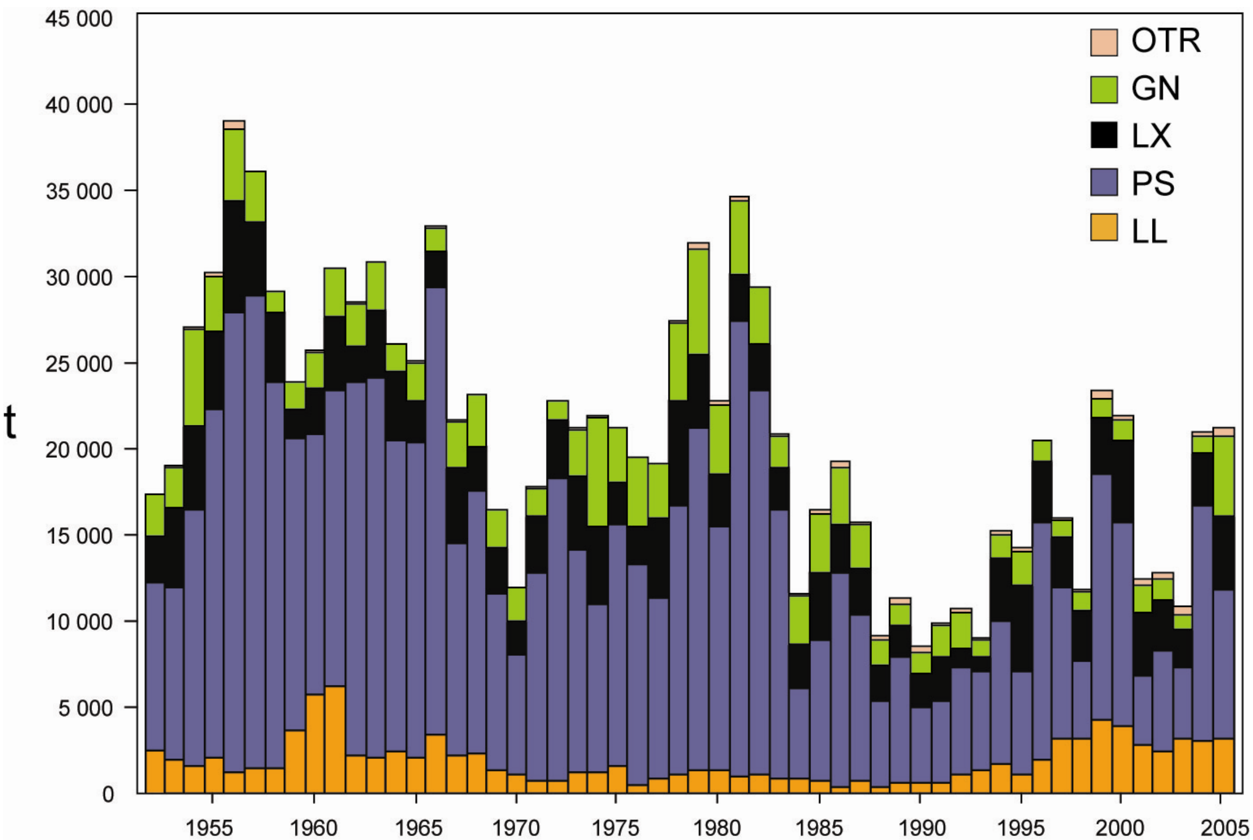

FIGURE E-1. Retained catches of Pacific bluefin, 1952-2005.
FIGURA E-1. Capturas retenidas de aleta azul del Pacífico, 1952-2005.

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

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

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

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

New age-structured stock assessments were presented for the South and North Pacific stocks of albacore in 2003 and 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 sustainable yield could increase as total biomass decreases is not well determined. Although the recent recruitments are estimated to be slightly below average, there currently appears to be no need to restrict the fisheries for albacore in the South Pacific Ocean.

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 five 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 estimates of the 2004 North Pacific Albacore Workshop, the higher fishing mortality of 0.68 implies an equilibrium spawning stock biomass at 17% of un-fished 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.

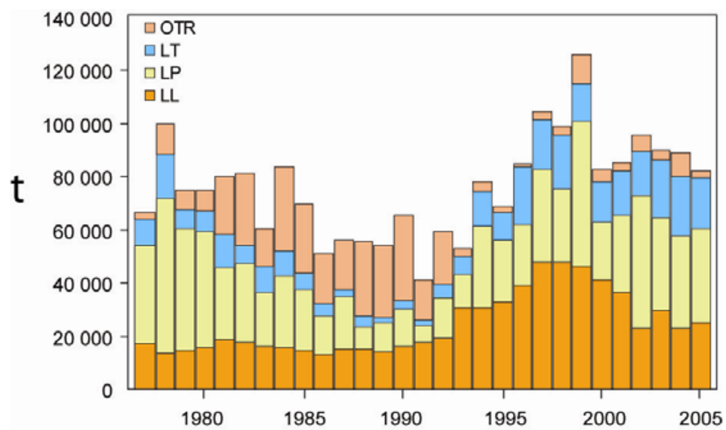

FIGURE F-1a. Retained catches of North Pacific albacore, 1950-2005.
FIGURA F-1a. Capturas retenidas de albacora del Pacífico norte, 1950-2005.

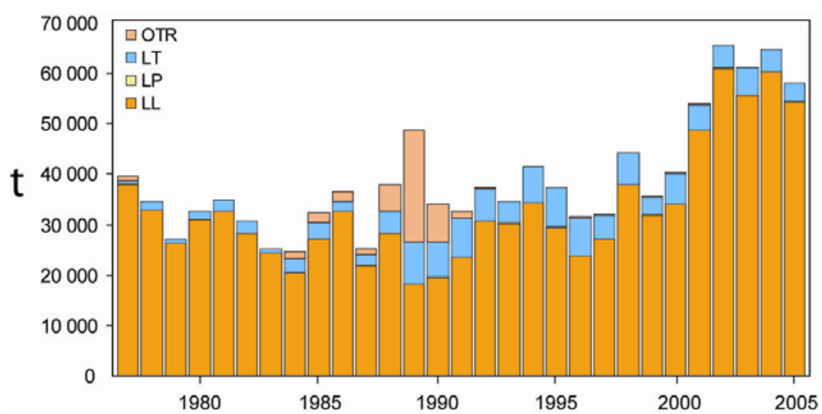

FIGURE F-1b. Retained catches of South Pacific albacore, 1950-2005.
FIGURA F-1b. Capturas retenidas de albacora del Pacífico sur, 1950-2005.

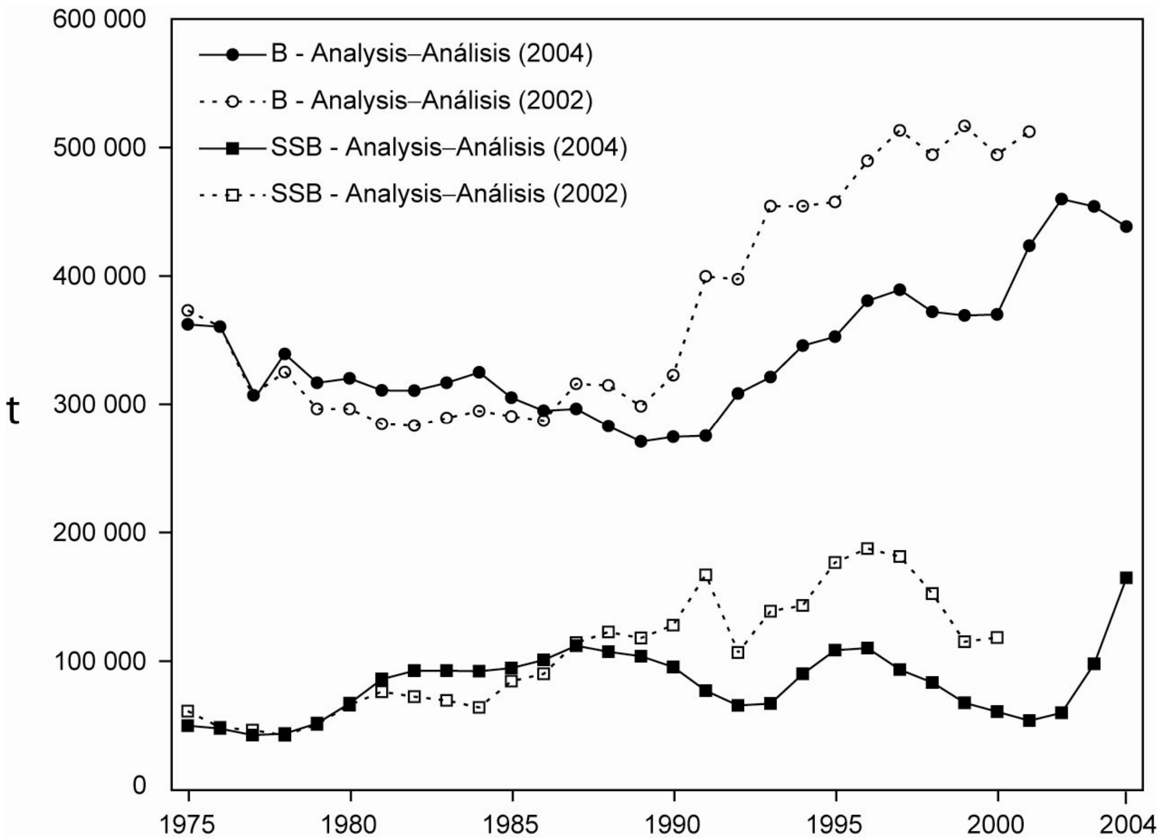

FIGURE F-2. Total biomass (B), and spawning stock biomass (SSB) of North Pacific albacore tuna, in metric tons (t), from the North Pacific Albacore Workshop analyses of 2002 and 2004. The time series for B are based on estimates of January 1 biomass, and those for SSB on estimates at the beginning of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

FIGURA F-2. 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 2002 y 2004. 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 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 targets predominantly bigeye tuna. Other nations with fisheries known to target swordfish are Mexico and the United States.

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

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.

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

The results of preliminary modeling with MULTIFAN-CL of a North Pacific swordfish stock in the area north of 10°N and west of 140°W indicate that in recent years the biomass level has been stable and well above 50% of the unexploited levels of stock biomass, indicating that these swordfish are not overexploited at current levels of fishing effort.

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 long period of relatively stable catches in the northern region (Figure G-1), it appears that swordfish are not overfished in the northern region of the EPO.

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

The 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 corresponding to the AMSY.

The average annual catch from the this stock during 1993–2000 was about 7,000 t (range ~ 4,800–8,900 t). Catches in recent years have been on the order of 12,000–16,000 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.

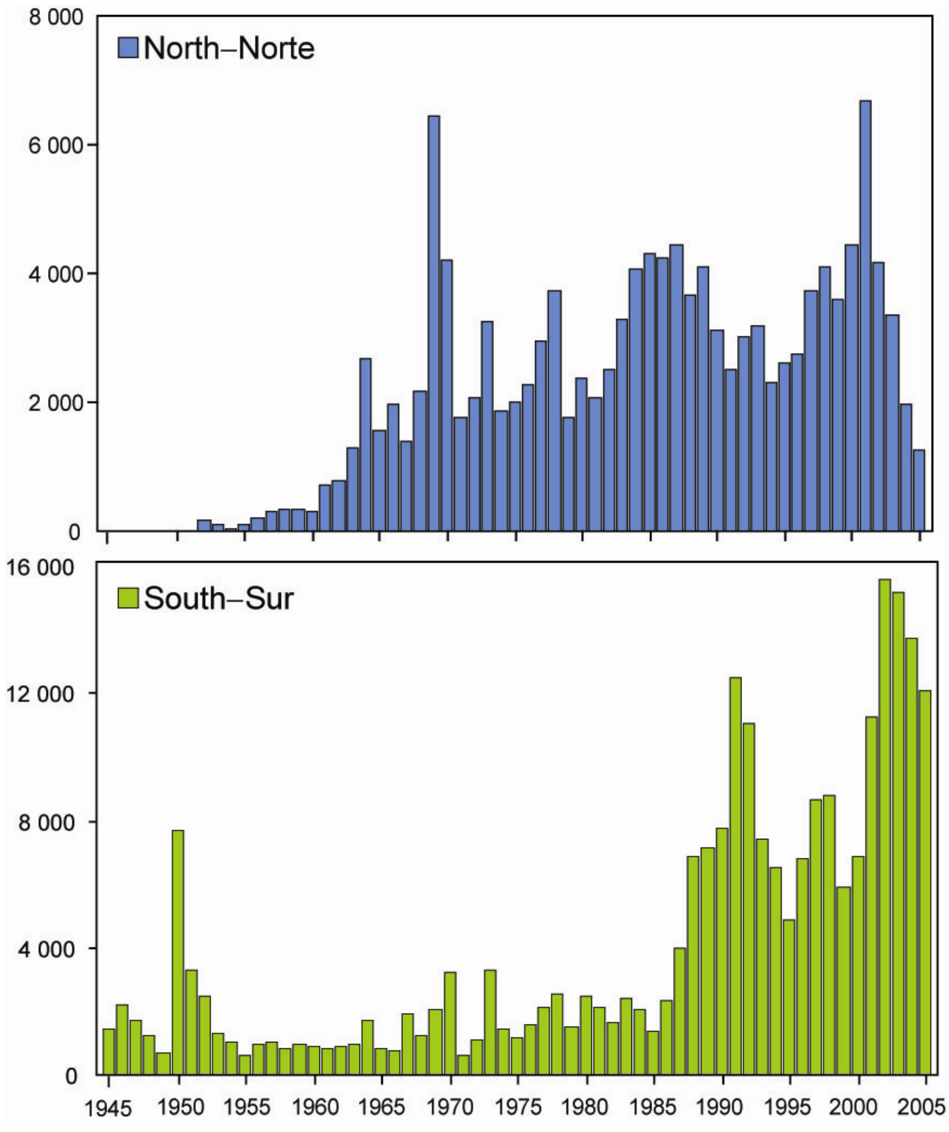

FIGURE G-1. Retained catch of swordfish in the eastern Pacific Ocean, 1945-2005, by stock (north and south).
FIGURA G-1. Captura retenida de pez espada en el Océano Pacífico oriental, 1945-2005, por población (norte y sur).

H. BLUE MARLIN

The best knowledge currently available indicates that blue marlin constitutes a single world-wide species and that there is a single stock of blue marlin in the Pacific Ocean. For this reason, statistics on catches (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 mostly by longline vessels of many nations that fish for tunas and billfishes between about 50°N and 50°S. Lesser amounts are taken by recreational fisheries and by various other commercial fisheries.

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

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

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

A more recent analysis of data from the same years but using MULTIFAN-CL was conducted to assess the status of blue marlin in the Pacific Ocean and to evaluate the efficacy of habitat-based standardization of longline effort. There is considerable uncertainty regarding the levels of fishing effort that would produce the 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 for which total Pacific Ocean catch data are available (1998-2003) averaging about 3,000 t, or 14% of the total harvest. Average annual catch of blue marlin in the EPO since 2001 is about 4,000 t.

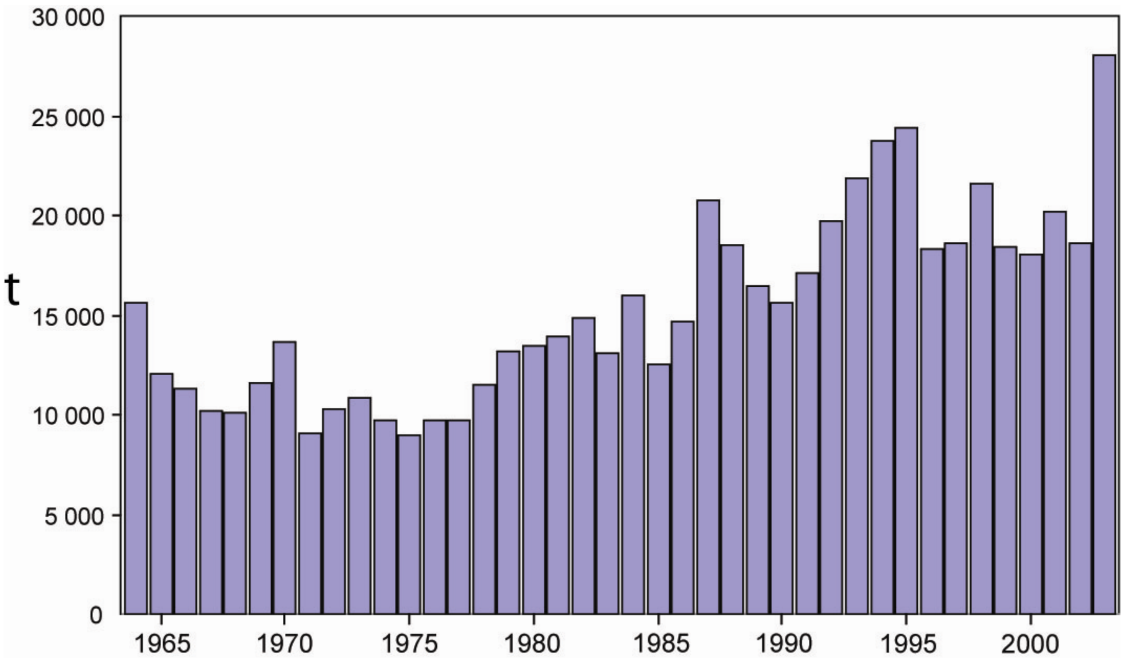

FIGURE H-1. Retained catches of blue marlin in the Pacific Ocean, 1964-2003.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, 1964-2003.

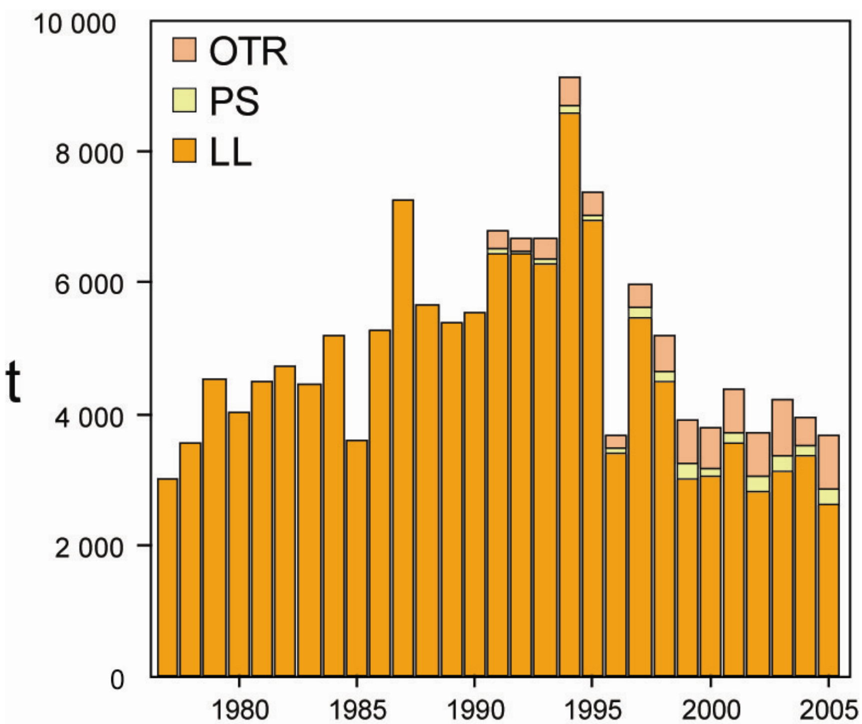

FIGURE H-2. Retained catches of blue marlin in the eastern Pacific Ocean, 1977-2005, by gear type.
FIGURA H-2. Capturas retenidas de marlín azul en el Océano Pacífico oriental, 1977-2005, por arte de pesca.

I. STRIPED MARLIN

Striped marlin occur throughout the Pacific Ocean between about 45°N and 45°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are caught by recreational, gillnet, and other fisheries. During recent years the greatest catches (Figure I-1) in the 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 WCPO, 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 regions are from a single stock.

Few tagging data are available for striped marlin. Most recaptures of fish tagged with conventional tags and released off the tip of the Baja California peninsula have been made in the general area of release, but some have been recaptured around the Revillagigedo Islands, a few around Hawaii, and one near Norfolk Island, north of New Zealand. Data on daily activities of striped marlin have been obtained by electronic tags, which due to tag detachment and settings, have not provided information on movements over long time periods.

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 sustainable yield (AMSY) in the range of 3,700 to 4,100 t, with the current biomass being about 47% of the unfished biomass. The current biomass is estimated to be greater than that corresponding to the 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 being 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 unfished biomass, the results indicated that 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 greater than that corresponding to the 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 2001-2005 between about 1,600 and 2,200 t, well below estimated AMSY. This may result in a continued increase in the biomass of the stock in the EPO.

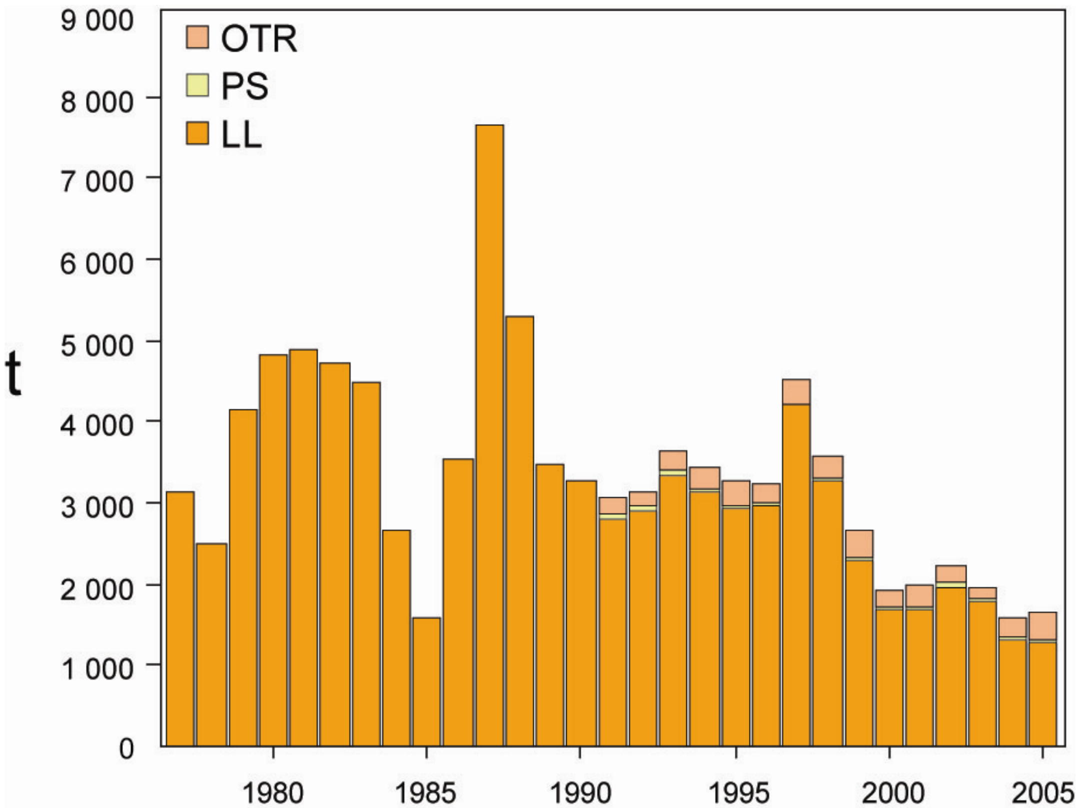

FIGURE I-1. Retained catches of striped marlin in the eastern Pacific Ocean, 1977-2005, by gear type.
FIGURA I-1. Capturas retenidas de marlín rayado en el Océano Pacífico oriental, 1977-2005, por arte de pesca.

J. ECOSYSTEM CONSIDERATIONS

1. INTRODUCTION

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

The IATTC has taken account of ecosystem issues in many of its decisions, and since 2003, has had this report on the entire ecosystem in which the target species, the tunas and billfishes, reside to consider in making its management decisions. This section provides a coherent view, summarizing what is known about the direct impact of the fisheries upon various species and species groups of the ecosystem, and reviews what is known about the environment and about other species that are not directly impacted by the fisheries.

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

It is important to remember that the view that we have of the ecosystem is based on the recent past; we have 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 Commission documents. The section below frequently refers to comparisons with the estimated unexploited stock size. There are no direct measurements of the stock size before the fishery began, and, in any case, it would have varied from year to year. In addition, the unexploited stock size may be influenced by predator and prey abundance, which is not included in the single species analyses.

2.2. Tunas

2.2.1. Yellowfin

The yellowfin stock changed into a higher recruitment regime in about 1985, but may have recently moved back into a lower recruitment regime. During 2004-2006, the yellowfin stock has been below the level corresponding to the average maximum sustainable yield (36% of its unexploited size). 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

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

2.2.3. Bigeye

Up to 1993, bigeye were taken mostly by longline fishing. The stock size in 1993 is estimated to have been 36% 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 17% of its unexploited size. Due to recent spikes in recruitment, the current level has increased to 20%.

2.2.4. Pacific bluefin

It is considered that there is a single stock of Pacific bluefin tuna in the Pacific Ocean, given that spawning 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 (ISC) in 2005, has indicated that the biomass of the spawning stock had local peaks during the early 1960s, late 1970s and late 1990s, with a decline after the last peak. A strong recruitment event that may have occurred in 2001 would maintain spawning stock biomass above recent levels until 2010.

2.2.5. Albacore

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

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

16,000 t annually.

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

2.3.2. Blue marlin

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

2.3.3. Striped marlin

A preliminary genetics analysis suggested that there are multiple stocks of striped marlin 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 by the ISC of the status of an hypothesized single stock of striped marlin spanning the entire north Pacific is in progress, and the results are expected to be available in July 2007.

2.3.4. Black marlin, sailfish, and shortbill spearfish

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

2.4. Summary

The estimated catches[1] (including purse-seine discards), in metric tons, of tunas during 2006 and billfishes during 2005 in the EPO are as follows.

	PS			LP	LL	OTR	Total
	OBJ	NOA	DEL				
Yellowfin tuna	36,772	42,200	89,261	693	3,976	1,878	174,780
Skipjack tuna	206,693	109,638	4,971	429	184	89	322,004
Bigeye tuna	71,399	1,644	0	0	30,271	8	103,322
Pacific bluefin	0	9,795	0	0	0	96	9,891
Albacore tuna	0	109	0	0	6,390	6,402	12,901
Swordfish	<1	<1	1	0	8,797	4,490	13,289
Blue marlin	203	16	17	0	2,619	820	3,676
Striped marlin	12	14	13	0	1,278	328	1,645
Black marlin	81	8	15	0	41	0	145
Sailfish	3	7	30	0	37	782	859
Shortbill spearfish	<1	<1	<1	0	276	0	276

2.5. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis*), are frequently found associated with yellowfin tuna in the size range of about 10 to 40 kg in the EPO. Purse-seine fishermen have found that their catches of yellowfin in the EPO can be maximized by setting their nets around herds of dolphins and the associated schools of tunas, and then releasing the dolphins while retaining the tunas. The incidental mortality of dolphins in this operation was high during the early years of the fishery, and the populations of dolphins were reduced from their unexploited levels during the 1960s and 1970s. After the late 1980s the incidental mortality decreased precipitously, and there is now evidence that the populations are recovering. Preliminary mortality estimates of dolphins in the fishery in 2006 are as follows:

Species and stock	Incidental mortality

[1] Preliminary data

	Number	tons
Offshore spotted dolphin		
Northeastern	144	9
Western-southern	135	9
Spinner dolphin		
Eastern	155	7
Whitebelly	157	9
Common dolphin		
Northern	130	9
Central	87	6
Southern	38	3
Other dolphins[2]	40	4
Total	**886**	**57**

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 poly-specific aggregations by purse seine vessels in the EPO demonstrate significant differences in food habits and trophic position of the three species, suggesting that the tuna-dolphin association is probably not maintained by feeding advantages. This conclusion is supported by radio tracking studies of spotted dolphins outfitted with time-depth recorders, which indicate that the dolphins feed primarily at night on organisms associated with the deep scattering layer, while food habits studies of yellowfin tuna show primarily daytime feeding.

During 2006, scientists of the U.S. National Marine Fisheries Service (NMFS) conducted the latest in a series of research cruises under the *Stenella* Abundance Research 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. Data on cetacean distribution, herd size, and herd composition were collected to estimate dolphin abundance. The 2006 survey covered the same areas and used the same methods as past surveys. Data from the large-scale line-transect survey of 2003 produced abundance estimates for 10 dolphin species and/or stocks. The estimates for northeastern offshore spotted and eastern spinner dolphins for 2003 were somewhat higher 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 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

[2] "Other dolphins" includes the following species and stocks, whose observed mortalities were as follows: striped dolphins 6 (0.4 t); Central American spinner dolphins (*Stenella longirostris centroamericana*) 6 (0.3 t); bottlenose dolphins 3 (0.3 t), shortfin pilot whales (*Globicephala macrorhynchus*) 2 (1.3 t), coastal spotted dolphins 3 (0.3 t); unidentified dolphins 20 (1.1 t).

(*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. At the 6th meeting of the Working Group in February 2007, it was reported that the Spanish longline fleet targeting swordfish in the EPO averaged 65 interactions and 8 mortalities per million hooks during 1990-2005. The mortality rates due to longlining in the EPO are likely to be similar for other fleets targeting bigeye tuna, and possibly greater for those that set lines at shallower depths for albacore and swordfish. About 23 million of the 200 million hooks set each year in the EPO by distant-water longline vessels target swordfish with shallow longlines.

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

Sea turtles are occasionally caught in purse seines in the EPO tuna fishery. Most interactions occur when the turtles associate with floating objects, and are captured when the object is encircled. In other cases, nets set around unassociated schools of tunas or schools associated with dolphins may capture sea turtles that happen to be at 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 agassizi*), 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. The estimated mortalities[3] (in numbers) of turtles caused by large purse-seine vessels during 2006 were as follows:

	Set type			Total
	OBJ	**NOA**	**DEL**	
Olive Ridley	9.7	4.3	4.3	18.3
Black or eastern Pacific green	0.0	0.0	0.0	0.0
Loggerhead	1.2	0.0	0.0	1.2
Hawksbill	0.0	0.0	0.0	0.0
Leatherback	0.0	0.0	0.0	0.0
Unidentified	1.0	0.0	0.0	1.0
Total	11.9	4.3	4.3	20.5

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,

[3] Preliminary data

entanglement in and ingestion of marine debris, and impacts of other fisheries.

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

2.7. Sharks and other large fishes

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

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

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

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

The estimated discards[4] (in metric tons) of sharks and other large fishes in the EPO during 2006, other than those discussed above, by large purse-seine vessels are as follows. Complete data are not available for small purse-seine, longline, and other types of vessels.

	Set type			
	OBJ	**NOA**	**DEL**	**Total**
Sharks	951	247	107	1,306
Rays (Mobulidae and Dasyatidae)	3	50	14	67
Dorado (*Coryphaena* spp.)	1,240	55	1	1,295
Wahoo (*Acanthocybium solandri)*	462	1	1	464
Rainbow runner (*Elagatis bipinnulata*) and yellowtail (*Seriola lalandi*)	245	228	<1	474
Black skipjack	1,647	132	10	1,789
Bonito	<1	84	0	84
Unidentified tunas	14,979	1,410	107	16,496

[4] Preliminary data

Billfishes	9	1	2	12
Other large fishes	47	14	2	62

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 lowest in floating-object sets. Because of these differences, it is necessary to follow the changes in frequency of the different types of sets to interpret the changes in bycatch figures. The estimated numbers of purse-seine sets of each type in the EPO during 1989-2006 are shown in Table A-8.

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

3. OTHER ECOSYSTEM COMPONENTS

3.1. Seabirds

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

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

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

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

3.2. Forage

The forage taxa occupying the middle trophic levels in the EPO are obviously important components of the ecosystem, providing a link between primary production at the base of the food web and the upper-trophic-level predators, such as tunas and billfishes. Indirect effects on those predators caused by environmental variability are transmitted to the upper trophic levels through the forage taxa. Little is known, however, about fluctuations in abundance of the large variety of prey species in the EPO. Scientists from the NMFS have recorded data on the distributions and abundances of common prey groups, including lantern fishes (Myctophidae), flying fishes, and some squids, in the tropical EPO during 1986-1990 and 1998-2000. Mean abundance estimates for all fish taxa, and to a lesser extent for squids, increased from 1986 through 1990. Estimates were low again in 1998, and then increased through 2000. Their interpretation of this pattern was that El Niño events in 1986-1987 and 1997-1998 had negative effects on these prey populations. More data on these taxa were collected during the NMFS STAR 2003 and 2006 cruises, and are currently being analyzed.

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

Some small fishes, many of which are forage for the larger predators, are incidentally caught by purse-seine vessels in the EPO. Frigate and bullet tunas (*Auxis* spp.), for example, are a common prey of many of the animals that occupy the upper trophic levels in the tropical EPO. In the tropical EPO ecosystem model (Section 7), frigate and bullet tunas comprise 10% or more of the diet of eight predator categories. Small quantities of frigate and bullet tunas are captured by purse-seine vessels on the high seas and by artisanal fisheries in some coastal regions of Central and South America. The vast majority of frigate and bullet tunas captured by tuna purse-seine vessels is discarded at sea. The estimated discards[5], in metric tons, of small fishes by large purse-seine vessels with observers aboard in the EPO during 2006 were as follows:

	Set type			
	OBJ	**NOA**	**DEL**	**Total**

[5] Preliminary data

Triggerfishes (Balistidae) and filefishes (Monacanthidae)	167	<1	<1	167
Other small fishes	155	4	1	160
Frigate and bullet tunas (*Auxis* spp.)	1,273	751	19	2,043

3.3. Larval fishes and plankton

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

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

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

4. TROPHIC INTERACTIONS

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

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

A short-term study was initiated during the fourth quarter of 2006 to examine the stomach contents of recently-captured yellowfin tuna to detect possible changes in their foraging behavior relative to previous years. Single-species stock assessments are not designed to consider the effect of trophic interactions (*e.g.* predation, competition, and changes in trophic structure) on the stock in question. Prey populations that feed the apex predators also vary over time (see 3.2 Forage), and some prey impart considerable predation pressure on animals that occupy the lower trophic levels (including the early life stages of the apex predators). Stomach samples of a ubiquitous predator, such as yellowfin tuna, compared with prevous diet data, can be used to infer changes in prey populations by identifying changes in foraging behavior. Changes in foraging behavior could cause the tunas, for example, to alter the typical depth distributions while foraging, and this could affect their catchability. Stomach samples of yellowfin tuna were collected from purse-seine sets made on fish associated with dolphins. Results are forthcoming.

5. PHYSICAL ENVIRONMENT[6]

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

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

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

The IATTC reports monthly average oceanographic and meteorological data for the EPO, including a summary of current ENSO conditions, on a quarterly basis. During 2005 the SSTs were nearly normal,

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[6] 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.

although there were small areas of cool water, mostly near the coast, and small areas of warm water, mostly offshore, during nearly every month. Weak La Niña (or anti-El Niño) conditions developed during the first quarter of 2006. Conditions became neutral during the second quarter of 2006, and weak El Niño conditions developed during the third quarter and continued during the rest of the year.

Variability on a decadal scale (*i.e.* 10 to 30 years) also affects the EPO. During the late 1970s there was a major shift in physical and biological states in the North Pacific Ocean. This climate shift was also detected in the tropical EPO by small increases in SSTs, weakening of the trade winds, and a moderate change in surface chlorophyll levels. Some researchers have reported another major shift in the North Pacific in 1989. Climate-induced variability in the ocean has often been described in terms of "regimes," characterized by relatively stable means and patterns in the physical and biological variables. Analyses by the IATTC staff have indicated that yellowfin tuna in the EPO have experienced 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.

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

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

6. AGGREGATE INDICATORS

Recognition of the consequences of fishing for marine ecosystems has stimulated considerable research in recent years. Numerous objectives have been proposed to evaluate fishery impacts on ecosystems and to define over-fishing from an ecosystem perspective. Whereas reference points have been used primarily for single-species management of target species, applying performance measures and reference points to non-target species is believed to be a tractable first step. Current examples include incidental mortality limits for dolphins in the EPO purse-seine fishery under the AIDCP. Another area of interest is whether useful performance indicators based on ecosystem-level properties might be developed. Several ecosystem metrics or indicators, including community size structure, diversity indices, species richness and evenness, overlap indices, 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.

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

Ecologically-based approaches to fisheries management place renewed emphasis on achieving accurate depictions of trophic links and biomass flows through the food web in exploited systems. 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 micro-zooplankton (TL 2) feed on the producers, phytoplankton and bacteria (TL 1).

In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as apex predators in the ecosystem. Over time, fishing can cause the overall size composition of the catch to 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 2003 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The estimates were made by applying the TLs from the EPO ecosystem model (see Section 7), weighted by the catch data by fishery and year for all model groups from the IATTC tuna, bycatch, and discard data bases. The TLs of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year (Figure J-2: Average PS+LP). The TL of the floating-object sets varied more than those of the other fisheries, due to the inter-annual 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 2003 (Figure J-3). The TLs of the retained catches were quite stable from year to year, while the TLs of the discarded catches varied considerably. The greatest variation occurred for sets on unassociated fish. 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 flying fishes), and sensitive species (*e.g*. sea turtles). Some taxa are further separated into size categories (*e.g*. large and small marlins). The model has finer taxonomic resolution at the upper trophic levels, but most of the system's biomass is contained in the middle and lower trophic levels. Fisheries landings and discards were estimated for five fishing "gears": pole-and-line, longline, and purse-seine sets on tunas associated with dolphins, with floating objects, and in unassociated schools. The model focuses on the pelagic regions; localized, coastal ecosystems are not adequately described by the model.

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

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

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

Both the IATTC and the Agreement on the International Dolphin Conservation Program (AIDCP) have objectives that address the incorporation of ecosystem considerations into the management of the tuna fisheries in the EPO. Actions taken in the past include:

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 longline fishing, and to compare the catch rates of tunas, billfishes, and dorado using circle and J hooks of two sizes. Circle hooks do not hook as many turtles as the J hooks currently used in the longline fishery, and the chance of serious injury to the sea turtles that bite the hooks is reduced because they are wider and they tend to hook the lower jaw, rather than the more dangerous deep hookings in the esophagus and other areas, which are more common with the J hooks. Improved procedures and instruments to release hooked and entangled sea turtles have also been disseminated to the longline fleets of the region.

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. Sea birds

a. IATTC Resolution C-05-01 recommends that CPCs[7] implement, if appropriate, the International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries; collect and provide information to the Commission on interactions with seabirds; and for the Working Group on Stock Assessment to present to the Commission an assessment of the impact of incidental catches of seabirds resulting from the activities of all the vessels fishing for tunas and tuna-like species in the EPO. This assessment should include an identification of the geographic areas in which there could be interactions between longline fisheries and seabirds.

b. The 6th meeting of the IATTC Working Group on Bycatch recommended that the Stock Assessment Working Group suggest possible mitigation measures in areas in which seabird distributions and longline effort overlap, and that the IATTC consider mitigation measures at its June 2007 meeting. It also recommended that seabird bycatch data be collected from all tuna longliners in the EPO.

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

8.4. Other species

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

b. 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.

[7] IATTC Parties and cooperating non-Parties, fishing entities and regional economic integration organizations

8.5. All species

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

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

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

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

9. FUTURE DEVELOPMENTS

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

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

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

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

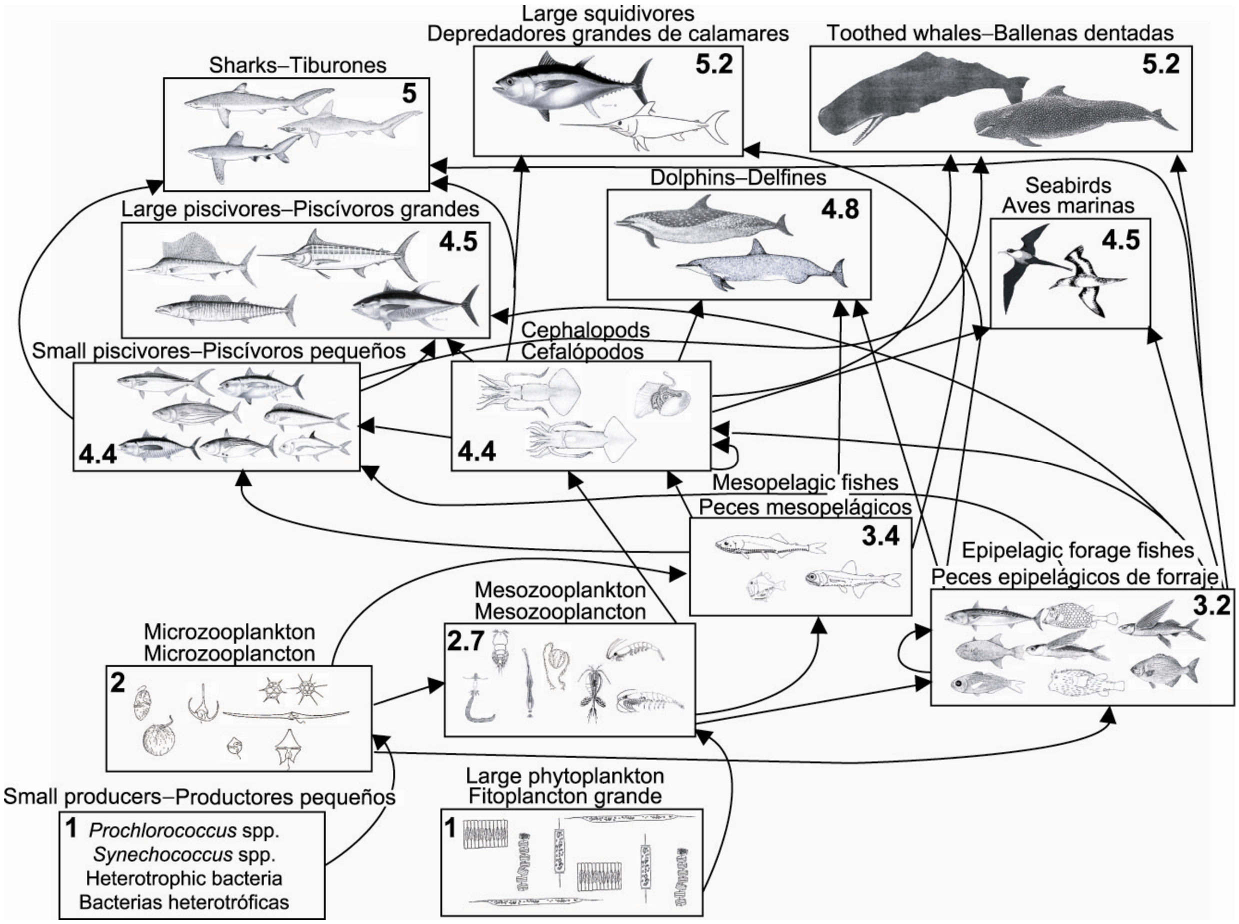

FIGURE J-1. Simplified food-web diagram of the pelagic ecosystem in the tropical eastern Pacific Ocean. The numbers inside the boxes indicate the approximate trophic levels of each group.

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.

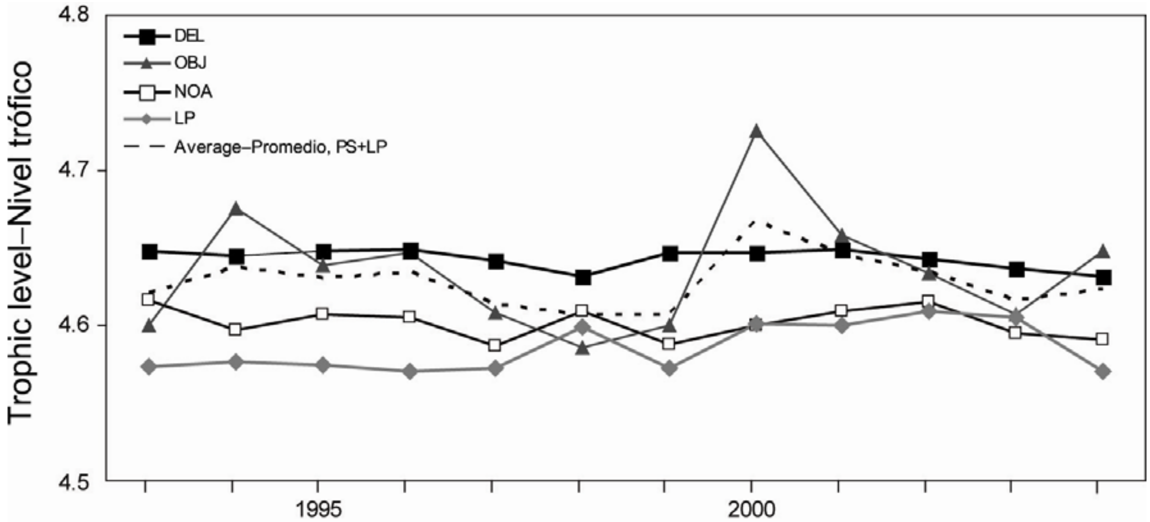

FIGURE J-2. Yearly trophic level estimates of the catches (retained and discarded) by the purse-seine and pole-and-line fisheries in the tropical eastern Pacific Ocean, 1993-2004.
FIGURA J-2. Estimaciones anuales del nivel trófico de las capturas (retenidas y descartadas) de las pesquerías cerquera y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

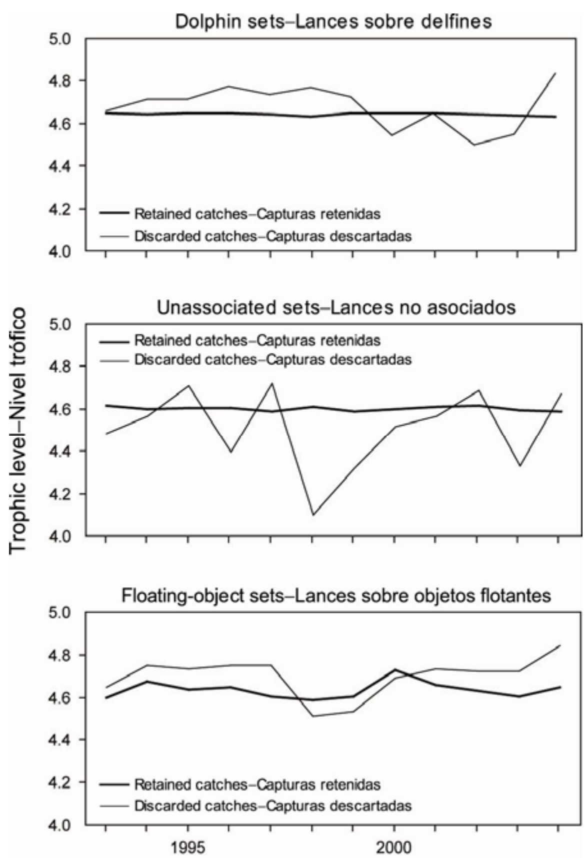

FIGURE J-3. Trophic level estimates of the retained catches and discarded catches by purse-seine fishing modes in the tropical eastern Pacific Ocean, 1993-2004.
FIGURA J-3. Estimaciones del nivel trófico de las capturas retenidas y descartadas por modalidad de pesca cerquera en el Océano Pacífico oriental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

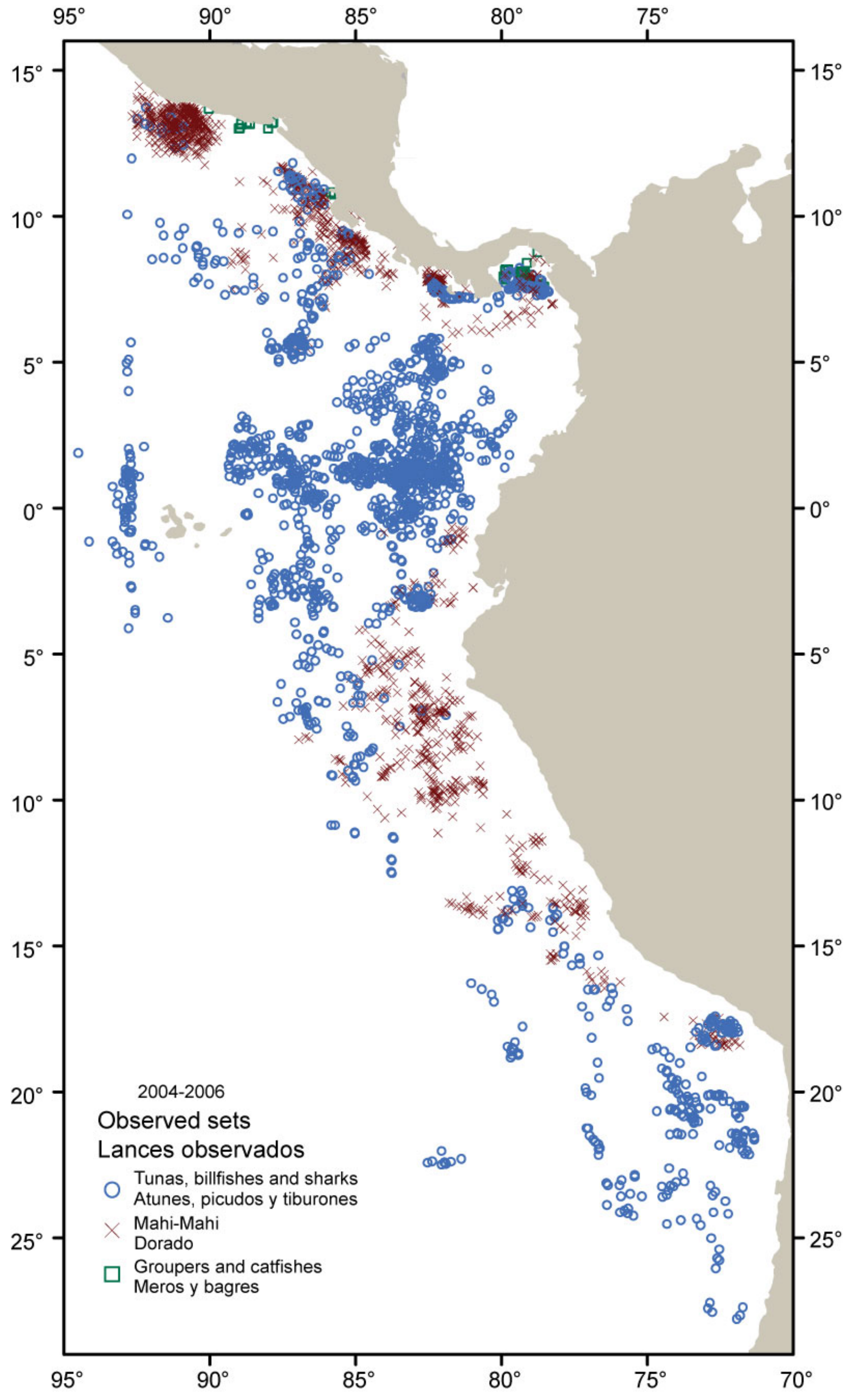

FIGURE J-4. Locations of longline sets by vessels from Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Panama and Peru (part), for which observers recorded data on the catches using different types of hooks.

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.