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TUNAS, BILLFISHES AND OTHER PELAGIC SPECIES IN THE EASTERN PACIFIC OCEAN IN 2017

INTRODUCTION

This report provides a summary of the fishery for tunas in the eastern Pacific Ocean (EPO), summary assessments of the major stocks of tunas and billfishes that are exploited in the fishery, updated stock status indicators for silky sharks, and an evaluation of the pelagic ecosystem in the EPO, in 2017.

The report is based on data available to the IATTC staff in March 2018. As a result, some of the data tables for 2017 are incomplete, and all data for 2016 and 2017 should be considered preliminary.

All weights of catches and discards are in metric tons (t). In the tables, 0 means no effort, or a catch of less than 0.5 t; - means no data collected; * means data missing or not available. The following acronyms 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.)
CGX	Carangids (Carangidae)
DOX	Dorado (*Coryphaena* spp.)
MLS	Striped marlin (*Kajikia audax*)
PBF	Pacific bluefin tuna (*Thunnus orientalis*)
SFA	Indo-Pacific sailfish (*Istiophorus platypterus)*
SKJ	Skipjack tuna (*Katsuwonus pelamis*)
SKX	Unidentified elasmobranchs
SSP	Shortbill spearfish (*Tetrapturus angustirostris*)
SWO	Swordfish (*Xiphias gladius*)
TUN	Unidentified tunas
YFT	Yellowfin tuna (*Thunnus albacares*)

Fishing gears:	
FPN	Trap
GN	Gillnet
HAR	Harpoon
LL	Longline
LP	Pole and line
LTL	Troll
LX	Hook and line

OTR	Other[1]
NK	Unknown
PS	Purse seine
RG	Recreational
TX	Trawl
Ocean areas:	
EPO	Eastern Pacific Ocean
WCPO	Western and Central Pacific Ocean
Set types:	
DEL	Dolphin
NOA	Unassociated school
OBJ	Floating object LOG: Flotsam FAD: Fish-aggregating device
Flags:	
IATTC Members & cooperating non-Members	
BLZ	Belize
BOL	Bolivia
CAN	Canada
CHN	China
COL	Colombia
CRI	Costa Rica
ECU	Ecuador
EU	European Union
EU (CYP)	Cyprus
EU (ESP)	Spain
EU (PRT)	Portugal
FRA	France
GTM	Guatemala
HND	Honduras
IDN	Indonesia
JPN	Japan
KIR	Kiribati
KOR	Republic of Korea
LBR	Liberia
MEX	Mexico
NIC	Nicaragua
PAN	Panama
PER	Peru
SLV	El Salvador
TWN	Chinese Taipei
USA	United States of America
VEN	Venezuela
VUT	Vanuatu
Other flags	
CHL	Chile
COK	Cook Islands
CYM	Cayman Islands
NZL	New Zealand
RUS	Russia
VCT	St. Vincent and the Grenadines
UNK	Unknown
Stock assessment:	
B	Biomass
C	Catch
CPUE	Catch per unit of effort
F	Rate of fishing mortality
MSY	Maximum sustainable yield
S	Index of spawning biomass
SBR	Spawning biomass ratio
SSB	Spawning stock biomass

[1] Used to group known gear types

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

This document summarizes the fisheries for species covered by the IATTC Convention ("tunas and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna-like species") 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 document also covers other species caught by tuna-fishing vessels in the EPO: billfishes (swordfish, marlins, shortbill spearfish, and sailfish) carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes.

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

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

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

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

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

Estimating the total catch of a species of fish is difficult, for various reasons. Some fish are discarded at sea, and the data for some gear types are incomplete. Data for fish discarded at sea by purse-seine vessels with carrying capacities greater than 363 metric tons (t) have been collected by observers since 1993, which allows for better estimation of the total amounts of fish caught by the purse-seine fleet. Estimates of the total amount of the catch that is landed (hereafter referred to as the "retained catch") are based principally on data from unloadings. Beginning with Fishery Status Report 3, which reports on the fishery in 2004, the unloading data for purse-seine and pole-and-line vessels have been adjusted, based on the species composition estimates for yellowfin, skipjack, and bigeye tunas. The current species composition sampling program, described in Section 1.3.1, began in 2000, so the catch data for 2000-2017 are adjusted, based on estimates by flag for each year. The catch data for the previous years were adjusted by applying the average ratio by species from the 2000-2004 estimates, by flag, and summing over all flags. This has tended to increase the estimated catches of bigeye and decrease those of yellowfin and/or skipjack. These adjustments are all preliminary, and may be improved in the future. All the purse-seine and pole-and-line data for 2016 and 2017 are preliminary.

Data on the retained catches of most of the larger longline vessels are obtained from the governments of the nations that fish for tunas in the EPO. Longline vessels, particularly the larger ones, direct their effort primarily at bigeye, yellowfin, albacore, or swordfish. Data from smaller longliners, artisanal vessels, and other vessels that fish for tunas, billfishes, dorado, and sharks in the EPO were gathered either directly from the governments, from logbooks, or from reports published by the governments. Data for the western and central Pacific Ocean (WCPO) were provided by the Ocean Fisheries Programme of the Secretariat of the Pacific Community (SPC). All data for catches in the EPO by longlines and other gears for 2015, 2016 and 2017 are preliminary.

The data from all 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 by other gear types, such as trolls, harpoons, gillnets, and recreational gears. The estimated total catches of yellowfin, skipjack, and bigeye in the entire Pacific Ocean from all sources mentioned above 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 1988-2017 are shown in Tables A-2a-c. The catches of yellowfin, skipjack, and bigeye tunas by flag, during 1988-2017, are shown in Tables A-3a-e, and the purse-seine and pole-and-line catches and landings of tunas and bonitos during 2016-2017 are summarized by flag in Table A-4a-b. The data for yellowfin, skipjack, and bigeye tunas in Table A-4b have not been adjusted to the species composition estimates, and are preliminary. 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 1998-2017. 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.

1.1. Catches by species

1.1.1. Yellowfin tuna

The annual catches of yellowfin during 1988-2017 are shown in Table A-1. The EPO totals for 1993-2017 include discards from purse-seine vessels with carrying capacities greater than 363 t. The El Niño event of 1982-1983 led to a reduction in the catches in those years, whereas the catches in the WCPO were apparently not affected. Although the El Niño episode of 1997-1998 was greater in scope, it did not have the same effect on the yellowfin catches in the EPO. In the EPO, catches increased steadily to a high of 443 thousand t in 2002; they decreased substantially in 2004, reaching their lowest level during 2006-2008, at only 44% of the highest catches of the 2001-2003 period. The 2017 catch of 212 thousand t is less than the average for the previous 5-year period (239 thousand t). In the WCPO, the catches of yellowfin reached a new high of 642 thousand t in 2017, surpassing the previous record of 607 thousand t in 2012.

The annual retained catches of yellowfin in the EPO by purse-seine and pole-and-line vessels during 1988-2017 are shown in Table A-2a. The average annual retained catch during 2002-2016 was 247 thousand t (range: 167 to 413 thousand t). The preliminary estimate of the retained catch in 2017, 210 thousand t, was 13% less than that of 2016, and 15% less than the average for 2002-2016. The average amount of yellowfin discarded at sea during 2002-2016 was about 0.7% of the total purse-seine catch (retained catch plus discards) of yellowfin (range: 0.1 to 1.5%) (Table A-2a).

The annual retained catches of yellowfin in the EPO by longliners during 1988-2017 are shown in Table A-2a. During 1990-2003 catches averaged about 23 thousand t (range: 12 to 35 thousand t), or about 8% of the total retained catches of yellowfin. Longline catches declined sharply beginning in 2005, averaging 10 thousand t per year (range: 8 to 13 thousand t), or about 4% of the total retained catches, through 2016. 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 2002-2016 they averaged about 2 thousand t.

1.1.2. Skipjack tuna

The annual catches of skipjack during 1988-2017 are shown in Table A-1. Most of the skipjack catch in the Pacific Ocean is taken in the WCPO. Prior to 1998, WCPO skipjack catches averaged about 900 thousand t. Beginning in 1998, catches increased steadily, from 1.2 million t to an all-time high of 2 million t in 2014. In the EPO, the greatest yearly catches occurred between 2003 and 2017, ranging from 153 to 343 thousand t, the record catch in 2016.

The annual retained catches of skipjack in the EPO by purse-seine and pole-and-line vessels during 1988-2017 are shown in Table A-2a. During 2002-2016 the annual retained catch averaged 255 thousand t (range 147 to 338 thousand t). The preliminary estimate of the retained catch in 2017, 326 thousand t, is 28% greater than the average for 2002-2016, and 3% lower than the record catch of 2016. Discards of skipjack at sea decreased each year during the period, from 8% in 2004 to a low of less than 1% in 2013. During the period about 3% of the total catch of the species was discarded at sea (Table A-2a).

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

1.1.3. Bigeye tuna

The annual catches of bigeye during 1988-2017 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased, but with considerable fluctuations. In the EPO, the average catch for the period was 104 thousand t, with a low of 73 thousand t in 1989 and a high of 149 thousand t in 2000. In the WCPO the catches of bigeye increased to more than 77 thousand t during the late 1970s, decreased during the early 1980s, and then increased steadily to 113 thousand t in 1996. In 1997 the total jumped to 158 thousand t, and reached a high of 180 thousand t in 2004. Since 2004 the catch has fluctuated between 132 and 158 thousand t.

The annual retained catches of bigeye in the EPO by purse-seine and pole-and-line vessels during 1988-2017 are shown in Table A-2a. The number of fish-aggregating devices (FADs), placed in the water by fishermen to attract tunas, increased from 550 in 1992 to over 2,700 by 1995. This led to a sudden and dramatic increase in the purse-seine catches. Prior to the increase in number of FADs, the annual retained purse-seine catch of bigeye in the EPO was about 5 thousand t (Table A-2a); by 1994 it was 35 thousand t, and in 1996 was over 60 thousand t. Since then, it has fluctuated between 44 and 95 thousand t. The preliminary estimate of the retained catch in the EPO in 2017 is 66 thousand t.

During 2000-2016 the percentage of the purse-seine catch of bigeye discarded at sea has steadily decreased, from 5% in 2000 to less than 1% in 2014, for an average discard rate of about 1.9%. No bigeye catch has been reported by pole-and-line vessels in recent years.

From 1985 to 1993, before the expansion of the FAD fishery, longliners caught an average of 95% of the bigeye in the EPO (average 86 thousand t; range; 66 to 104 thousand t). During 2002-2016 this average dropped to 38%, with a low of 25% in 2008 (average: 39 thousand t; range: 26 to 74 thousand t) (Table A-2a). The preliminary estimate of the longline catch in the EPO in 2017 is 31 thousand t (Table A-2a).

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

1.1.4. Bluefin tuna

The catches of Pacific bluefin in the EPO during 1988-2017, by gear, are shown in Table A-2a. Purse-seine and pole-and-line vessels accounted for over 94% of the total EPO retained catch during 2002-2016. During this period the annual retained catch of bluefin in the EPO by purse-seine vessels averaged 4.8 thousand t (range 1.8 to 9.9 thousand t); the preliminary estimate for 2017 is 4.1 thousand t (Table A-2a).

The catches of Pacific bluefin in the entire Pacific Ocean, by flag and gear, are shown in Table A-5a. 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.

Catches of Pacific bluefin by recreational gear in the EPO are reported in numbers of individual fish caught, whereas all other gears report catches in weight. These numbers are then converted to metric tons for inclusion in the EPO catch totals for all gears. The original catch data for 1988-2017, in numbers of fish, are presented in Table A-5b.

1.1.5. Albacore tuna

Data provided by the relevant Members on catches of albacore, by gear and area (north and south of the equator), are shown in Table A-6. Albacore catches for the entire EPO are shown in Table A-2a. A portion of the albacore catch is taken by troll vessels, included under "Other gears" (OTR) in Table A-2a.

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 1988-2017 are presented in Table A-2a. The catches reported in the "unidentified tunas" category (TUN) in Table A-2a contain some catches reported by species (frigate or bullet tunas) along with the unidentified tunas. The total retained catch of these other species by the purse-seine fishery in 2017 was 8.6 thousand t, which is greater than the 2002-2016 average retained catch of 7.6 thousand t (range: 500 to 19 thousand t).

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

1.1.7. Billfishes

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

Swordfish are caught in the EPO with large-scale and artisanal longlines, gillnets, harpoons, and occasionally with recreational gear. During 1999-2008 the longline catch of swordfish averaged 12 thousand t, but during 2014-2016 this almost doubled, to over 23 thousand t. More research is needed to determine whether this is due to increased abundance of swordfish, increased effort directed toward that species, increased reporting, or a combination of all of these.

Other billfishes are caught with large-scale and artisanal longlines and recreational gear. The average annual longline catches of blue marlin and striped marlin during 2002-2016 were about 3.2 thousand and 1.9 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.

Prior to 2011, all billfishes caught in the purse-seine fishery were classified as discarded dead; however, the growing rate of retention of bycatches of billfishes made it important to reflect this in the data, and since 2011 retained catch and discards are reported separately in Table A-2b. During 2002-2016 purse seiners accounted about 1% of the total catch of billfishes in the EPO; some are retained, and others are considered to be discarded, although some may be landed but not reported.

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. Since 2011, bycatches in the purse-seine fishery are reported in Table A-2c as either retained or discarded.

Dorado are unloaded mainly in ports in Central and South America. The reported catches of dorado have declined, from a high of 71 thousand t in 2009 to 14 thousand t in 2016.

1.2. Distributions of the catches of tunas

1.2.1. Purse-seine catches

The average annual distributions of purse-seine catches in the EPO, by set type, of yellowfin, skipjack, and bigeye during 2012-2016 are shown in Figures A-1a, A-2a, and A-3a, respectively, and preliminary estimates for 2017 are shown in Figures A-1b, A-2b, and A-3b.

Most of the yellowfin catches in 2017 were taken in sets associated with dolphins, in three main areas: from 10°N to the coast of Mexico between about 105°W and 120°W, east of 95°W and north of 5°S, and from about 110°W to 130°W between the equator and 5°S. Lesser amounts of yellowfin were taken in unassociated sets along the coast of South America, and in floating-object sets south of 10°N throughout the EPO (Figure A-1b).

The distribution of skipjack catches in the EPO in 2017 closely matched the previous 5-year average, in both total catches and types of set. Most of the catch was taken in sets associated with floating objects throughout the EPO, with lesser amounts taken in unassociated sets east of the Galapagos Islands and near the coast of Peru (Figure A-2b).

Bigeye are not often caught north of about 7°N in the EPO. 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. As in most years, most of the 2017 bigeye catches were taken in sets on FADs between 5°N and 5°S, with above-average catches near 150°W (Figure A-3b).

1.2.2. Longline catches

The IATTC holds data on the spatial and temporal distributions of EPO longline catches dating back to 1952. Since 2009 the IATTC has received catch and effort data from Belize, China, France (French Polynesia), Japan, the Republic of Korea, Spain, Chinese Taipei, the United States, and Vanuatu. Albacore, 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 in the Pacific Ocean by Chinese, Japanese, Korean, and Chinese Taipei longline vessels during 2012-2016 are shown in Figure A-4.

1.3. Size compositions of the catches of tunas

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

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

Length-frequency samples of yellowfin, skipjack, bigeye, Pacific bluefin, and, occasionally, black skipjack are collected from the catches of purse-seine vessels in the EPO by IATTC personnel at ports of landing in Ecuador, Mexico, Panama, the United States, and Venezuela. Data on catches of yellowfin and skipjack have been collected since 1954, bluefin since 1973, and bigeye since 1975.

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 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, or dolphin), and in the same sampling area. These data are then categorized by fishery (Figure A-5).

Data for fish caught during the 2012-2017 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 2017, and the second shows the combined data for each year of the 2012-2017 period. For bluefin, the histograms show the 2007-2012 catches by commercial and recreational gear combined. For black skipjack, the histograms show the 2012-2017 catches by commercial gear. Only a small amount of catch was taken by pole-and-line vessels during 2013-2017, 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 968 wells sampled during 2017, 740 contained yellowfin. The estimated size compositions of the fish caught are shown in Figure A-6a. Most of the yellowfin catch was taken in sets associated with dolphins in the Northern and Southern dolphin fisheries throughout the year, and in the Inshore dolphin fishery, primarily in the first quarter. These fisheries also produced most of the larger (>90 cm) yellowfin. Smaller yellowfin were caught primarily in the floating-object fisheries throughout the year.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2012-2017 are shown in Figure A-6b. The average weight of the yellowfin in 2017, 7.2 kg, was higher than 2016 (6.3 kg), but lower than any of the other annual averages for the six-year period (range: 6.3-13.3 kg). Additionally, the overall size distribution was more uniform than other years during the period.

For stock assessments of skipjack, seven purse-seine fisheries (four associated with floating objects, two unassociated, one associated with dolphins) and one pole-and-line fishery are defined (Figure A-5). The last two fisheries include all 13 sampling areas. Of the 968 wells sampled, 738 contained skipjack. The estimated size compositions of the fish caught during 2017 are shown in Figure A-7a. Most of the 2017 skipjack catch was taken in the Northern and Southern floating-object fisheries throughout the year, and in the Equatorial and Inshore floating-object fisheries, and the Southern unassociated fishery, in the first and second quarters. The smallest skipjack, less than 45 cm, were caught in the Northern and Southern floating-object fisheries in the third and fourth quarters.

The estimated size compositions of the skipjack caught by all fisheries combined during 2012-2017 are shown in Figure A-7b. The average weight of skipjack in 2017 (2.2 kg) was higher than in 2016 (1.8 kg), and consistent with the other average annual weights for the 6-year period (1.9-2.5 kg).

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 968 wells sampled, 276 contained bigeye. The estimated size compositions of the fish caught during 2017 are shown in Figure A-8a. Most of the 2017 catch of bigeye was taken in the Northern and Southern floating-object fisheries throughout the year. Lesser amounts were caught in the Equatorial floating-object fishery, and the majority were 100 cm or larger.

The estimated size compositions of bigeye caught by all fisheries combined during 2012-2017 are shown in Figure A-8b. The average weight of bigeye in 2017 (4.7 kg) was consistent with the previous two years.

Pacific bluefin are caught by purse-seine and recreational gear off California and Baja California from about 23°N to 35°N, with most of the catch being taken during May through October. During 2012 bluefin were caught between 28°N and 32°N from June through August. Most of the catches of bluefin by both commercial and recreational vessels were taken during July and August. Prior to 2004, the sizes of the fish in the commercial and recreational catches have been reported separately. During 2004-2012, however, small sample sizes made it infeasible to estimate the size compositions separately. Therefore, the sizes of the fish in the commercial and recreational catches of bluefin were combined for each year of the 2004-2012 period. The average weight of the fish caught during 2012 (14.2 kg) was less than that of 2011 (15.4 kg), but very close to the average weights in 2009 and 2010. The estimated size compositions are shown in Figure A-9. Prior to 2013, IATTC staff collected length-frequency samples from recreational vessels with landings in San Diego and from purse seiners. Beginning in 2013, sampling of recreational vessels was taken over by the U.S. National Marine Fisheries Service (NMFS). Very few samples were collected from commercial purse-seiners during 2013-2017. The size composition estimates for bluefin will be updated after development of a methodology that will incorporate the changes in sampling.

Black skipjack are caught incidentally by fishermen who direct their effort toward yellowfin, skipjack, and bigeye tuna. The demand for this species is low, so most of the catches are discarded at sea, but small amounts, mixed with the more desirable species, are sometimes retained. The estimated size compositions for each year of the 2012-2017 period are shown in Figure A-10.

1.3.2. Longline fishery

The size compositions of yellowfin and bigeye caught by the Japanese longline fleet (commercial and training vessels) in the EPO during 2012-2015 are shown in Figures A-11 and A-12. The average annual weight during that period ranged from 49.4 to 60.5 kg for yellowfin, and from 57.3 kg to 63.5 kg for bigeye. The data for 2016 are incomplete, and available for training vessels only (see Document SAC-07-03d). Information on the size compositions of fish caught by the Japanese longline fishery in the EPO during 1958-2008 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 1988-2017 by flag and gear, are shown in Tables A-3a-e. These tables include all the known catches of tunas and bonitos compiled from various sources, including vessel logbooks, observer data, unloading records provided by canners and other processors, export and import records, reports from governments and other entities, and estimates derived from the species- and size-composition sampling program. Similar information on tunas and bonitos prior to 2001, and historical data for tunas, billfishes, sharks, carangids, dorado, and miscellaneous fishes are available on the IATTC website. The purse-seine catches of tunas and bonitos in 2016 and 2017, by flag, are summarized in Table A-4a. Of the nearly 615 thousand t of tunas and bonitos caught in 2017, 47% were caught by Ecuadorian vessels, and 18% by Mexican vessels. Other countries with significant catches of tunas and bonitos in the EPO included Panama (11%), Colombia (6%), United States (6%) and Venezuela (4%). The purse-seine landings of tunas and bonitos in 2016 and 2017, by flag, are summarized in Table A-4b. Of the more than 657 thousand t of tunas and bonitos landed in the EPO in 2017 (which include some catches from 2016), 61% were landed in Ecuadorian ports, and 21% in Mexican ports. Other countries with landings of tunas and bonitos in the EPO included Peru (3%) and Colombia (2%).

2. FISHING EFFORT

2.1. Purse seine

Estimates of the numbers of purse-seine sets of each type (associated with dolphins, associated with floating objects, and unassociated) in the EPO during 2002-2017, and the retained catches from those sets, are shown in Table A-7 and 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.

There are two types of floating objects, flotsam and fish-aggregating devices (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. The use of FADs increased sharply in the mid-1990s, and they now account for 98% of all floating-object sets by vessels of >363 t carrying capacity (Table A-8).

2.2. Longline

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

3. THE FLEETS

3.1. Purse-seine and pole-and-line fleets

The IATTC staff maintains detailed records of gear, flag, and fish-carrying capacity for most of the vessels that fish with purse-seine or pole-and-line gear for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO. However, since 2016 there have been no pole-and-line vessels fishing for tuna in the EPO. Only purse-seine vessels that fished for any of these four species during all or part of the year are included in the following paragraphs describing the purse seine fleet.

The IATTC uses well volume, in cubic meters (m^3), to measure the carrying capacity of vessels. Until 2000, the owner's or builder's estimates of the carrying capacity of individual vessels, in tons of fish, were used, but since the density of fish in a well can vary, measuring carrying capacity in weight is subjective. Using volume as a measure of capacity eliminates this problem.

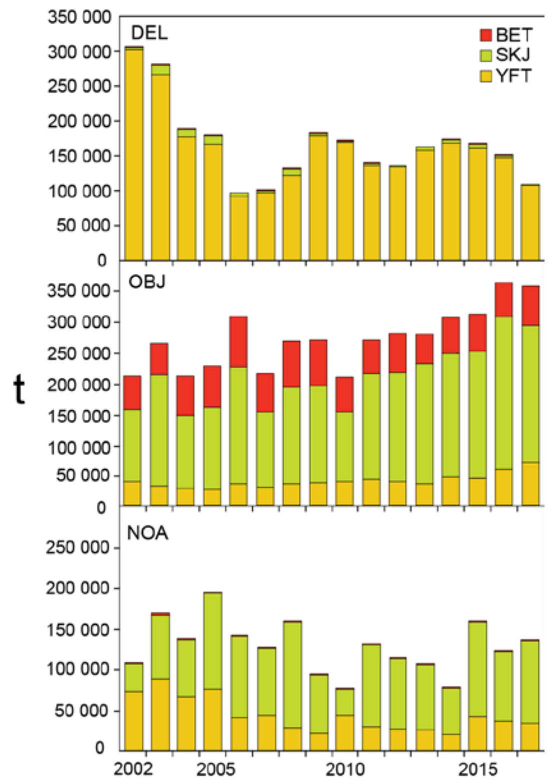

FIGURE 1. Purse-seine catches of tunas, by species and set type, 2002-2017

Reliable well volume data are not available for some vessels. In such cases, the estimated capacity in metric tons is 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, which by 1961 dominated the EPO fishery. Since then the number of pole-and-line vessels has decreased from 93, with a total well volume of about 11 thousand m^3, to zero, and the number of purse-seine vessels has increased from 125 to 254, and their total well volume from about 32 thousand to about 263 thousand m^3, an average of about 1,035 m^3 per vessel. An earlier peak in numbers and total well volume of purse seiners occurred from the mid-1970s to the early 1980s, when the number of vessels reached 282 and the total well volume about 195 thousand m^3, an average of about 700 m^3 per vessel (Table A-10; Figure 2).

The catch rates in the EPO were low during 1978-1981, due to concentration of fishing effort on small fish, and the situation was exacerbated by a major El Niño event, which began in mid-1982 and persisted until late 1983 and made the fish less vulnerable to capture. The total well volume of purse-seine and pole-and-line vessels then declined as vessels were deactivated or left the EPO to fish in other areas, primarily the western Pacific Ocean, and in 1984 it reached its lowest level since 1971, about 119 thousand m^3. In early

1990 the U.S. tuna-canning industry adopted a policy of not purchasing tunas caught during trips during which sets on tunas associated with dolphins were made. This caused many U.S.-flag vessels to leave the EPO, with a consequent reduction in the fleet to about 117 thousand m^3 in 1992. With increases in participation of vessels of other nations in the fishery, the total well volume has increased steadily since 1992, and in 2017 was 263 thousand m^3.

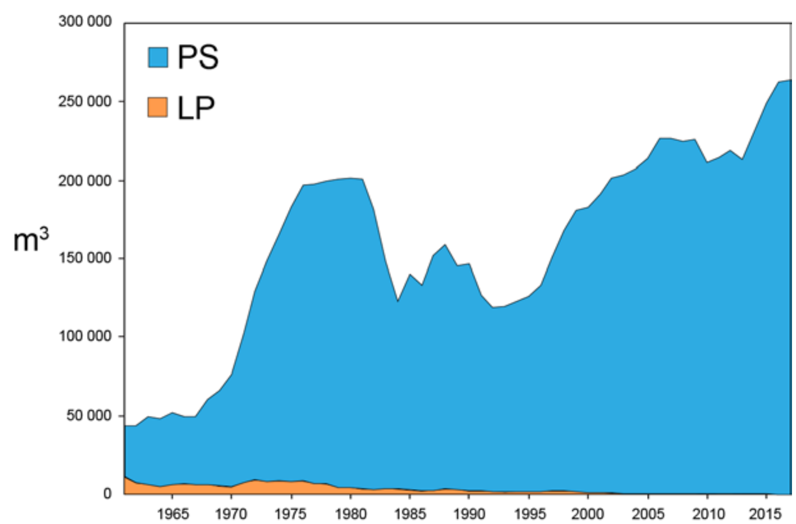

FIGURE 2. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2017

The 2016 and preliminary 2017 data for numbers and total well volumes of purse-seine vessels that fished for tunas in the EPO are shown in Tables A-11a and A-11b. During 2017, the fleet was dominated by vessels operating under the Ecuadorian and Mexican flags, with about 35% and 23%, respectively, of the total well volume; they were followed by the United States (12%), Panama (8%), Venezuela (7%), Colombia (6%), Nicaragua (4%), El Salvador (2%), Peru (2%) and the European Union (Spain) (1%). The sum of the percentages may not add up to 100% due to rounding.

The cumulative capacity at sea during 2017 is compared to those of the previous five 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 2007-2016, and the 2017 values, are shown in Table A-12. The monthly values are averages of the VAS estimated at weekly intervals by the IATTC staff. Since 2000 the fishery has been regulated during some or all of the last four months of the year, so the VAS values for September-December 2017 are not comparable to the average VAS values for those months of 2000-2017. The average VAS values for 2007-2016 and 2017 were a little over 138 thousand m^3 (61% of total capacity) and about 160 thousand m^3 (61% of total capacity), respectively.

3.2. Other fleets of the EPO

Information on other types of vessels that are authorized to fish or that fish for tunas in the EPO is available in the IATTC's Regional Vessel Register, on the IATTC website. 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 2017, or ever.

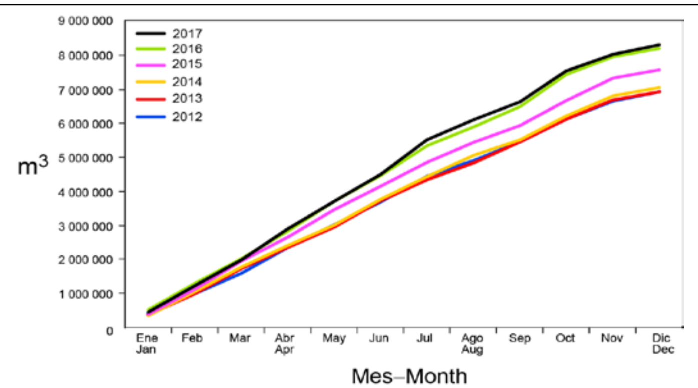

FIGURE 3. Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2012-2017

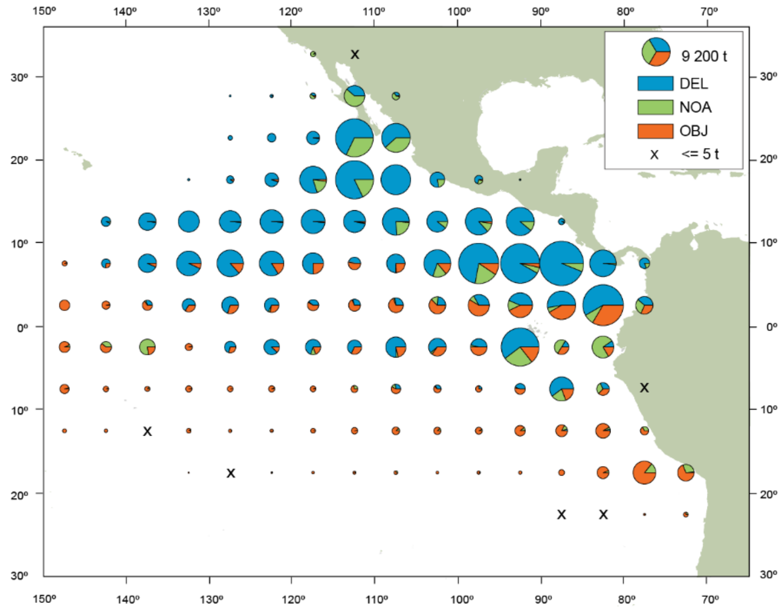

FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 2012-2016. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2012-2016. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

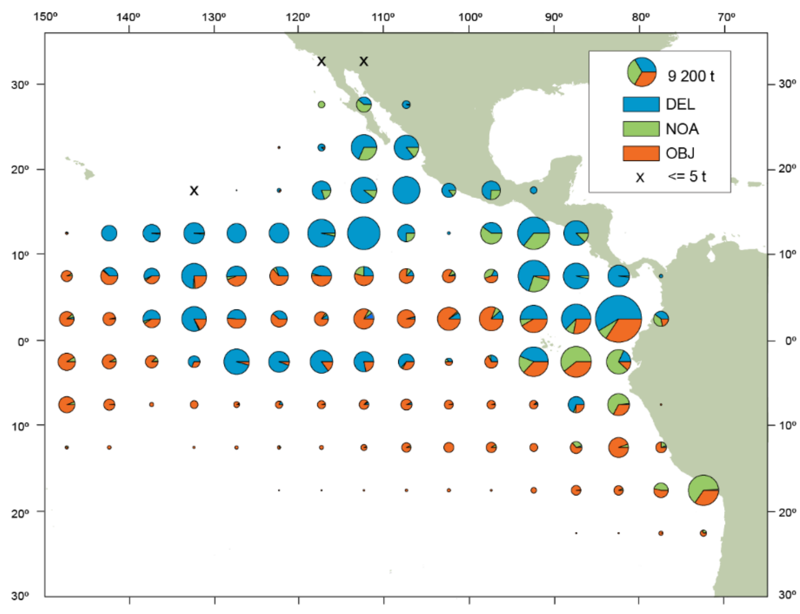

FIGURE A-1b. Annual distributions of the purse-seine catches of yellowfin, by set type, 2017. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2017. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

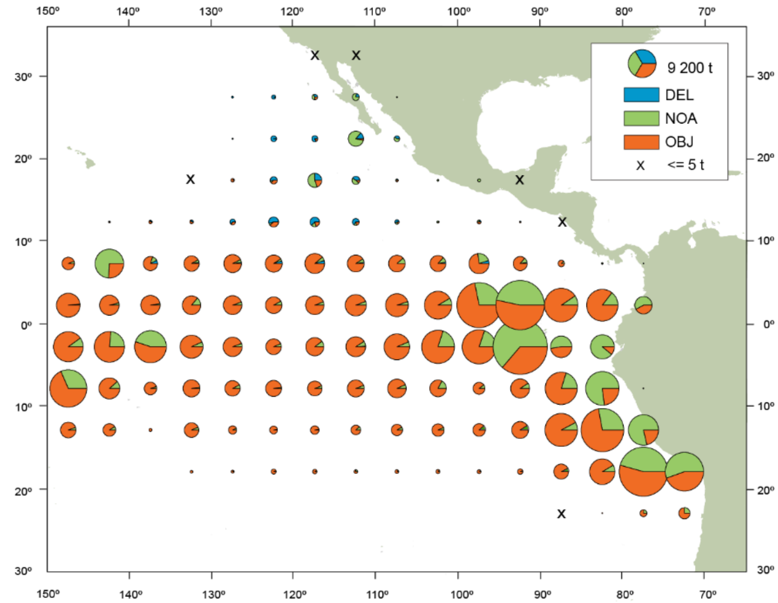

FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 2012-2016. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 2012-2016. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

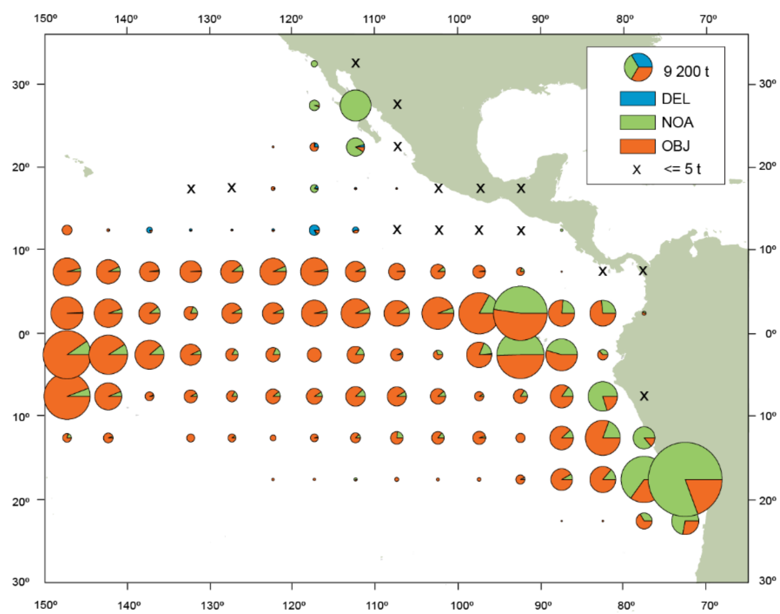

FIGURE A-2b. Annual distributions of the purse-seine catches of skipjack, by set type, 2017. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.

FIGURA A-2b. Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2017. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

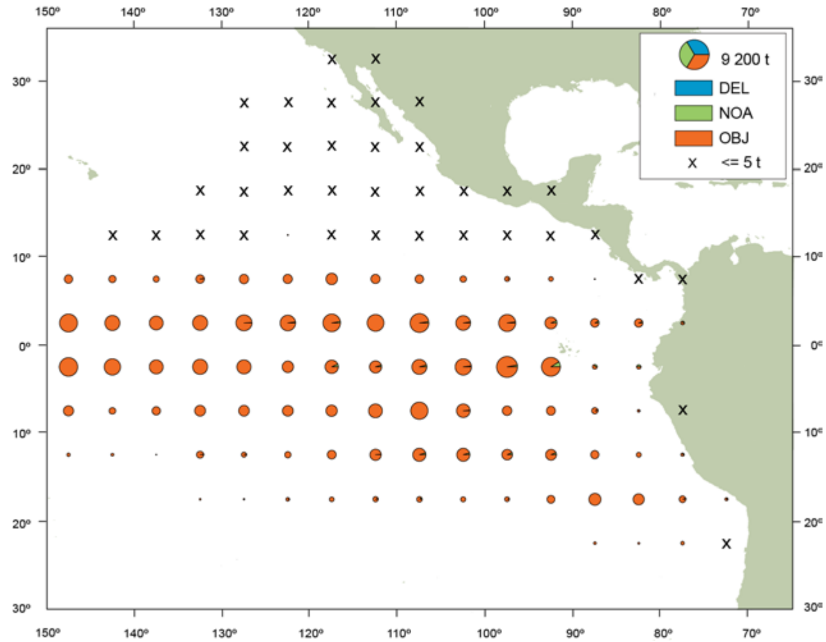

FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 2012-2016. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 2012-2016. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

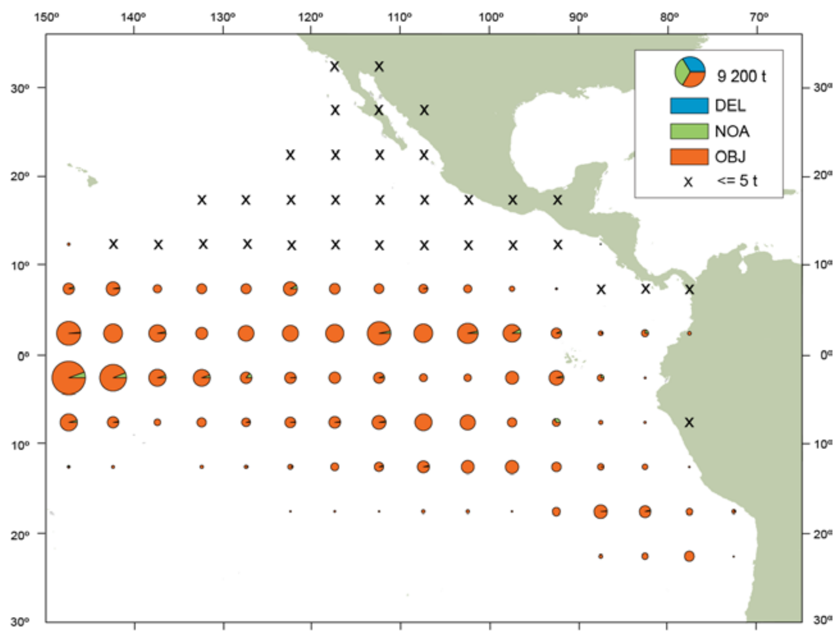

FIGURE A-3b. Annual distributions of the purse-seine catches of bigeye, by set type, 2017. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3b. Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2017. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

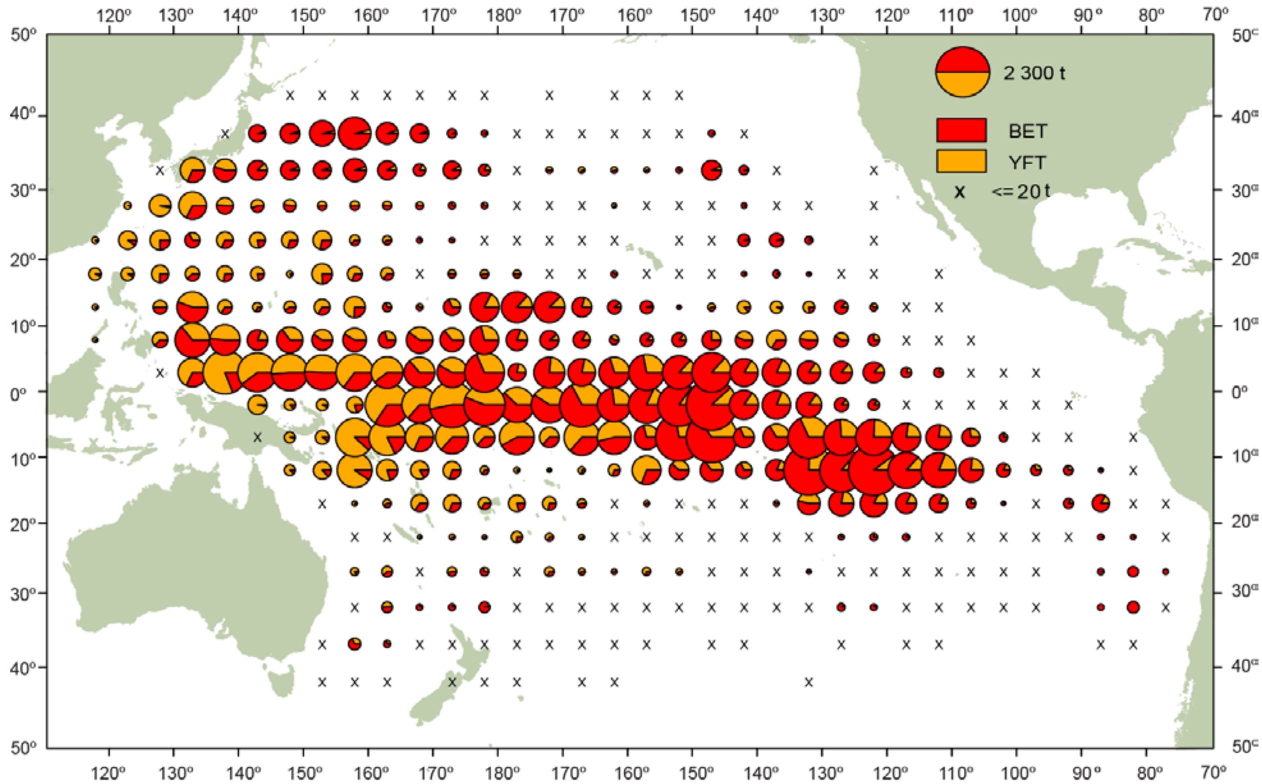

FIGURE A-4. Distributions of the average annual catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by Chinese, Japanese, Korean, and Chinese Taipei longline vessels, 2012-2016. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° by 5° areas.

FIGURA A-4. Distribución de las capturas anuales medias de atunes patudo y aleta amarilla en el Océano Pacifico, en toneladas métricas, por buques palangreros de China, Corea, Japón, y Taipei Chino, 2012-2016. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

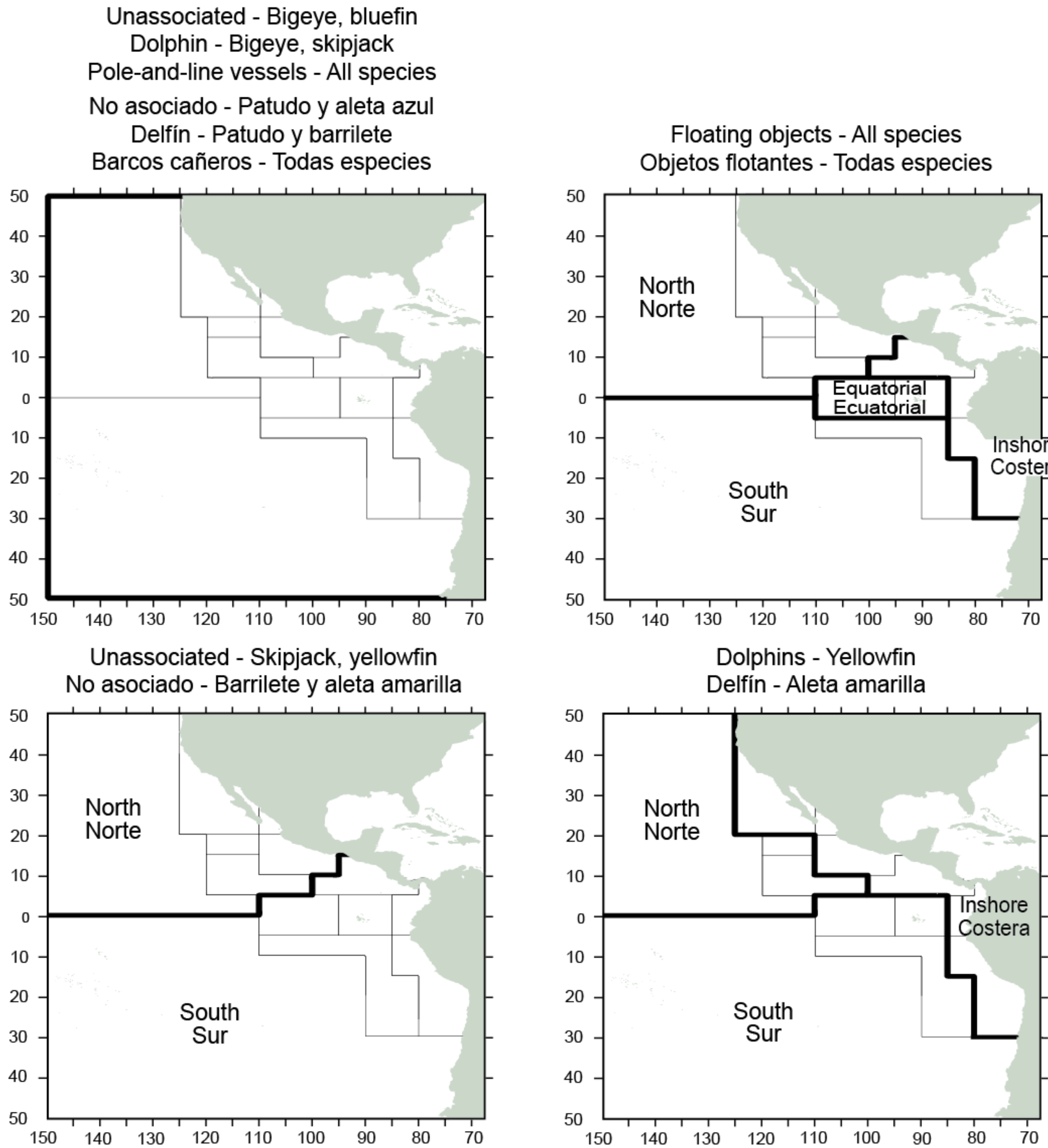

FIGURE A-5. The fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

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.

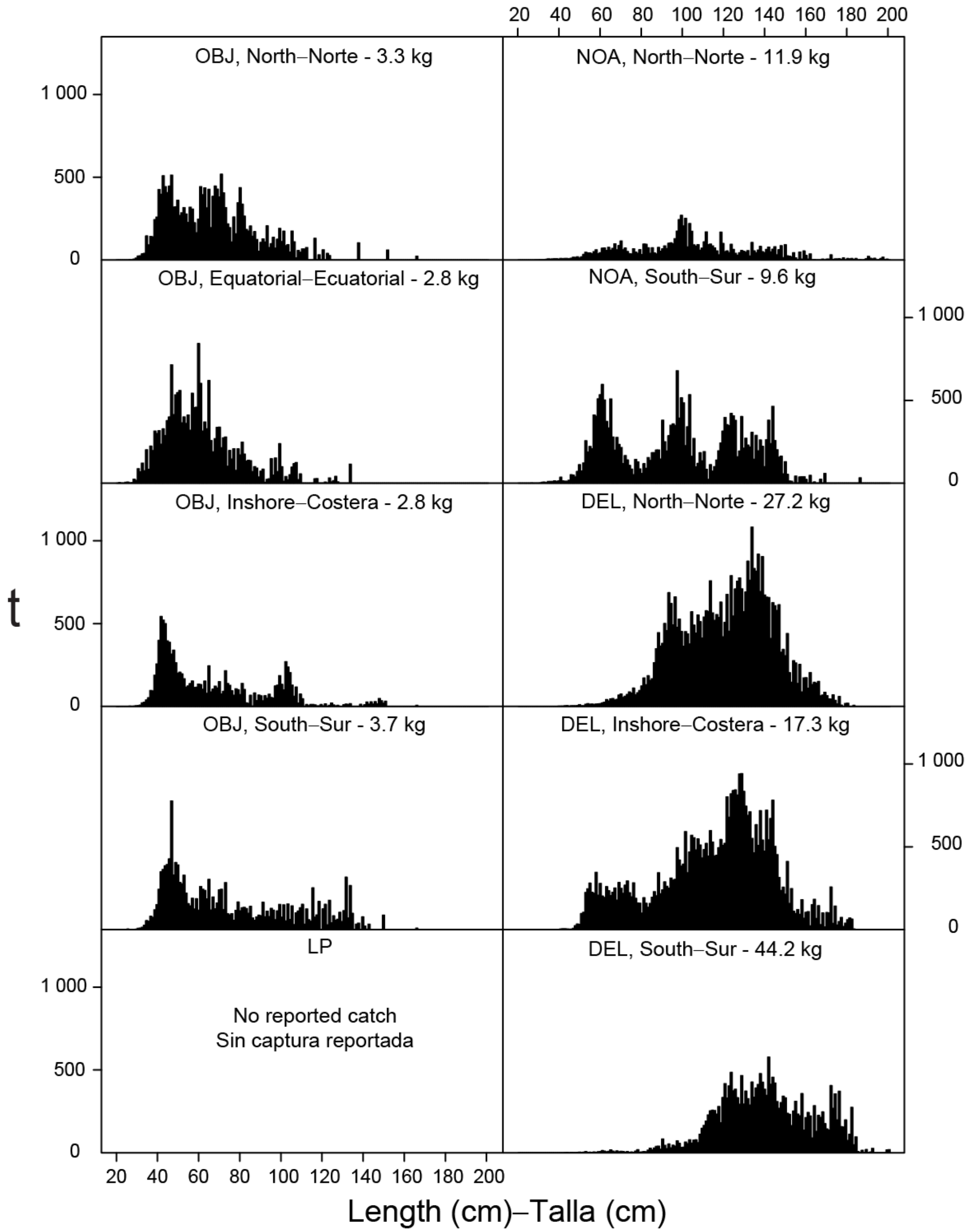

FIGURE A-6a. Estimated size compositions of the yellowfin caught in the EPO during 2017 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2017 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

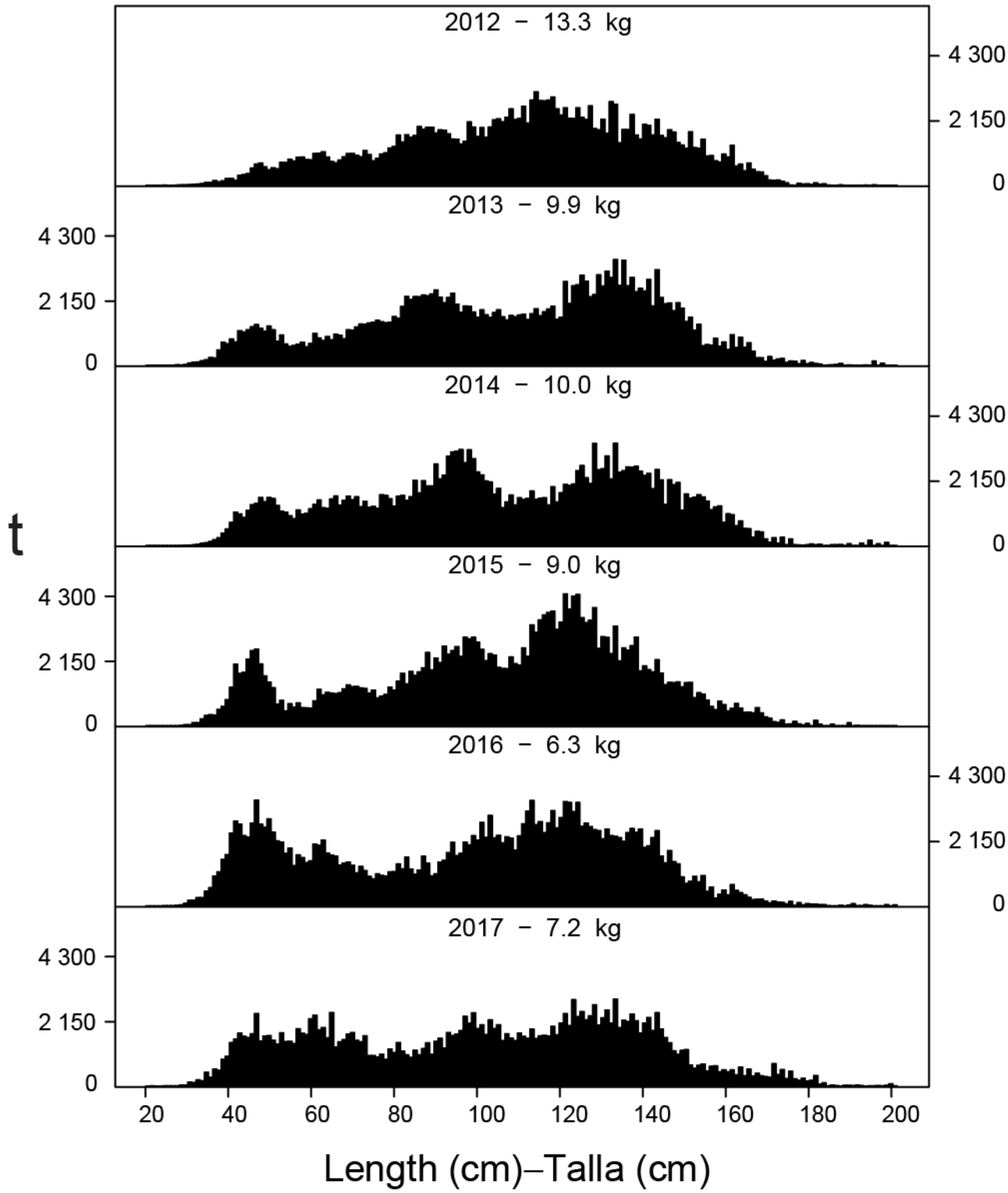

FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2012-2017. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2012-2017. En cada recuadro se detalla el peso promedio de los peces en las muestras.

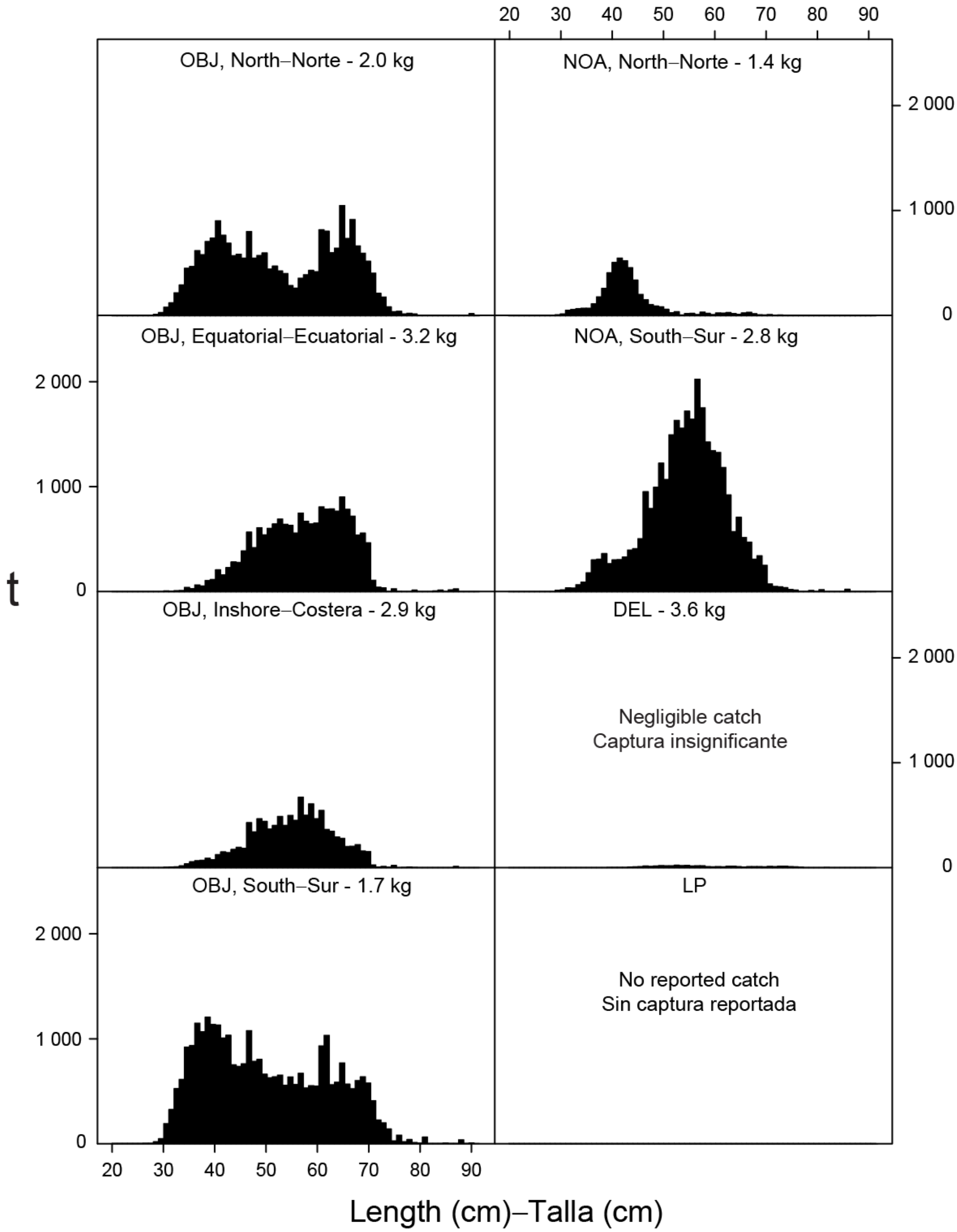

FIGURE A-7a. Estimated size compositions of the skipjack caught in the EPO during 2017 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.
FIGURA A-7a. Composición por tallas estimada del barrilete capturado en el OPO durante 2017 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

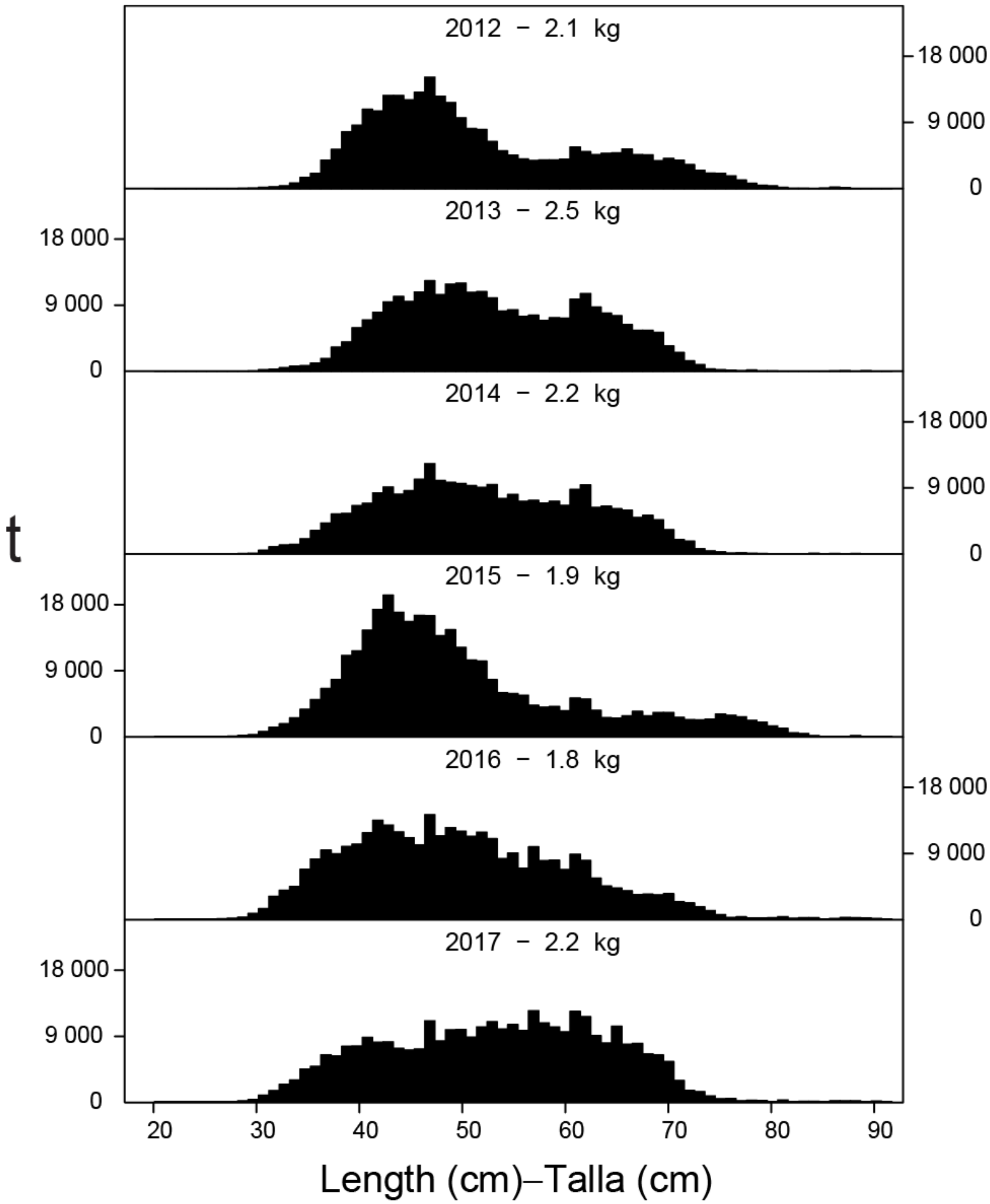

FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2012-2017. The value at the top of each panel is the average weight of the fish in the samples .

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2012-2017. En cada recuadro se detalla el peso promedio de los peces en las muestras.

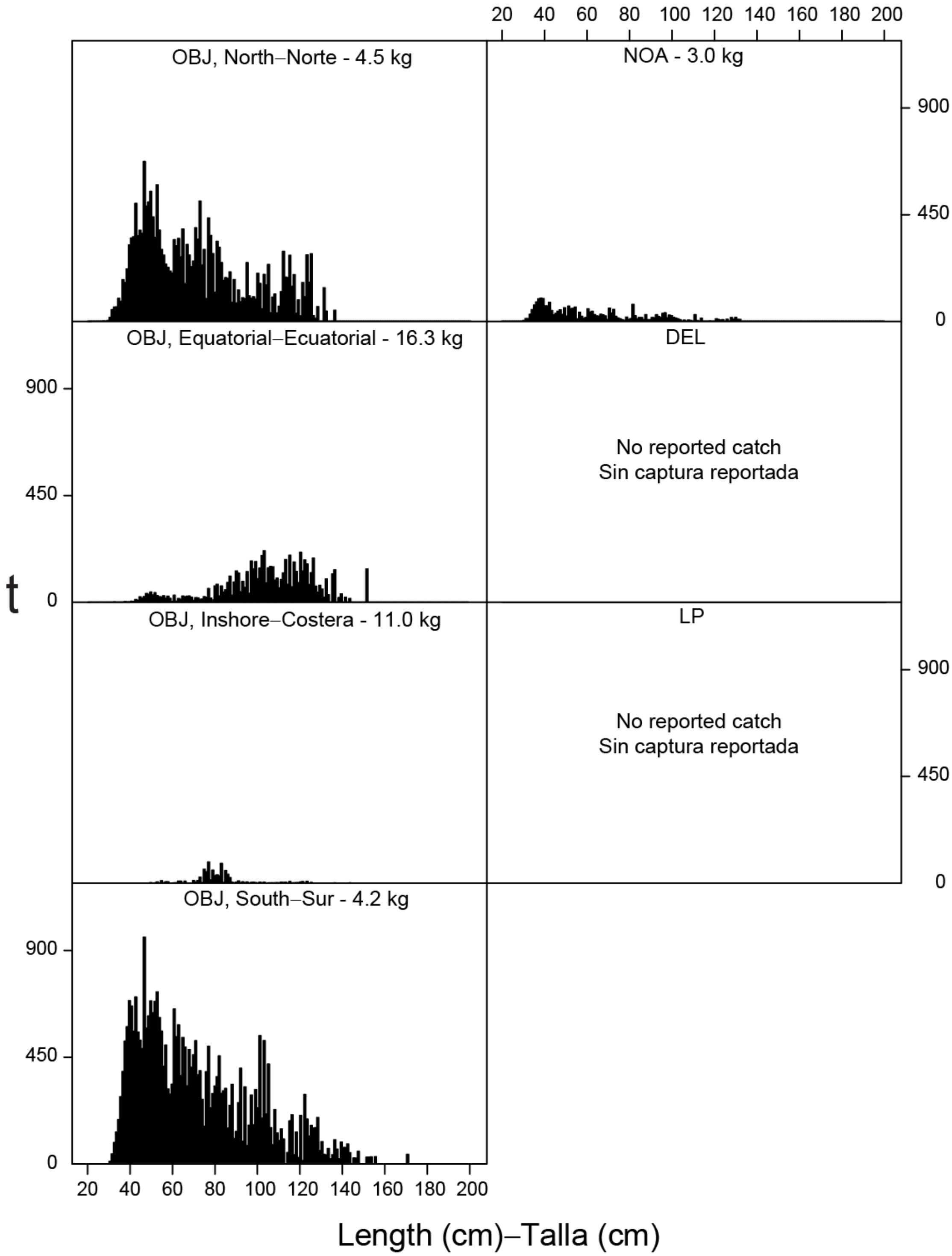

FIGURE A-8a. Estimated size compositions of the bigeye caught in the EPO during 2017 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight.

FIGURA A-8a. Composición por tallas estimada del patudo capturado e en el OPO durante 2017 en cada pesquería ilustrada en la Figura A-5. En cada recuadro se detalla el peso promedio de los peces en las muestras.

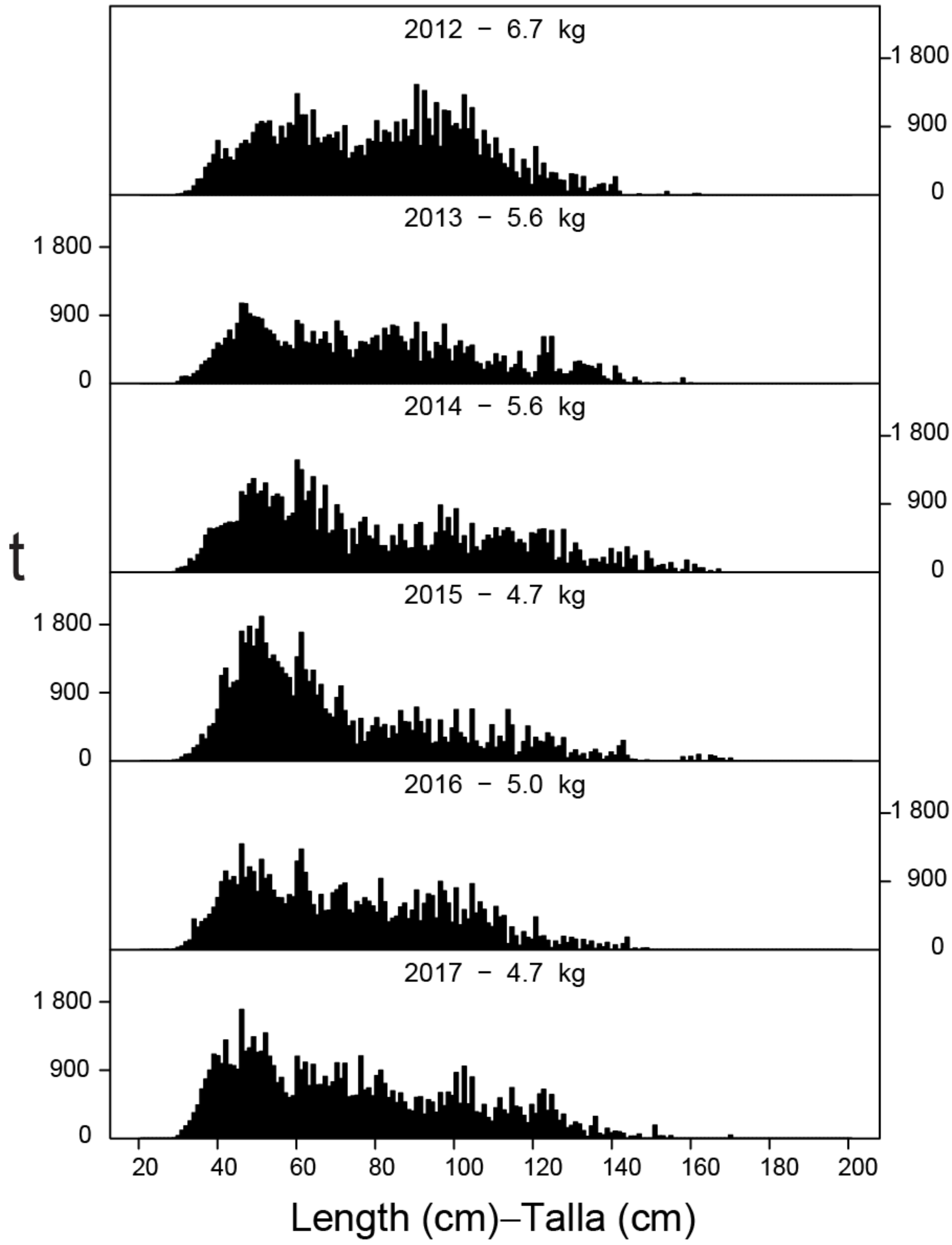

FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2012-2017. The value at the top of each panel is the average weight.

FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2012-2017. En cada recuadro se detalla el peso promedio de los peces en las muestras.

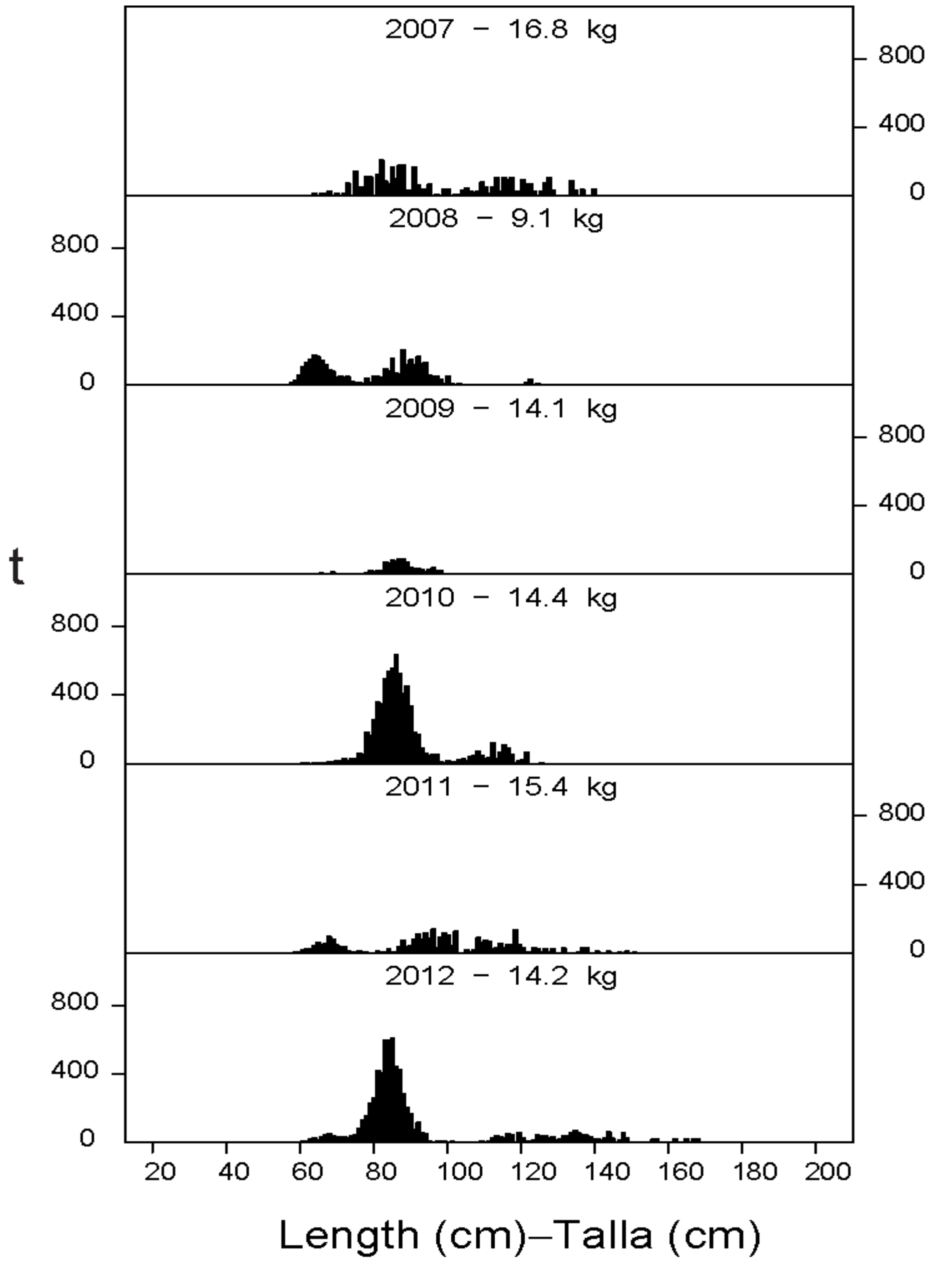

FIGURE A-9. Estimated catches of Pacific bluefin by purse-seine and recreational gear in the EPO during 2007-2012. The value at the top of each panel is the average weight.
FIGURA A-9. Captura estimada de aleta azul del Pacífico con arte de cerco y deportiva en el OPO durante 2007-2012. El valor en cada recuadro representa el peso promedio.

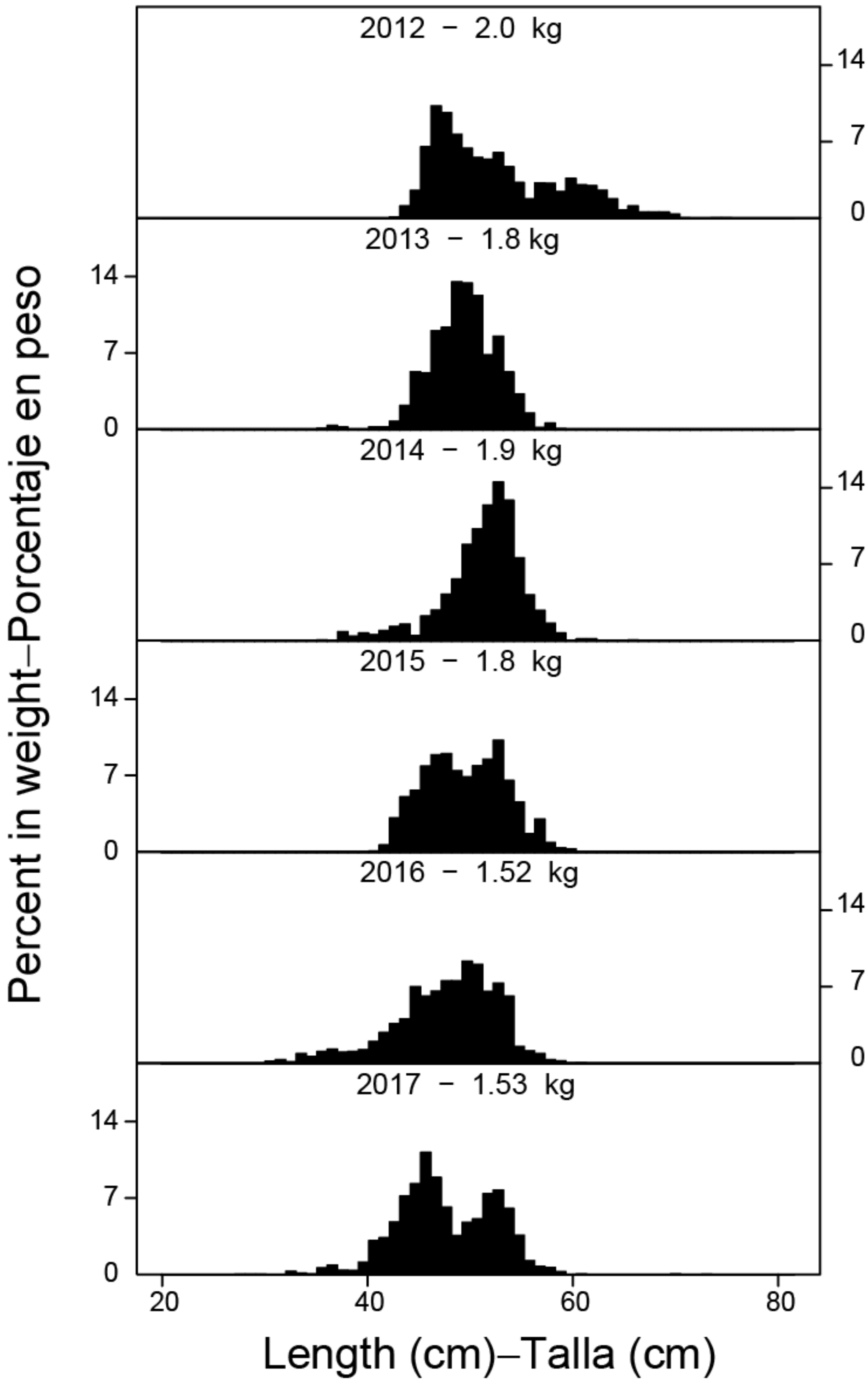

FIGURE A-10. Preliminary size compositions of the catches of black skipjack by purse-seine vessels in the EPO, 2012-2017. The value at the top of each panel is the average weight.
FIGURA A-10. Composición por tallas preliminar del barrilete negro capturado por buques cerqueros en el OPO, 2012-2017. El valor en cada recuadro representa el peso promedio.

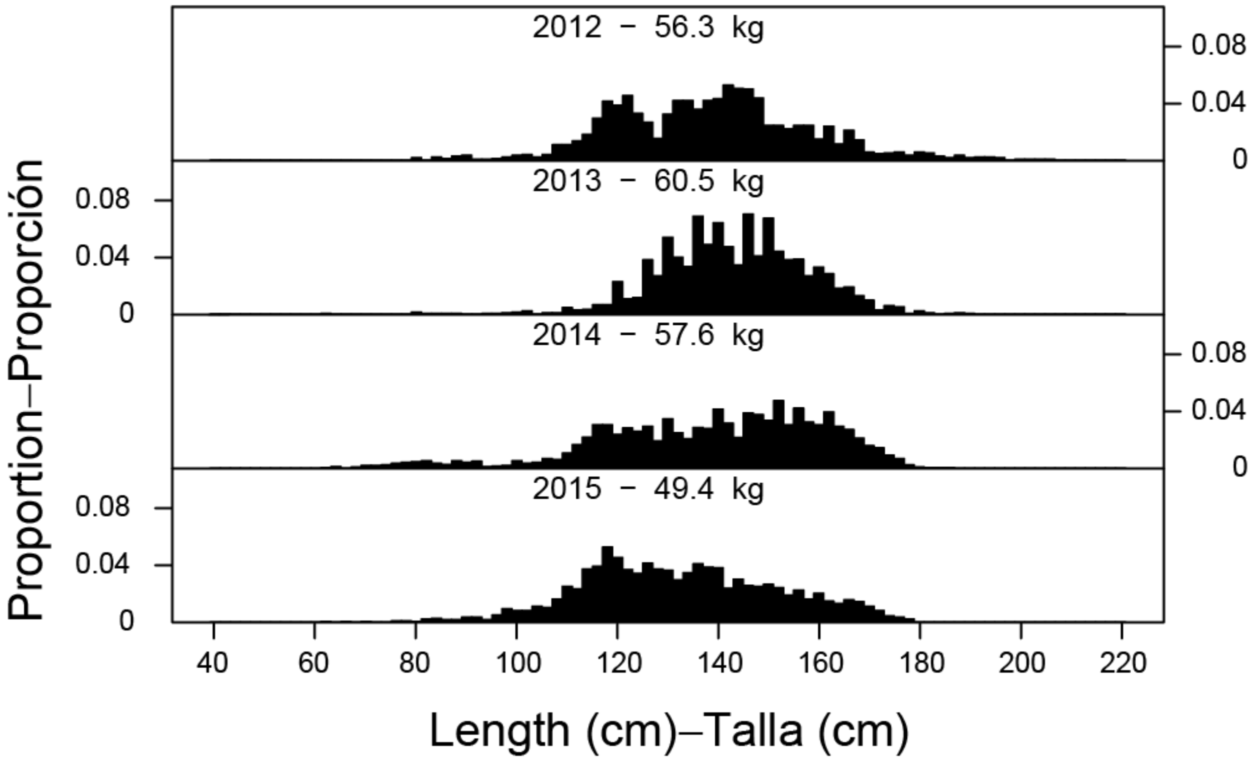

FIGURE A-11. Estimated size compositions of the catches of yellowfin by the Japanese longline fleet in the EPO, 2012-2015. The value at the top of each panel is the average weight.

FIGURA A-11. Composición por tallas estimada de las capturas de aleta amarilla por la flota palangrera japonesa en el OPO, 2012-2015. El valor en cada recuadro representa el peso promedio.

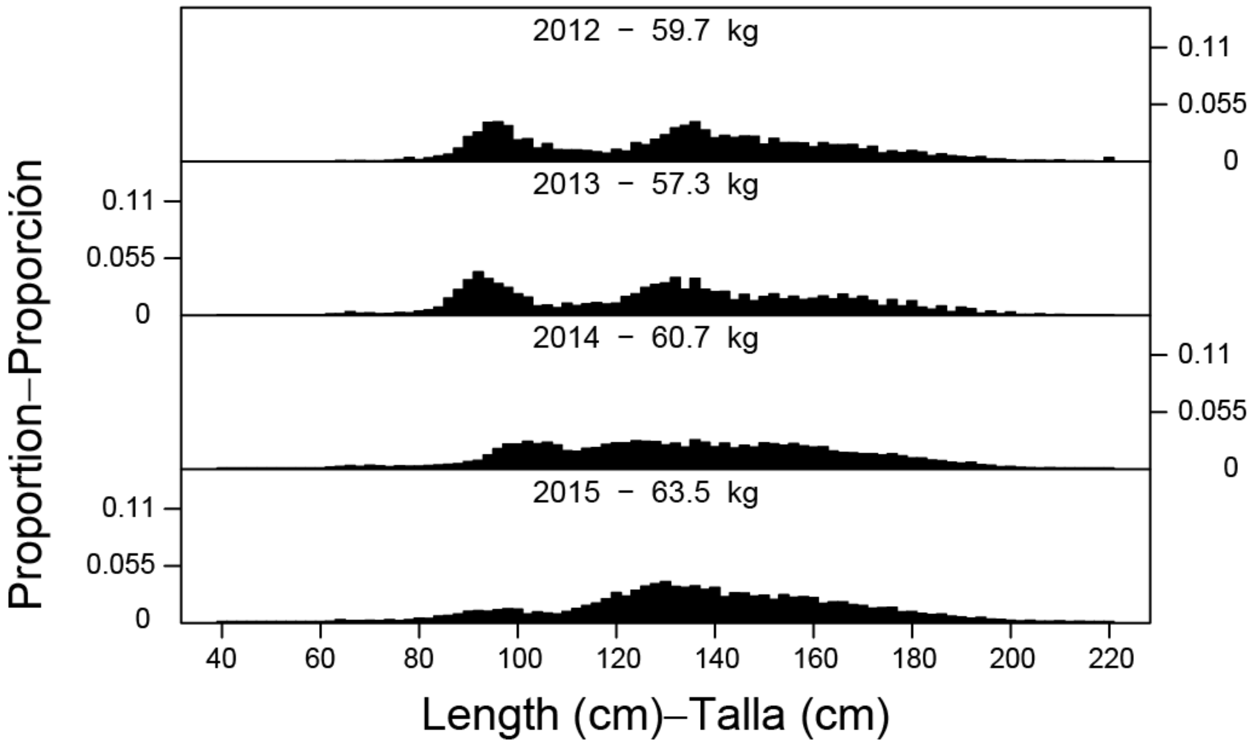

FIGURE A-12. Estimated size compositions of the catches of bigeye by the Japanese longline fleet in the EPO, 2012-2015. The value at the top of each panel is the average weight.

FIGURA A-12. Composición por tallas estimada de las capturas de patudo por la flota palangrera japonesa en el OPO, 2012-2015. El valor en cada recuadro representa el peso promedio.

TABLE A-1. Annual catches of yellowfin, skipjack, and bigeye tunas, by all types of gear combined, in the Pacific Ocean. The EPO totals for 1993-2017 include discards from purse-seine vessels with carrying capacities greater than 363 t. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-1. Capturas anuales de atunes aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico. Los totales del OPO de 1993-2017 incluyen los descartes de buques cerqueros de más de 363 t de capacidad de acarreo. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	YFT			SKJ			BET			Total		
	EPO	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**	**EPO**	**WCPO**	**Total**
1988	296,428	299,262	595,690	92,127	812,796	904,923	74,313	91,432	165,745	462,868	1,203,490	1,666,358
1989	299,436	348,104	647,540	98,921	787,708	886,629	72,994	98,489	171,483	471,351	1,234,301	1,705,652
1990	301,522	390,428	691,950	77,107	857,067	934,174	104,851	116,370	221,221	483,480	1,363,865	1,847,345
1991	265,970	416,609	682,579	65,890	1,077,398	1,143,288	109,121	99,354	208,475	440,981	1,593,361	2,034,342
1992	252,514	424,965	677,479	87,294	971,558	1,058,852	92,000	119,335	211,335	431,808	1,515,858	1,947,666
1993	256,199	365,631	621,830	100,434	926,617	1,027,051	82,843	103,733	186,576	439,476	1,395,981	1,835,457
1994	248,071	405,421	653,492	84,661	990,437	1,075,098	109,331	117,497	226,828	442,063	1,513,355	1,955,418
1995	244,639	409,174	653,813	150,661	1,020,852	1,171,513	108,210	100,642	208,852	503,510	1,530,668	2,034,178
1996	266,928	411,433	678,361	132,335	1,011,907	1,144,242	114,706	112,724	227,430	513,969	1,536,064	2,050,033
1997	277,575	493,038	770,613	188,285	906,376	1,094,661	122,274	158,380	280,654	588,134	1,557,794	2,145,928
1998	280,606	598,998	879,604	165,489	1,169,422	1,334,911	93,954	168,127	262,081	540,049	1,936,547	2,476,596
1999	304,638	512,991	817,629	291,249	1,047,417	1,338,666	93,078	150,842	243,920	688,965	1,711,250	2,400,215
2000	286,865	560,932	847,797	230,480	1,156,160	1,386,639	148,557	137,201	285,758	665,901	1,854,293	2,520,194
2001	425,008	527,859	952,867	157,676	1,080,053	1,237,729	130,546	137,859	268,405	713,230	1,745,771	2,459,001
2002	443,458	482,664	926,122	167,048	1,258,988	1,426,036	132,806	158,153	290,959	743,312	1,899,805	2,643,117
2003	415,933	540,331	956,264	300,470	1,252,996	1,553,466	115,175	128,596	243,771	831,578	1,921,923	2,753,501
2004	296,847	578,045	874,892	217,249	1,348,940	1,566,189	110,722	180,393	291,115	624,818	2,107,378	2,732,196
2005	286,492	547,082	833,574	283,453	1,397,441	1,680,894	110,514	143,482	253,996	680,459	2,088,005	2,768,464
2006	180,519	481,285	661,804	309,090	1,494,070	1,803,160	117,328	152,574	269,902	606,937	2,127,929	2,734,866
2007	182,141	512,270	694,411	216,324	1,647,760	1,864,084	94,260	138,656	232,916	492,725	2,298,686	2,791,411
2008	197,328	606,650	803,978	307,699	1,619,329	1,927,028	103,350	149,059	252,409	608,377	2,375,038	2,983,415
2009	250,413	540,660	791,073	239,408	1,784,286	2,023,694	109,255	147,666	256,921	599,076	2,472,612	3,071,688
2010	261,871	559,280	821,151	153,092	1,689,179	1,842,271	95,408	132,417	227,825	510,371	2,380,876	2,891,247
2011	216,720	520,709	737,429	283,509	1,534,763	1,818,272	89,460	154,798	244,258	589,689	2,210,270	2,799,959
2012	213,310	607,269	820,579	273,519	1,752,092	2,025,611	102,687	157,700	260,387	589,516	2,517,061	3,106,577
2013	231,803	554,255	786,058	284,043	1,827,026	2,111,069	86,063	145,712	231,775	601,909	2,526,993	3,128,902
2014	246,512	593,311	839,823	265,490	1,999,774	2,265,264	96,045	156,304	252,349	608,047	2,749,389	3,357,436
2015	246,380	575,821	822,201	334,066	1,790,123	2,124,189	104,755	136,863	241,618	685,201	2,502,807	3,188,008
2016	254,784	642,240	897,024	342,557	1,784,512	2,127,069	92,801	144,857	237,658	690,142	2,571,609	3,261,751
2017	211,899	*	211,899	327,979	*	327,979	97,519	*	97,519	637,397	*	637,397

TABLE A-2a. Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels with carrying capacities greater than 363 t only, of tunas and bonitos, in metric tons, in the EPO. 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 2016-2017 are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-2a. Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de atunes y bonitos, en toneladas métricas, en el OPO. 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 2016-2017 son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	Yellowfin—Aleta amarilla						Skipjack—Barrilete						Bigeye—Patudo					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1988	277,293	-	3,723	14,660	752	296,428	87,113	-	4,325	26	663	92,127	1,535	-	5	72,758	15	74,313
1989	277,996	-	4,145	17,032	263	299,436	94,934	-	2,940	28	1,019	98,921	2,030	-	-	70,963	1	72,994
1990	263,253	-	2,676	34,633	960	301,522	74,369	-	823	41	1,874	77,107	5,921	-	-	98,871	59	104,851
1991	231,257	-	2,856	30,899	958	265,970	62,228	-	1,717	36	1,909	65,890	4,870	-	31	104,195	25	109,121
1992	228,121	-	3,789	18,646	1,958	252,514	84,283	-	1,957	24	1,030	87,294	7,179	-	-	84,808	13	92,000
1993	219,492	4,713	4,951	24,009	3,034	256,199	83,830	10,515	3,772	61	2,256	100,434	9,657	653	-	72,498	35	82,843
1994	208,408	4,525	3,625	30,026	1,487	248,071	70,126	10,491	3,240	73	731	84,661	34,899	2,266	-	71,360	806	109,331
1995	215,434	5,275	1,268	20,596	2,066	244,639	127,047	16,373	5,253	77	1,911	150,661	45,321	3,251	-	58,269	1,369	108,210
1996	238,607	6,312	3,762	16,608	1,639	266,928	103,973	24,494	2,555	52	1,261	132,335	61,311	5,689	-	46,958	748	114,706
1997	244,878	5,516	4,418	22,163	600	277,575	153,456	31,338	3,260	135	96	188,285	64,272	5,402	-	52,580	20	122,274
1998	253,959	4,697	5,085	15,336	1,529	280,606	140,631	22,643	1,684	294	237	165,489	44,129	2,822	-	46,375	628	93,954
1999	281,920	6,547	1,783	11,682	2,706	304,638	261,565	26,046	2,044	201	1,393	291,249	51,158	4,932	-	36,450	538	93,078
2000	253,263	6,205	2,431	23,855	1,109	286,863	205,647	24,467	231	68	66	230,479	95,282	5,417	-	47,605	253	148,557
2001	383,936	7,028	3,916	29,608	520	425,008	143,165	12,815	448	1,214	34	157,676	60,518	1,254	-	68,755	19	130,546
2002	412,286	4,140	950	25,531	551	443,458	153,546	12,506	616	261	119	167,048	57,421	949	-	74,424	12	132,806
2003	383,279	5,865	470	25,174	1,145	415,933	273,968	22,453	638	634	2,777	300,470	53,052	2,326	-	59,776	21	115,175
2004	272,557	3,000	1,884	18,779	627	296,847	197,824	17,078	528	713	1,106	217,249	65,471	1,574	-	43,483	194	110,722
2005	268,101	2,771	1,822	11,946	1,852	286,492	263,229	16,915	1,299	231	1,779	283,453	67,895	1,900	-	40,694	25	110,514
2006	166,631	1,534	686	10,210	1,458	180,519	296,268	11,177	435	224	986	309,090	83,838	1,680	-	31,770	40	117,328
2007	170,016	1,725	894	8,067	1,439	182,141	208,295	6,450	276	238	1,065	216,324	63,450	890	-	29,876	44	94,260
2008	185,057	696	814	9,820	941	197,328	296,603	8,249	499	1,185	1,163	307,699	75,028	2,086	-	26,208	28	103,350
2009	236,757	1,262	709	10,444	1,241	250,413	230,523	6,064	151	1,584	1,086	239,408	76,799	1,019	-	31,422	15	109,255
2010	251,009	1,031	460	8,339	1,032	261,871	147,192	2,769	47	1,815	1,269	153,092	57,752	564	-	37,090	2	95,408
2011	206,851	415	276	8,048	1,130	216,720	276,035	5,215	24	1,384	851	283,509	56,512	631	-	32,317	-	89,460
2012	198,017	451	400	12,954	1,488	213,310	266,215	3,511	303	2,381	1,109	273,519	66,020	473	-	36,167	27	102,687
2013	218,187	207	759	10,783	1,234	231,170	278,560	2,254	164	2,024	1,041	284,043	49,487	273	-	36,204	99	86,063
2014	234,066	517	C	8,646	3,549	246,778	261,469	2,596	C	194	1,231	265,490	60,445	83	-	35,340	177	96,045
2015	245,727	334	C	10,787	3,568	260,416	328,907	3,699	C	205	1,255	334,066	62,913	177	-	41,644	21	104,755
2016	242,095	404	-	9,402	2,883	254,784	337,562	4,086	-	191	718	342,557	56,713	541	-	35,525	22	92,801
2017	209,699	418	-	1,782*	*	211,899	326,120	1,859	-	*	*	327,979	66,192	189	-	31,138	*	97,519

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

	Pacific bluefin—Aleta azul del Pacífico						Albacore—Albacora						Black skipjack—Barrilete negro					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1988	1,379	-	-	2	52	1,433	17	-	271	9,934	5,549	15,771	956	-	-	-	311	1,267
1989	1,103	-	5	4	91	1,203	1	-	21	6,784	2,695	9,501	803	-	-	-	-	803
1990	1,430	-	61	12	103	1,606	39	-	170	6,536	4,105	10,850	787	-	-	-	4	791
1991	419	-	-	5	55	479	-	-	834	7,893	2,754	11,481	421	-	-	-	25	446
1992	1,928	-	-	21	147	2,096	-	-	255	17,080	5,740	23,075	105	-	-	3	-	108
1993	580	-	-	11	316	907	-	-	1	11,194	4,410	15,605	104	3,925	-	31	-	4,060
1994	969	-	-	12	116	1,097	-	-	85	10,390	10,154	20,629	188	857	-	40	-	1,085
1995	659	-	-	25	264	948	-	-	465	6,185	7,427	14,077	202	1,448	-	-	-	1,650
1996	8,333	-	-	19	83	8,435	11	-	72	7,631	8,398	16,112	704	2,304	-	12	-	3,020
1997	2,608	3	2	14	235	2,862	1	-	59	9,678	7,540	17,278	100	2,512	-	11	-	2,623
1998	1,772	-	-	95	516	2,383	42	-	81	12,635	13,158	25,916	489	1,876	39	-	-	2,404
1999	2,553	54	5	151	514	3,277	47	-	227	11,633	14,510	26,417	171	3,404	-	-	-	3,575
2000	3,712	-	61	46	349	4,168	71	-	86	9,663	13,453	23,273	294	1,995	-	-	-	2,289
2001	1,155	3	1	148	378	1,685	3	-	157	19,410	13,727	33,297	2,258	1,019	-	-	-	3,277
2002	1,758	1	3	71	620	2,453	31	-	381	15,289	14,433	30,134	1,459	2,283	8	-	-	3,750
2003	3,233	-	3	87	369	3,692	34	-	59	24,901	20,397	45,391	433	1,535	6	13	117	2,104
2004	8,880	19	-	15	59	8,973	105	-	126	18,444	22,011	40,686	884	387	-	27	862	2,160
2005	4,743	15	-	-	80	4,838	2	-	66	9,350	15,668	25,086	1,472	2,124	-	-	22	3,618
2006	9,928	-	-	-	93	10,021	109	-	1	13,831	18,980	32,921	1,999	1,972	-	-	-	3,971
2007	4,189	-	-	-	14	4,203	187	-	21	11,107	19,261	30,576	2,307	1,625	-	2	54	3,988
2008	4,392	14	15	-	63	4,484	49	-	1,050	9,218	16,505	26,822	3,624	2,251	-	-	8	5,883
2009	3,428	24	-	-	161	3,613	50	2	C	12,072	19,090	31,214	4,256	1,020	-	2	-	5,278
2010	7,746	-	-	3	89	7,838	25	-	C	14,256	19,363	33,644	3,425	1,079	-	8	184	4,696
2011	2,829	4	-	1	244	3,078	10	-	C	16,191	16,074	32,275	2,317	719	-	6	-	3,042
2012	6,705	-	-	1	405	7,111	-	-	C	24,198	18,100	42,298	4,504	440	-	5	7	4,956
2013	3,154	-	-	1	819	3,974	-	-	C	25,401	18,513	43,914	3,580	805	-	10	24	4,419
2014	5,263	66	-	-	442	5,771	-	-	C	29,231	19,437	48,668	4,153	486	-	11	81	4,731
2015	3,168	-	-	26	387	3,581	-	-	C	28,957	17,099	46,056	3,763	356	-	1	111	4,231
2016	3,025	-	-	30	308	3,363	2	-	-	28,537	14,502	43,041	6,606	792	-	-	178	7,576
2017	4,109	-	-	*	14	4,123	-	-	-	*	*	*	5,006	397	-	*	*	5,403

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

	Bonitos						Unidentified tunas—Atunes no identificados						Total					
	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total	PS		LP	LL	OTR + NK	Total
	Ret.	Dis.					Ret.	Dis.					Ret.	Dis.				
1988	8,811	-	739	-	947	10,497	79	-	-	-	2,939	3,018	377,183	-	9,063	97,380	11,227	494,853
1989	11,278	-	818	-	465	12,561	36	-	-	-	626	662	388,181	-	7,928	94,812	5,161	496,082
1990	13,641	-	215	-	371	14,227	200	-	-	3	692	895	359,640	-	3,946	140,096	8,167	511,850
1991	1,207	-	82	-	242	1,531	4	-	-	29	192	225	300,406	-	5,520	143,057	6,161	455,144
1992	977	-	-	-	318	1,295	24	-	-	27	1,071	1,122	322,617	-	6,001	120,610	10,276	459,504
1993	599	12	1	-	436	1,048	9	1,975	-	10	4,082	6,076	314,271	21,793	8,725	107,814	14,570	467,173
1994	8,331	147	362	-	185	9,025	9	498	-	1	464	972	322,930	18,784	7,311	111,901	13,943	474,870
1995	7,929	55	81	-	54	8,119	11	626	-	-	1,004	1,641	396,603	27,028	7,066	85,152	14,096	529,945
1996	647	1	7	-	16	671	37	1,028	-	-	1,038	2,103	413,623	39,828	6,395	71,283	13,183	544,312
1997	1,097	4	8	-	34	1,143	71	3,383	-	7	1,437	4,898	466,483	48,158	7,747	84,588	9,962	616,937
1998	1,330	4	7	-	588	1,929	13	1,233	-	24	18,158	19,428	442,365	33,275	6,897	74,758	34,815	592,109
1999	1,719	-	-	24	369	2,112	27	3,092	-	2,113	4,279	9,511	599,160	44,075	4,059	62,254	24,310	733,858
2000	636	-	-	75	56	767	190	1,410	-	1,992	1,468	5,060	559,095	39,497	2,809	83,305	16,756	701,462
2001	17	-	-	34	19	70	191	679	-	2,448	55	3,373	591,243	22,798	4,523	121,616	14,755	754,934
2002	-	-	-	-	1	1	576	1,863	-	482	1,422	4,343	627,077	21,742	1,958	116,057	17,158	783,992
2003	-	-	1	-	25	26	80	1,238	-	215	750	2,283	714,079	33,417	1,177	110,799	25,600	885,072
2004	15	35	1	8	3	62	256	973	-	349	258	1,836	545,992	23,066	2,539	81,818	25,120	678,535
2005	313	18	-	-	11	342	190	1,922	-	363	427	2,902	605,945	25,665	3,187	62,585	19,865	717,248
2006	3,507	80	12	-	3	3,602	50	1,910	-	29	193	2,182	562,330	18,353	1,134	56,066	21,754	659,636
2007	15,906	628	107	2	-	16,643	598	1,221	-	2,197	301	4,317	464,948	12,539	1,298	51,488	22,179	552,451
2008	7,874	37	9	6	26	7,952	136	1,380	1	727	883	3,127	572,763	14,713	2,388	47,164	19,617	656,645
2009	9,720	15	-	8	77	9,820	162	469	-	1,933	74	2,638	561,695	9,875	860	57,466	21,743	651,640
2010	2,820	19	4	2	70	2,915	136	709	-	1,770	36	2,651	470,105	6,171	511	63,279	22,045	562,112
2011	7,969	45	18	10	11	8,053	108	784	-	3,178	-	4,070	552,631	7,813	318	61,136	18,311	640,209
2012	8,191	156	-	1	64	8,412	41	354	-	196	221	812	549,693	5,385	704	75,900	21,419	653,101
2013	2,067	9	-	13	27	2,116	53	461	-	-	529	1,043	555,088	4,009	923	74,439	22,286	656,745
2014	2,821	38	-	-	154	3,013	113	328	-	269	392	1,102	568,330	4,114	-	73,692	25,463	671,599
2015	789	28	-	-	-	817	85	242	-	-	1,232	1,559	645,352	4,836	-	81,620	23,673	755,481
2016	3,801	15	-	-	1	3,817	123	212	-	-	270	605	649,927	6,050	-	73,685	18,882	748,544
2017	3,357	37	-	*	*	3,394	231	256	-	*	*	487	614,714	3,156	-	32,920	14	650,804

TABLE A-2b. Estimated retained catches, by gear type, and estimated discards, by purse-seine vessels with carrying capacities greater than 363 t only, of billfishes, in metric tons, in the EPO. Data for 2016-2017 are preliminary. PS dis. = discards by purse-seine vessels. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

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. Los datos de 2016-2017 son preliminares. PS dis. = descartes por buques cerqueros. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	Swordfish—Pez espada					Blue marlin—Marlín azul					Black marlin—Marlín negro					Striped marlin—Marlín rayado				
	PS		LL	OTR	Total	PS		LL	OTR	Total	PS		LL	OTR	Total	PS		LL	OTR	Total
	Ret.	Dis.				Ret.	Dis.				Ret.	Dis.				Ret.	Dis.			
1988	-	-	4,916	5,642	10,558	-	-	5,663	-	5,663	-	-	288	-	288	-	-	5,283	-	5,283
1989	-	-	5,202	6,072	11,274	-	-	5,392	-	5,392	-	-	193	-	193	-	-	3,473	-	3,473
1990	-	-	5,807	5,066	10,873	-	-	5,540	-	5,540	-	-	223	-	223	-	-	3,260	333	3,593
1991	-	17	10,671	4,307	14,995	-	69	6,719	-	6,788	-	58	246	-	304	-	76	2,993	409	3,478
1992	-	4	9,820	4,267	14,091	-	52	6,626	-	6,678	-	95	228	-	323	-	69	3,054	239	3,362
1993	3	1	6,187	4,414	10,605	84	20	6,571	-	6,675	57	31	218	-	306	47	20	3,575	259	3,901
1994	1	-	4,990	3,822	8,813	69	15	9,027	-	9,111	39	23	256	-	318	20	9	3,396	257	3,682
1995	3	-	4,495	2,974	7,472	70	16	7,288	-	7,374	43	23	158	-	224	18	8	3,249	296	3,571
1996	1	-	7,071	2,486	9,558	62	15	3,596	-	3,673	46	24	100	-	170	20	9	3,218	430	3,677
1997	2	1	10,580	1,781	12,364	126	15	5,915	-	6,056	71	22	154	-	247	28	3	4,473	329	4,833
1998	3	-	9,800	3,246	13,049	130	20	4,856	-	5,006	72	28	168	-	268	20	3	3,558	509	4,090
1999	2	-	7,569	1,965	9,536	181	38	3,691	-	3,910	83	42	94	-	219	26	11	2,621	376	3,034
2000	3	-	8,930	2,383	11,316	120	23	3,634	-	3,777	67	21	105	-	193	17	3	1,889	404	2,313
2001	3	1	16,007	1,964	17,975	119	40	4,196	-	4,355	67	48	123	-	238	13	8	1,961	342	2,324
2002	1	-	17,598	2,119	19,718	188	33	3,480	-	3,701	86	30	78	-	194	69	5	2,158	412	2,644
2003	3	1	18,161	354	18,519	185	21	4,015	-	4,221	121	26	73	-	220	31	4	1,904	417	2,356
2004	2	-	15,372	309	15,683	140	21	3,783	-	3,944	62	5	41	-	108	23	1	1,547	390	1,961
2005	2	-	8,935	4,304	13,241	209	14	3,350	-	3,573	95	9	39	-	143	37	4	1,531	553	2,125
2006	7	-	9,890	3,800	13,697	164	21	2,934	105	3,224	124	21	77	-	222	54	3	1,735	490	2,282
2007	4	-	9,639	4,390	14,033	124	13	2,393	106	2,636	74	8	47	-	129	32	4	1,656	1,024	2,716
2008	6	-	12,248	3,071	15,325	125	8	1,705	114	1,952	76	9	100	-	185	33	2	1,291	1,045	2,371
2009	4	-	15,539	3,905	19,448	159	15	2,102	131	2,407	76	8	94	-	178	23	2	1,333	7	1,365
2010	4	-	18,396	4,480	22,880	176	12	2,920	126	3,234	62	9	160	-	231	21	2	2,129	9	2,161
2011	3	-	20,400	5,101	25,504	150	6	2,025	144	2,325	59	7	187	-	253	28	1	2,640	16	2,685
2012	5	-	23,587	7,148	30,740	178	15	3,723	177	4,093	71	4	444	-	519	28	-	2,703	20	2,751
2013	2	-	22,264	5,560	27,826	172	15	4,202	168	4,557	99	4	138	-	241	21	1	2,439	19	2,480
2014	4	-	20,938	6,421	27,363	209	12	4,069	186	4,476	70	4	151	-	225	22	1	1,929	3	1,955
2015	5	1	25,494	6,079	31,579	307	11	4,121	182	4,621	117	14	240	-	371	26	-	1,269	4	1,299
2016	4	-	23,854	7,112	30,970	247	6	3,687	175	4,115	62	3	78	-	143	19	-	2,039	4	2,062
2017	1	-	*	*	1	154	4	*	*	158	16	1	*	*	17	4	-	*	*	4

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

	Shortbill spearfish—Marlín trompa corta					Sailfish—Pez vela					Unidentified istiophorid billfishes—Picudos istiofóridos no identificados					Total billfishes—Total de peces picudos				
	PS		LL	OTR	Total	PS		LL	OTR	Total	PS		LL	OTR	Total	PS		LL	OTR	Total
	Ret.	Dis.				Ret.	Dis.				Ret.	Dis.				Ret.	Dis.			
1988	-	-	13	-	13	-	-	649	-	649	-	-	368	-	368	-	-	17,180	5,642	22,822
1989	-	-	-	-	-	-	-	192	-	192	-	-	51	-	51	-	-	14,503	6,072	20,575
1990	-	-	-	-	-	-	-	6	-	6	-	-	125	-	125	-	-	14,961	5,399	20,360
1991	-	-	1	-	1	-	-	717	-	717	-	-	112	-	112	-	220	21,459	4,716	26,395
1992	-	1	1	-	2	-	-	1,351	-	1,351	-	-	1,123	-	1,123	-	221	22,203	4,506	26,930
1993	-	-	1	-	1	26	32	2,266	-	2,324	29	68	1,650	-	1,747	246	172	20,468	4,673	25,559
1994	-	-	144	-	144	19	21	1,682	-	1,722	7	16	1,028	-	1,051	155	84	20,523	4,079	24,841
1995	1	-	155	-	156	12	15	1,351	-	1,378	4	9	232	-	245	151	71	16,928	3,270	20,420
1996	1	-	126	-	127	10	12	738	-	760	6	13	308	-	327	146	73	15,157	2,916	18,292
1997	1	-	141	-	142	12	11	1,891	-	1,914	3	5	1,324	-	1,332	243	57	24,478	2,110	26,888
1998	-	-	200	-	200	28	31	1,382	-	1,441	5	7	575	55	642	258	89	20,539	3,810	24,696
1999	1	-	278	-	279	33	8	1,216	-	1,257	6	12	1,136	-	1,154	332	111	16,605	2,341	19,389
2000	1	-	285	-	286	33	17	1,380	-	1,430	3	6	880	136	1,025	244	70	17,103	2,923	20,340
2001	-	-	304	-	304	18	45	1,539	325	1,927	2	5	1,741	204	1,952	222	147	25,871	2,835	29,075
2002	1	-	273	-	274	19	15	1,792	17	1,843	4	5	1,862	14	1,885	368	88	27,241	2,562	30,259
2003	1	4	290	-	295	38	49	1,174	-	1,261	6	5	1,389	-	1,400	385	110	27,006	771	28,272
2004	1	-	207	-	208	19	13	1,400	17	1,449	4	4	1,385	-	1,393	251	44	23,735	716	24,746
2005	1	-	229	-	230	32	11	805	15	863	5	3	901	-	909	381	41	15,790	4,872	21,084
2006	1	-	231	-	232	30	13	1,007	35	1,085	23	4	490	1	518	403	62	16,364	4,431	21,260
2007	1	-	239	-	240	41	8	1,032	64	1,145	13	4	1,171	15	1,203	289	37	16,177	5,599	22,102
2008	1	-	266	-	267	28	7	524	72	631	16	5	1,587	4	1,612	285	31	17,721	4,306	22,343
2009	1	-	446	-	447	17	6	327	8	358	11	1	1,799	12	1,823	291	32	21,640	4,063	26,026
2010	1	-	519	-	520	27	20	655	3	705	8	2	2,604	-	2,614	299	45	27,383	4,618	32,345
2011	-	-	462	-	462	18	5	658	28	709	15	1	2,377	3	2,396	273	20	28,749	5,292	34,334
2012	1	-	551	-	552	14	2	685	15	716	10	1	2,178	-	2,189	307	22	33,871	7,360	41,560
2013	1	-	913	-	914	16	2	614	9	641	15	3	2,743	1	2,762	326	25	33,314	5,757	39,422
2014	-	-	721	-	721	16	1	481	8	506	8	2	196	10	216	329	20	28,485	6,628	35,462
2015	1	-	497	-	498	18	8	1,402	22	1,450	19	1	672	4	696	493	35	33,695	6,292	40,515
2016	1	-	416	-	417	49	9	400	-	458	111	9	631	-	751	493	27	31,104	7,290	38,914
2017	-	-	*	-	-	8	-	*	-	8	238	17	*	-	255	421	22	*	*	443

TABLE A-2c. Estimated retained catches (Ret.), by gear type, and estimated discards (Dis.), by purse-seine vessels of more than 363 t carrying capacity only, of other species, in metric tons, in the EPO. The data for 2016-2017 are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-2c. Estimaciones de las capturas retenidas (Ret.), por arte de pesca, y de los descartes (Dis.), por buques cerqueros de más de 363 t de capacidad de acarreo únicamente, de otras especies, en toneladas métricas, en el OPO. Los datos de 2016-2017 son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	Carangids—Carángidos					**Dorado (*Coryphaena* spp.)**					**Elasmobranchs—Elasmobranquios**					**Other fishes—Otros peces**				
	PS		**LL**	**OTR**	**Total**	**PS**		**LL**	**OTR**	**Total**	**PS**		**LL**	**OTR**	**Total**	**PS**		**LL**	**OTR**	**Total**
	Ret.	**Dis.**				**Ret.**	**Dis.**				**Ret.**	**Dis.**				**Ret.**	**Dis.**			
1988	825	-	-	1	826	69	-	-	1,560	1,629	1	-	23	1,041	1,065	321	-	361	-	682
1989	60	-	-	2	62	211	-	-	1,680	1,891	29	-	66	1,025	1,120	670	-	152	-	822
1990	234	-	-	1	235	63	-	-	1,491	1,554	-	-	280	1,095	1,375	433	-	260	14	707
1991	116	-	-	-	116	57	-	7	613	677	1	-	1,112	1,352	2,465	463	-	458	1	922
1992	116	-	-	-	116	69	-	37	708	814	-	-	2,294	1,190	3,484	555	-	183	-	738
1993	31	43	-	2	76	266	476	17	724	1,483	253	1,153	1,028	916	3,350	142	554	185	2	883
1994	19	28	-	16	63	687	826	46	3,459	5,018	372	1,029	1,234	1,314	3,949	243	567	250	-	1,060
1995	27	32	-	9	68	465	729	39	2,127	3,360	278	1,093	922	1,075	3,368	174	760	211	-	1,145
1996	137	135	-	57	329	548	885	43	183	1,659	239	1,001	1,120	2,151	4,511	152	467	457	-	1,076
1997	38	111	-	39	188	569	703	6,866	3,109	11,247	413	1,232	956	2,328	4,929	261	654	848	-	1,763
1998	83	149	-	4	236	424	426	2,528	9,167	12,545	279	1,404	2,099	4,393	8,175	300	1,133	1,340	-	2,773
1999	108	136	-	1	245	568	751	6,284	1,160	8,763	260	843	5,997	2,088	9,188	242	748	976	-	1,966
2000	97	66	4	4	171	813	785	3,537	1,041	6,176	263	772	8,418	405	9,858	146	408	1,490	-	2,044
2001	15	145	18	26	204	1,028	1,275	15,942	2,825	21,070	183	641	12,540	107	13,471	391	1,130	1,727	-	3,248
2002	20	111	15	20	166	932	938	9,464	4,137	15,471	137	758	12,398	99	13,392	355	722	1,913	-	2,990
2003	12	141	54	-	207	583	346	5,301	288	6,518	118	833	14,498	372	15,821	279	406	4,682	-	5,367
2004	41	103	1	-	145	811	317	3,986	4,645	9,759	157	622	11,273	173	12,225	339	1,031	670	-	2,040
2005	82	79	-	-	161	863	295	3,854	8,667	13,679	199	496	12,117	220	13,032	439	276	636	-	1,351
2006	247	146	-	-	393	1,002	385	3,408	13,127	17,922	235	674	5,869	14,943	21,721	496	381	590	100	1,567
2007	174	183	6	17	380	1,266	350	6,907	7,827	16,350	343	395	8,348	16,892	25,978	828	675	2,321	120	3,944
2008	85	55	5	17	162	933	327	15,845	5,458	22,563	540	357	14,984	15,360	31,241	522	429	1,526	85	2,562
2009	65	42	10	16	133	1,923	476	17,136	51,328	70,863	279	339	14,423	16,721	31,762	1,034	374	2,435	378	4,221
2010	82	15	8	23	128	1,243	253	9,484	47,881	58,861	335	463	26,342	14,433	41,573	881	192	2,341	384	3,798
2011	71	24	8	-	103	1,291	386	12,438	20,935	35,050	280	316	28,978	16,566	46,140	507	219	1,972	507	3,205
2012	53	23	1	-	77	1,805	401	17,254	26,627	46,087	230	278	16,446	15,871	32,825	873	230	2,695	381	4,179
2013	17	17	1	3	38	1,448	489	11,247	22,673	35,857	216	321	16,575	16,676	33,788	1,389	370	2,931	267	4,957
2014	20	11	-	35	66	1,753	369	3,326	20,916	26,364	247	474	12,995	16,395	30,111	1,450	438	2,659	486	5,033
2015	28	15	-	217	260	1,045	169	1,193	17,359	19,766	398	620	14,440	28,160	43,618	696	208	3,181	237	4,322
2016	27	47	-	-	74	890	175	438	12,989	14,492	224	580	14,986	22,024	37,814	991	514	2,205	159	3,869
2017	38	23	-	*	61	1,587	291	*	*	1,878	112	750	*	*	862	332	151	*	*	483

TABLE A-3a. Catches of yellowfin tuna by purse-seine vessels in the EPO, by vessel flag. The data have been adjusted to the species composition estimate, and are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-3a. Capturas de atún aleta amarilla por buques de cerco en el OPO, por bandera del buque. Los datos están ajustados a la estimación de composición por especie, y son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C + OTR[1]	Total
1988	-	-	23,947	C	104,565	-	7,364	1,430	C	82,231	38,257	C	19,499	277,293
1989	-	C	17,588	C	116,928	-	10,557	1,724	C	73,688	42,944	C	14,567	277,996
1990	C	C	16,279	C	115,898	-	6,391	C	-	50,790	47,490	22,208	4,197	263,253
1991	C	-	15,011	C	115,107	-	1,731	C	-	18,751	45,345	29,687	5,625	231,257
1992	C	-	12,119	C	118,455	-	3,380	45	-	16,961	44,336	27,406	5,419	228,121
1993	3,863	-	18,094	C	101,792	-	5,671	-	-	14,055	43,522	24,936	7,559	219,492
1994	7,533	-	18,365	C	99,618	-	3,259	-	-	8,080	41,500	25,729	4,324	208,408
1995	8,829	C	17,044	C	108,749	-	1,714	-	-	5,069	47,804	22,220	4,005	215,434
1996	9,855	C	17,125	C	119,878	-	3,084	-	-	6,948	62,846	10,549	8,322	238,607
1997	9,402	-	18,697	C	120,761	-	4,807	-	-	5,826	57,881	20,701	6,803	244,878
1998	15,592	-	36,201	5,449	106,840	-	3,330	-	C	2,776	61,425	17,342	5,004	253,959
1999	13,267	-	53,683	8,322	114,545	C	5,782	-	C	3,400	55,443	16,476	11,002	281,920
2000	6,138	-	35,492	10,318	101,662	C	5,796	-	-	4,374	67,672	8,247	13,563	253,262
2001	12,950	-	55,347	18,448	130,087	C	9,552	-	C	5,670	108,974	10,729	32,180	383,937
2002	17,574	-	32,512	16,990	152,864	C	15,719	C	7,412	7,382	123,264	7,502	31,068	412,287
2003	9,770	-	34,271	12,281	172,807	-	16,591	C	C	3,601	96,914	9,334	27,710	383,279
2004	C	-	40,886	13,622	91,442	C	33,563	-	C	C	39,094	7,371	46,577	272,555
2005	C	-	40,596	11,947	110,898	4,838	33,393	-	6,470	C	28,684	C	31,276	268,102
2006	C	-	26,049	8,409	69,449	4,236	22,521	-	C	C	13,286	C	22,679	166,629
2007	C	-	19,749	2,631	65,091	3,917	26,024	-	C	C	20,097	C	32,507	170,016
2008	C	-	18,463	3,023	84,462	4,374	26,993	C	C	C	17,692	C	30,050	185,057
2009	C	-	18,167	7,864	99,785	6,686	35,228	C	C	C	25,298	C	43,729	236,757
2010	20,493	-	34,764	2,820	104,969	9,422	34,538	C	C	-	21,244	C	22,758	251,008
2011	18,643	-	32,946	1,072	99,812	7,781	18,607	-	C	C	18,712	C	9,278	206,851
2012	20,924	-	29,485	1,065	93,323	7,541	15,932	-	C	C	23,408	C	6,339	198,017
2013	16,476	-	27,655	511	114,706	8,261	18,301	C	C	-	24,896	C	7,381	218,187
2014	17,185	-	37,546	760	120,980	8,100	19,349	C	C	1,105	23,025	-	6,016	234,066
2015	17,270	-	50,153	C	106,171	6,876	26,558	783	C	3,212	30,428	-	4,276	245,727
2016	19,253	-	59,154	C	93,904	11,040	23,204	1,920	C	4,535	23,798	-	5,287	242,095
2017	15,103	-	55,105	C	80,747	9,349	19,996	3,394	C	6,070	16,481	-	3,454	209,699

[1] Includes—Incluye: BLZ, BOL, CHN, GTM, HND, UNK

TABLE A-3b. Annual catches of yellowfin tuna by longline vessels, and totals for all gears, in the EPO, by vessel flag. The data for 2016-2017 are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-3b. Capturas anuales de atún aleta amarilla por buques de palangre en el OPO, y totales de todas las artes, por bandera del buque. Los datos de 2016-2017 son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS+LL	OTR[2]
1988	-	-	-	12,481	1,893	232	-	54	-	-	*	14,660	291,953	4,475
1989	-	-	-	15,335	1,162	9	-	526	-	-	*	17,032	295,028	4,408
1990	-	-	-	29,255	4,844	-	-	534	-	-	*	34,633	297,886	3,636
1991	-	169	-	23,721	5,688	-	-	1,319	2	-	*	30,899	262,156	3,814
1992	-	119	57	15,296	2,865	-	-	306	3	-	*	18,646	246,767	5,747
1993	-	200	39	20,339	3,257	C	-	155	17	-	2	24,009	243,501	7,985
1994	-	481	214	25,983	3,069	41	-	236	2	-	*	30,026	238,434	5,112
1995	-	542	198	17,042	2,748	7	-	28	31	-	*	20,596	236,030	3,334
1996	-	183	253	12,631	3,491	0	-	37	13	-	*	16,608	255,215	5,401
1997	-	715	307	16,218	4,753	-	-	131	11	-	28	22,163	267,041	5,018
1998	-	1,124	388	10,048	3,624	16	-	113	15	-	8	15,336	269,295	6,614
1999	-	1,031	206	7,186	3,030	10	-	186	7	-	26	11,682	293,602	4,489
2000	-	1,084	1,052	15,265	5,134	153	359	742	10	5	51	23,855	277,118	3,540
2001	942	1,133	846	14,808	5,230	29	732	3,928	29	13	1,918	29,608	413,544	4,436
2002	1,457	1,563	278	8,513	3,626	4	907	7,360	5	290	1,528	25,531	437,817	1,501
2003	2,739	1,418	462	9,125	4,911	365	C	3,477	5	699	1,973	25,174	408,453	1,615
2004	798	1,701	767	7,338	2,997	32	2,802	1,824	6	171	343	18,779	291,336	2,511
2005	682	1,791	530	3,966	532	0	1,782	2,422	7	51	183	11,946	280,047	3,674
2006	246	1,402	537	2,968	928	0	2,164	1,671	21	164	109	10,210	176,841	2,144
2007	224	1,204	408	4,582	353	8	-	745	11	154	378	8,067	178,083	2,333
2008	469	1,248	335	5,383	83	5	-	247	33	175	1,842	9,820	194,877	1,755
2009	629	1,003	590	4,268	780	10	-	636	84	244	2,200	10,444	247,201	1,950
2010	459	3	301	3,639	737	6	-	872	54	269	1,999	8,339	259,348	1,492
2011	1,807	-	349	2,373	754	6	-	647	55	150	1,907	8,048	214,899	1,406
2012	2,591	1,482	538	3,600	631	7	519	749	39	155	2,643	12,954	210,971	1,888
2013	1,874	1,424	410	3,117	928	4	325	572	43	101	1,986	10,784	228,970	1,993
2014	2,120	1,072	567	2,633	704	1	249	896	61	323	20	8,646	242,712	3,500
2015	2,642	1,415	929	2,180	957	-	419	1,287	289	530	139	10,787	256,514	3,568
2016	2,398	1,010	825	1,832	1,124	-	401	1,134	258	166	254	9,402	251,497	2,883
2017	*	*	*	1,782	*	*	*	*	*	*	*	1,782	211,481	*

[1] Includes—Incluye: BLZ, CHL, ECU, EU(ESP), GTM, HND, NIC, SLV
[2]Includes gillnets, pole-and-line, recreational, troll and unknown gears—Incluye red agallera, caña, artes deportivas, y desconocidas

TABLE A-3c. Catches of skipjack tuna by purse-seine and longline vessels in the EPO, by vessel flag. The data have been adjusted to the species composition estimate, and are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-3c. Capturas de atún barrilete por buques de cerco y de palangre en el OPO, por bandera del buque. Los datos están ajustados a la estimación de composición por especie, y son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	PS														LL+ OTR[2]
	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C+OTR[1]	Total	
1988	-	-	11,743	C	15,195	-	1,863	714	C	36,792	12,312	C	8,494	87,113	5,014
1989	-	C	22,922	C	14,960	-	4,361	276	-	21,115	16,847	C	14,453	94,934	3,987
1990	C	C	24,071	C	6,696	-	3,425	C	-	13,188	11,362	11,920	3,707	74,369	2,738
1991	C	-	18,438	C	10,916	-	1,720	C	-	13,162	5,217	9,051	3,724	62,228	3,662
1992	C	-	25,408	C	9,188	-	3,724	352	-	14,108	10,226	13,315	7,962	84,283	3,011
1993	3,292	-	21,227	C	13,037	-	1,062	-	-	17,853	7,270	10,908	9,181	83,830	6,089
1994	7,348	-	15,083	C	11,783	-	2,197	-	-	8,947	6,356	9,541	8,871	70,126	4,044
1995	13,081	C	31,934	C	29,406	-	4,084	-	-	14,032	5,508	13,910	15,092	127,047	7,241
1996	13,230	C	32,433	C	14,501	-	3,619	-	-	12,012	4,104	10,873	13,201	103,973	3,868
1997	12,332	-	51,826	C	23,416	-	4,277	-	-	13,687	8,617	14,246	25,055	153,456	3,491
1998	4,698	-	67,074	20,012	15,969	-	1,136	-	C	6,898	6,795	11,284	6,765	140,631	2,215
1999	11,210	-	124,393	34,923	16,767	C	5,286	-	C	13,491	16,344	21,287	17,864	261,565	3,638
2000	10,138	-	104,849	17,041	14,080	C	9,573	-	-	7,224	6,720	13,620	22,399	205,644	365
2001	9,445	-	66,144	13,454	8,169	C	6,967	-	C	4,135	3,215	7,824	23,813	143,166	1,696
2002	10,908	-	80,378	10,546	6,612	C	9,757	C	4,601	4,582	2,222	4,657	19,283	153,546	996
2003	14,771	-	139,804	18,567	8,147	-	25,084	C	C	5,445	6,143	14,112	41,895	273,968	4,049
2004	C	-	89,621	8,138	24,429	C	20,051	-	C	C	23,356	4,404	27,825	197,824	2,349
2005	C	-	140,927	9,224	32,271	3,735	25,782	-	4,995	C	22,146	C	24,149	263,229	3,309
2006	C	-	138,490	16,668	16,790	8,396	44,639	-	C	C	26,334	C	44,952	296,269	1,645
2007	C	-	93,553	2,879	21,542	4,286	28,475	-	C	C	21,990	C	35,571	208,296	1,579
2008	C	-	143,431	4,841	21,638	7,005	43,230	C	C	C	28,333	C	48,125	296,603	2,847
2009	C	-	132,712	6,021	6,847	5,119	26,973	C	C	C	19,370	C	33,481	230,523	2,821
2010	11,400	-	82,280	1,569	3,010	5,242	19,213	C	C	-	11,818	C	12,660	147,192	3,132
2011	23,269	-	149,637	5,238	11,899	3,889	29,837	-	C	C	27,026	C	25,240	276,035	2,259
2012	15,760	-	151,280	15,773	18,058	3,931	25,786	-	C	C	20,829	C	14,798	266,215	3,793
2013	22,168	-	172,002	2,900	17,350	4,345	31,022	C	C	-	17,522	C	11,251	278,560	3,229
2014	22,732	-	172,239	5,581	8,783	6,300	21,776	C	C	521	13,767	-	9,771	261,470	1,425
2015	16,431	-	208,765	C	23,515	1,261	31,427	5,225	C	16,826	4,792	-	20,665	328,907	1,460
2016	20,665	-	190,577	C	13,286	1,971	32,844	6,449	C	40,036	9,067	-	22,667	337,562	909
2017	19,436	-	190,776	C	21,400	7,011	37,808	6,275	C	25,032	7,191	-	11,191	326,120	*

[1] Includes—Incluye: BLZ, BOL, CHN, EU(CYP), GTM, HND, KOR, LBR, NZL, RUS, VCT, UNK
[2] Includes gillnets, pole-and-line, recreational, and unknown gears—Incluye red agallera, caña, artes deportivas y desconocidas

TABLE A-3d. Catches of bigeye tuna by purse-seine vessels in the EPO, by vessel flag. The data have been adjusted to the species composition estimate, and are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-3d. Capturas de atún patudo por buques de cerco en el OPO, por bandera del buque. Los datos están ajustados a la estimación de composición por especie, y son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C + OTR[1]	Total
1988	-	-	385	C	-	-	431	*	C	256	202	C	261	1,535
1989	-	-	854	C	-	-	-	*	-	172	294	C	710	2,030
1990	-	-	1,619	C	29	-	196	-	-	209	1,405	2,082	381	5,921
1991	-	-	2,224	C	5	-	-	-	-	50	591	1,839	161	4,870
1992	-	-	1,647	C	61	-	38	*	-	3,002	184	1,397	850	7,179
1993	686	-	2,166	C	120	-	10	*	-	3,324	253	1,848	1,250	9,657
1994	5,636	-	5,112	C	171	-	-	*	-	7,042	637	8,829	7,472	34,899
1995	5,815	C	8,304	C	91	-	839	*	-	11,042	706	12,072	6,452	45,321
1996	7,692	C	20,279	C	82	-	1,445	*	-	8,380	619	12,374	10,440	61,311
1997	3,506	-	30,092	C	38	-	1,811	*	-	8,312	348	6,818	13,347	64,272
1998	596	-	25,113	5,747	12	-	12	*	C	5,309	348	4,746	2,246	44,129
1999	1,511	-	24,355	11,703	33	C	1,220	*	C	2,997	10	5,318	4,011	51,158
2000	7,443	-	36,094	12,511	0	C	7,028	*	-	5,304	457	10,000	16,446	95,283
2001	5,230	-	24,424	7,450	0	C	3,858	*	C	2,290	0	4,333	12,933	60,518
2002	5,283	-	26,262	5,108	0	C	4,726	C	2,228	2,219	0	2,256	9,340	57,422
2003	3,664	-	22,896	4,605	0	-	6,222	C	C	1,350	424	3,500	10,390	53,051
2004	C	-	30,817	3,366	0	C	8,294	*	C	C	9,661	1,822	11,511	65,471
2005	C	-	30,507	3,831	0	1,551	10,707	*	2,074	C	9,197	C	10,028	67,895
2006	C	-	39,302	5,264	6	2,652	14,099	*	C	C	8,317	C	14,197	83,837
2007	C	-	40,445	711	0	1,058	7,029	*	C	C	5,428	C	8,780	63,451
2008	C	-	41,177	1,234	327	1,785	11,018	C	C	C	7,221	C	12,266	75,028
2009	C	-	35,646	2,636	1,334	2,241	11,807	C	C	C	8,479	C	14,657	76,800
2010	4,206	-	34,902	579	11	1,934	7,089	C	C	-	4,360	C	4,672	57,753
2011	3,210	-	31,282	4,111	133	2,256	7,953	*	C	C	301	C	7,266	56,512
2012	1,873	-	45,633	3,866	225	1,250	7,238	*	C	C	848	C	5,087	66,020
2013	1,405	-	32,444	1,672	124	2,749	6,118	-	C	-	963	C	4,012	49,487
2014	2,479	-	39,094	2,812	40	3,068	8,168	-	C	129	1,183	-	3,472	60,445
2015	2,470	-	44,063	C	156	774	10,113	-	C	2,384	100	-	2,853	62,913
2016	2,759	-	33,311	C	257	671	8,486	2	C	2,816	347	-	8,064	56,713
2017	3,532	-	37,827	C	345	1,556	10,170	5	C	6,382	1,539	-	4,836	66,192

[1] Includes—Incluye: BLZ, BOL, CHN, GTM, HND, UNK

TABLE A-3e. Annual catches of bigeye tuna by longline vessels, and totals for all gears, in the EPO, by vessel flag. The data for 2016-2017 are preliminary. *: data missing or not available; -: no data collected; C: data combined with those of other flags; this category is used to avoid revealing the operations of individual vessels or companies.

TABLA A-3e. Capturas anuales de atún patudo por buques de palangre en el OPO, y totales de todas las artes, por bandera del buque. Los datos de 2016-2017 son preliminares. *: datos faltantes o no disponibles; -: datos no tomados; C: datos combinados con aquéllos de otras banderas; se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS + LL	OTR[2]
1988	-	-	-	66,015	6,151	1	-	591	-	-	*	72,758	74,293	20
1989	-	-	-	67,514	3,138	-	-	311	-	-	*	70,963	72,993	1
1990	-	-	-	86,148	12,127	-	-	596	-	-	*	98,871	104,792	59
1991	-	1	-	85,011	17,883	-	-	1,291	9	-	*	104,195	109,065	56
1992	-	9	7	74,466	9,202	-	-	1,032	92	-	*	84,808	91,987	13
1993	-	25	7	63,190	8,924	*	-	297	55	-	*	72,498	82,155	35
1994	-	1	102	61,471	9,522	-	-	255	9	-	*	71,360	106,259	806
1995	-	13	97	49,016	8,992	-	-	77	74	-	*	58,269	103,590	1,369
1996	-	1	113	36,685	9,983	-	-	95	81	-	*	46,958	108,269	748
1997	-	9	250	40,571	11,376	-	-	256	118	-	*	52,580	116,852	20
1998	-	28	359	35,752	9,731	-	-	314	191	-	*	46,375	90,504	628
1999	-	25	3,652	22,224	9,431	-	-	890	228	-	*	36,450	87,608	538
2000	-	27	653	28,746	13,280	42	14	1,916	162	2,754	11	47,605	142,887	253
2001	2,639	28	684	38,048	12,576	1	80	9,285	147	3,277	1,990	68,755	129,273	19
2002	7,614	19	388	34,193	10,358	-	6	17,253	132	2,995	1,466	74,424	131,845	12
2003	10,066	18	346	24,888	10,272	-	C	12,016	232	1,258	680	59,776	112,828	21
2004	2,645	21	405	21,236	10,729	-	48	7,384	149	407	459	43,483	108,954	194
2005	2,104	23	398	19,113	11,580	-	30	6,441	536	318	151	40,694	108,589	25
2006	709	18	388	16,235	6,732	-	37	6,412	85	960	195	31,771	115,608	40
2007	2,324	15	361	13,977	5,611	-	-	6,057	417	1,013	101	29,876	93,326	44
2008	2,379	16	367	14,908	4,150	-	-	1,852	1,277	790	468	26,207	101,236	28
2009	2,481	13	484	15,490	6,758	-	-	3,396	730	1,032	1,038	31,422	108,221	15
2010	2,490	4	314	15,847	9,244	-	-	5,276	1,356	1,496	1,063	37,090	94,842	2
2011	5,450	-	445	13,399	6,617	-	-	3,957	1,050	694	706	32,318	88,829	-
2012	4,386	3	464	16,323	7,450	-	-	4,999	875	1,063	604	36,167	102,187	27
2013	5,199	-	527	14,258	8,822	-	-	4,162	2,054	604	577	36,203	85,691	99
2014	5,253	9	526	13,634	8,203	-	114	4,511	2,073	897	120	35,340	95,785	177
2015	8,401	8	692	13,097	8,635	*	364	5,181	3,050	1,888	328	41,644	104,557	21
2016	7,052	3	477	10,427	7,692	*	293	6,054	2,087	762	679	35,525	92,238	22
2017	7,076	*	*	9,617	7,407	*	*	6,281	*	757	*	31,138	97,330	*

[1] Includes—Incluye: BLZ, CHL, ECU, EU(ESP), HND, SLV

[2] Includes gillnets, pole-and-line, recreational, and unknown gears—Incluye red agallera, caña, artes deportivas, y desconocidas

TABLE A-4a. Preliminary estimates of the retained catches in metric tons, of tunas and bonitos caught by purse-seine vessels in the EPO in 2016 and 2017, by species and vessel flag. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimates, and are preliminary.
TABLA A-4a. Estimaciones preliminares de las capturas retenidas, en toneladas métricas, de atunes y bonitos por buques cerqueros en el OPO en 2016 y 2017, por especie y bandera del buque. Los datos de los atunes aleta amarilla, barrilete, y patudo fueron ajustados a las estimaciones de composición por especie, y son preliminares.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
2016	**Retained catches–Capturas retenidas**									
COL	19,253	20,665	2,759	-	-	56	-	-	42,733	6.6
ECU	59,154	190,577	33,311	-	-	2,509	2,629	103	288,283	44.4
MEX	93,904	13,286	257	2,709	-	3,813	641	-	114,610	17.6
NIC	11,040	1,971	671	-	-	-	-	-	13,682	2.1
PAN	23,204	32,844	8,486	-	-	60	30	2	64,626	9.9
PER	1,920	6,449	2	-	-	-	241	3	8,615	1.3
USA	4,535	40,036	2,816	316	2	116	261	7	48,089	7.4
VEN	23,798	9,067	347	-	-	51	-	9	33,272	5.1
OTR[1]	5,287	22,667	8,064	-	-	1	-	-	36,019	5.5
Total	242,095	337,562	56,713	3,025	2	6,606	3,802	124	649,929	
2017	**Retained catches–Capturas retenidas**									
COL	15,103	19,436	3,532	-	-	49	-	-	38,120	6.2
ECU	55,105	190,776	37,827	-	-	1,991	1,075	72	286,846	46.7
MEX	80,747	21,400	345	3,643	-	2,822	1,740	157	110,854	18.0
NIC	9,349	7,011	1,556	-	-	-	-	-	17,916	2.9
PAN	19,996	37,808	10,170	-	-	140	-	-	68,114	11.1
PER	3,394	6,275	5	-	-	-	527	-	10,201	1.7
USA	6,070	25,032	6,382	466	-	-	15	-	37,965	6.2
VEN	16,481	7,191	1,539	-	-	3	-	-	25,214	4.1
OTR[2]	3,454	11,191	4,836	-	-	1	-	2	19,484	3.2
Total	209,699	326,120	66,192	4,109	-	5,006	3,357	231	614,714	

[1] Includes El Salvador, European Union (Spain) and Guatemala - This category is used to avoid revealing the operations of individual vessels or companies.
[1] Incluye El Salvador, Guatemala y Unión Europea (España) - Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.
[2] Includes El Salvador and European Union (Spain) - This category is used to avoid revealing the operations of individual vessels or companies.
[2] Incluye El Salvador y Unión Europea (España) - Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

TABLE A-4b. Preliminary estimates of the retained landings in metric tons, of tunas and bonitos caught by purse-seine vessels in the EPO in 2016 and 2017, by species and country of landing. The data for yellowfin, skipjack, and bigeye tunas have not been adjusted to the species composition estimates, and are preliminary.

TABLA A-4b. Estimaciones preliminares de las descargas, en toneladas métricas, de atunes y bonitos por buques cerqueros en el OPO en 2016 y 2017, por especie y país de descarga. Los datos de los atunes aleta amarilla, barrilete, y patudo no fueron ajustados a las estimaciones de composición por especie, y son preliminares.

	YFT	SKJ	BET	PBF	ALB	BKJ	BZX	TUN	Total	%
2016	**Landings-Descargas**									
COL	6,942	1,513	346	-	-	-	-	-	8,801	1.3
ECU	98,143	260,196	42,683	-	-	2,618	2,863	115	406,618	60.7
MEX	99,481	30,943	1,801	2,709	-	3,864	641	-	139,439	20.8
VEN	6,081	1,433	99	-	-	-	-	-	7,613	1.1
OTR[1]	35,300	64,347	7,015	316	2	57	297	6	107,340	16.0
Total	245,947	358,432	51,944	3,025	2	6,539	3,801	121	669,811	
2017	**Landings-Descargas**									
COL	5,839	6,169	1,625	-	-	2	-	-	13,635	2.1
ECU	88,051	257,926	50,849	-	-	1,958	573	72	399,429	60.8
MEX	85,085	42,094	4,904	3,643	-	2,801	1,674	162	140,363	21.4
PER	5,550	15,071	1,111	-	-	130	796	1	22,659	3.4
OTR[2]	29,310	40,121	11,123	466	-	133	67	3	81,223	12.4
Total	213,835	361,381	69,612	4,109	-	5,024	3,110	238	657,309	

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

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

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

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

TABLE A-5a. Annual retained catches of Pacific bluefin tuna, by gear type and flag, in metric tons. The data for 2016 and 2017 are preliminary.

TABLA A-5a. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas métricas. Los datos de 2016 y 2017 son preliminares.

PBF	Western Pacific flags—Banderas del Pacífico occidental[1]										EPO flags—Banderas del OPO						Total
	JPN				KOR[1]		TWN			Sub-total	MEX		USA		Sub-total	OTR	
	PS	LP	LL	OTR	PS	OTR	PS	LL	OTR		PS	OTR	PS	OTR			
1988	3,605	907	157	2,465	32	-	197	108	62	7,533	447	1	923	51	1,422	9	8,964
1989	6,190	754	209	1,934	71	-	259	205	54	9,676	57	-	1,046	96	1,199	-	10,875
1990	2,989	536	309	2,421	132	-	149	189	315	7,040	50	-	1,380	164	1,594	-	8,634
1991	9,808	286	218	4,204	265	-	-	342	119	15,242	9	-	410	55	474	-	15,716
1992	7,162	166	513	3,204	288	-	73	464	8	11,878	-	-	1,928	148	2,076	-	13,954
1993	6,600	129	812	1,759	40	-	1	471	3	9,815	-	-	580	316	896	-	10,711
1994	8,131	162	1,206	5,667	50	-	-	559	-	15,775	63	2	906	115	1,086	-	16,861
1995	18,909	270	678	7,223	821	-	-	335	2	28,238	11	-	649	275	935	-	29,173
1996	7,644	94	901	5,359	102	-	-	956	-	15,056	3,700	-	4,633	90	8,423	-	23,479
1997	13,152	34	1,300	4,354	1,054	-	-	1,814	-	21,708	367	-	2,240	245	2,852	-	24,560
1998	5,391	85	1,255	4,450	188	-	-	1,910	-	13,279	1	-	1,771	597	2,369	-	15,648
1999	16,173	35	1,157	5,246	256	-	-	3,089	-	25,956	2,369	35	184	617	3,205	-	29,161
2000	16,486	102	953	7,031	2,401	-	-	2,780	2	29,755	3,019	99	693	352	4,163	-	33,919
2001	7,620	180	791	5,614	1,176	10	-	1,839	4	17,234	863	-	292	384	1,539	131	18,904
2002	8,903	99	841	4,338	932	1	-	1,523	4	16,641	1,708	2	50	622	2,382	67	19,090
2003	5,768	44	1,237	3,345	2,601	-	-	1,863	21	14,879	3,211	43	22	372	3,648	42	18,569
2004	8,257	132	1,847	3,855	773	-	-	1,714	3	16,581	8,880	14	-	59	8,953	-	25,534
2005	12,817	549	1,925	6,363	1,318	9	-	1,368	2	24,351	4,542	-	201	80	4,823	-	29,174
2006	8,880	108	1,121	4,058	1,012	3	-	1,149	1	16,332	9,927	-	-	93	10,020	-	26,352
2007	6,840	236	1,762	4,983	1,281	4	-	1,401	10	16,517	4,147	-	42	14	4,203	-	20,720
2008	10,221	64	1,390	5,505	1,866	10	-	979	2	20,037	4,392	15	-	63	4,470	-	24,507
2009	8,077	50	1,080	4,814	936	4	-	877	11	15,849	3,019	-	410	161	3,590	-	19,439
2010	3,742	83	890	3,681	1,196	16	-	373	36	10,017	7,746	-	-	89	7,835	-	17,852
2011	8,340	63	837	3,754	670	14	-	292	24	13,994	2,730	1	99	244	3,074	-	17,068
2012	2,462	113	673	2,845	1,421	2	-	210	4	7,730	6,667	1	38	405	7,111	-	14,841
2013	2,771	8	784	2,848	604	1	-	332	3	7,351	3,154	-	-	819	3,973	-	11,324
2014	5,456	5	683	3,429	1,305	6	-	483	42	11,409	4,862	-	401	442	5,705	-	17,114
2015	3,645	4	619	2,087	676	1	-	552	26	7,610	3,082	-	94	386	3,562	-	11,171
2016	5,096	37	654	2,512	1,024	5	-	454	26	9,808	2,709	*	347	337	3,243	-	13,051
2017	*	*	*	*	*	*	*	*	*	*	3,643	*	466	14	4,123	-	4,123

[1] Source: International Scientific Committee, 17th Plenary Meeting, PBFWG workshop report on Pacific Bluefin Tuna, July 2017—Fuente: Comité Científico Internacional, 17ª Reunión Plenaria, Taller PBFWG sobre Atún Aleta Azul del Pacífico, julio de 2017

TABLE A-5b. Reported catches of Pacific bluefin tuna in the EPO by recreational gear, in number of fish, 1988-2017.

TABLA A-5b. Capturas reportadas de atún aleta azul del Pacifico en el OPO por artes deportivas, en número de peces, 1988-2017.

PBF			
1988	330	2003	22,291
1989	6,519	2004	3,391
1990	3,755	2005	5,757
1991	5,330	2006	7,473
1992	8,586	2007	1,028
1993	10,535	2008	10,187
1994	2,243	2009	12,138
1995	16,025	2010	8,453
1996	2,739	2011	31,494
1997	8,338	2012	40,012
1998	20,466	2013	63,158
1999	36,797	2014	26,105
2000	20,669	2015	26,077
2001	21,913	2016	9,173
2002	33,399	2017	13,438

TABLE A-6. Annual retained catches of albacore in the EPO, by gear and area (north and south of the equator), in metric tons. The data for 2015 and 2016 are preliminary.

TABLA A-6. Capturas retenidas anuales de atún albacora en el OPO, por arte y zona (al norte y al sur de la línea ecuatorial), en toneladas. Los datos de 2015 y 2016 son preliminares.

ALB	North—Norte				South—Sur				Total
	LL	LTL[1]	OTR	Subtotal	LL	LTL	OTR	Subtotal	
1988	899	4,473	81	5,453	9,035	1,282	1	10,318	15,771
1989	952	1,873	161	2,986	5,832	593	90	6,515	9,501
1990	1,143	2,610	63	3,816	5,393	1,336	305	7,034	10,850
1991	1,514	2,617	6	4,137	6,379	795	170	7,344	11,481
1992	1,635	4,770	2	6,407	15,445	1,205	18	16,668	23,075
1993	1,772	4,332	25	6,129	9,422	35	19	9,476	15,605
1994	2,356	9,666	106	12,128	8,034	446	21	8,501	20,629
1995	1,380	7,773	102	9,255	4,805	2	15	4,822	14,077
1996	1,675	8,267	99	10,041	5,956	94	21	6,071	16,112
1997	1,365	6,115	1,019	8,499	8,313	466	0	8,779	17,278
1998	1,730	12,019	1,250	14,999	10,905	12	0	10,917	25,916
1999	2,701	11,028	3,668	17,397	8,932	81	7	9,020	26,417
2000	1,880	10,960	1,869	14,709	7,783	778	3	8,564	23,273
2001	1,822	11,727	1,638	15,187	17,588	516	6	18,110	33,297
2002	1,227	12,286	2,388	15,901	14,062	131	40	14,233	30,134
2003	1,129	17,808	2,260	21,197	23,772	419	3	24,194	45,391
2004	854	20,288	1,623	22,765	17,590	331	0	17,921	40,686
2005	405	13,807	1,741	15,953	8,945	181	7	9,133	25,086
2006	3,671	18,515	408	22,594	10,161	48	118	10,327	32,921
2007	2,708	17,948	1,415	22,071	8,399	19	87	8,505	30,576
2008	1,160	17,137	308	18,605	8,058	0	159	8,217	26,822
2009	91	17,933	996	19,020	11,981	0	213	12,194	31,214
2010	1,134	18,246	892	20,272	13,122	3	247	13,372	33,644
2011	1,833	15,437	426	17,696	14,357	0	222	14,579	32,275
2012	4,580	16,633	1,224	22,437	19,616	35	210	19,861	42,298
2013	6,771	17,398	844	25,013	18,630	0	271	18,901	43,914
2014	3,342	18,077	1,045	22,464	25,889	72	243	26,204	48,668
2015	2,474	15,949	927	19,350	26,483	0	223	26,706	46,056
2016	2,096	13,528	684	16,308	26,441	0	292	26,733	43,041
2017	*	*	*	*	*	*	*	*	*

[1] Includes pole-and-line—Incluye caña

TABLE A-7. Estimated numbers of sets, by set type and vessel capacity category, and estimated retained catches, in metric tons, of yellowfin, skipjack, and bigeye tuna by purse-seine vessels in the EPO. The data for 2016 and 2017 are preliminary. The data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate and are preliminary.

TABLA A-7. Números estimados de lances, por tipo de lance y categoría de capacidad de buque, y capturas retenidas estimadas, en toneladas métricas, de atunes aleta amarilla, barrilete, y patudo por buques cerqueros en el OPO. Los datos de 2016 y 2017 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 a delfines**					
2002	0	12,290	12,290	301,099	3,180	2
2003	0	13,760	13,760	265,512	13,332	1
2004	0	11,783	11,783	177,460	10,730	3
2005	0	12,173	12,173	166,211	12,127	2
2006	0	8,923	8,923	91,978	4,787	0
2007	0	8,871	8,871	97,032	3,277	7
2008	0	9,246	9,246	122,105	8,382	5
2009	0	10,910	10,910	178,304	2,694	1
2010	0	11,646	11,646	168,984	1,627	4
2011	0	9,604	9,604	134,839	4,372	2
2012	0	9,220	9,220	133,716	2,120	0
2013	0	10,736	10,736	157,432	4,272	0
2014	0	11,382	11,382	167,780	4,413	3
2015	0	11,020	11,020	160,595	5,608	2
2016	0	11,219	11,219	146,971	3,196	4
2017	0	8,864	8,864	107,767	1,458	0
OBJ	**Sets on fish associated with floating objects / Lances sobre peces asociados a objetos flotantes**					
2002	867	5,771	6,638	38,057	116,793	55,901
2003	706	5,457	6,163	30,307	181,214	51,296
2004	615	4,986	5,601	28,340	117,212	64,005
2005	639	4,992	5,631	26,126	133,509	66,257
2006	1,158	6,862	8,020	34,313	191,093	82,136
2007	1,384	5,857	7,241	29,619	122,286	62,189
2008	1,819	6,655	8,474	34,819	157,274	73,855
2009	1,821	7,077	8,898	36,137	156,963	75,890
2010	1,788	6,399	8,187	38,113	113,716	57,167
2011	2,538	6,921	9,459	42,189	170,986	55,589
2012	3,067	7,610	10,677	37,527	177,239	65,040
2013	3,081	8,038	11,119	35,089	194,372	48,337
2014	3,858	8,777	12,635	46,049	199,696	59,797
2015	3,455	9,385	12,840	43,603	206,515	60,975
2016	4,226	10,377	14,603	58,360	248,714	55,246
2017	4,341	11,147	15,488	68,582	222,964	63,850

TABLE A-7. (continued)

TABLA A-7. (continuación)

	Number of sets—Número de lances			Retained catch—Captura retenida		
	Vessel capacity—Capacidad del buque		Total	YFT	SKJ	BET
	≤363 t	>363 t				
NOA	**Sets on unassociated schools Lances sobre cardúmenes no asociados**					
2002	4,938	3,442	8,380	73,130	33,573	1,518
2003	7,274	5,131	12,405	87,460	79,422	1,755
2004	4,969	5,696	10,665	66,757	69,882	1,463
2005	6,109	7,816	13,925	75,764	117,593	1,636
2006	6,189	8,443	14,632	40,340	100,388	1,702
2007	4,845	7,211	12,056	43,365	82,732	1,254
2008	4,771	6,210	10,981	28,133	130,947	1,168
2009	3,308	4,109	7,417	22,316	70,866	908
2010	2,252	3,885	6,137	43,912	31,849	581
2011	2,840	5,182	8,022	29,823	100,677	921
2012	2,996	5,369	8,365	26,774	86,856	980
2013	3,064	4,156	7,220	25,666	79,916	1,150
2014	2,427	3,369	5,796	20,237	57,360	645
2015	3,116	6,201	9,317	41,529	116,784	1,936
2016	2,274	5,101	7,375	36,764	85,652	1,463
2017	2,017	4,959	6,976	33,350	101,698	2,342
ALL	**Sets on all types of schools Lances sobre todos tipos de cardumen**					
2002	5,805	21,503	27,308	412,286	153,546	57,421
2003	7,980	24,348	32,328	383,279	273,968	53,052
2004	5,584	22,465	28,049	272,557	197,824	65,471
2005	6,748	24,981	31,729	268,101	263,229	67,895
2006	7,347	24,228	31,575	166,631	296,268	83,838
2007	6,229	21,939	28,168	170,016	208,295	63,450
2008	6,590	22,111	28,701	185,057	296,603	75,028
2009	5,129	22,096	27,225	236,757	230,523	76,799
2010	4,040	21,930	25,970	251,009	147,192	57,752
2011	5,378	21,707	27,085	206,851	276,035	56,512
2012	6,063	22,199	28,262	198,017	266,215	66,020
2013	6,145	22,930	29,075	218,187	278,560	49,487
2014	6,285	23,528	29,813	234,066	261,469	60,445
2015	6,571	26,606	33,177	245,727	328,907	62,913
2016	6,500	26,697	33,197	242,095	337,562	56,713
2017	6,358	24,970	31,328	209,699	326,120	66,192

TABLE A-8. Types of floating objects involved in sets by vessels of >363 t carrying capacity. The 2017 data are preliminary.

TABLA A-8. Tipos de objetos flotantes sobre los que realizaron lances buques de >363 t de capacidad de acarreo. Los datos de 2017 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
2002	778	13.5	4,966	86.1	27	0.5	5,771
2003	715	13.1	4,722	86.5	20	0.4	5,457
2004	586	11.8	4,370	87.6	30	0.6	4,986
2005	603	12.1	4,281	85.8	108	2.2	4,992
2006	697	10.2	6,123	89.2	42	0.6	6,862
2007	597	10.2	5,188	88.6	72	1.2	5,857
2008	560	8.4	6,070	91.2	25	0.4	6,655
2009	322	4.5	6,728	95.1	27	0.4	7,077
2010	337	5.3	6,038	94.3	24	0.4	6,399
2011	563	8.1	6,342	91.6	16	0.2	6,921
2012	286	3.8	7,321	96.2	3	< 0.1	7,610
2013	274	3.4	7,759	96.5	5	0.1	8,038
2014	283	3.2	8,490	96.7	4	< 0.1	8,777
2015	273	2.9	9,093	96.9	19	0.2	9,385
2016	278	2.7	10,070	97.0	29	0.3	10,377
2017	266	2.4	10,881	97.6	0	0	11,147

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

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

LL	CHN		JPN		KOR		FRA(PYF)		TWN		USA		OTR[1]
	E	C	E	C	E	C	E	C	E	C	E	C	C
1988	-	-	182,709	82,383	43,056	10,172	-	-	9,567	4,590	-	-	234
1989	-	-	170,370	84,961	43,365	4,879	-	-	16,360	4,962	-	-	9
1990	-	-	178,414	117,923	47,167	17,415	-	-	12,543	4,755	-	-	-
1991	-	-	200,374	112,337	65,024	24,644	-	-	17,969	5,862	42	12	173
1992	-	-	191,300	93,011	45,634	13,104	199	89	33,025	14,142	325	106	128
1993	-	-	159,956	87,977	46,375	12,843	153	79	18,064	6,566	415	81	227
1994	-	-	163,999	92,606	44,788	13,250	1,373	574	12,588	4,883	303	25	523
1995	-	-	129,599	69,435	54,979	12,778	1,776	559	2,910	1,639	828	180	562
1996	-	-	103,649	52,298	40,290	14,121	2,087	931	5,830	3,553	510	182	185
1997	-	-	96,385	59,325	30,493	16,663	3,464	1,941	8,720	5,673	464	215	752
1998	-	-	106,568	50,167	51,817	15,089	4,724	2,858	10,586	5,039	1,008	406	1,176
1999	-	-	80,950	32,886	54,269	13,294	5,512	4,446	23,247	7,865	1,756	469	1,157
2000	-	-	79,311	45,216	33,585	18,759	8,090	4,382	18,152	7,809	737	204	4,868
2001	13,056	5,162	102,219	54,775	72,261	18,201	7,445	5,086	41,920	20,060	1,438	238	15,612
2002	34,889	10,398	103,919	45,401	96,273	14,370	943	3,238	78,018	31,773	613	138	10,258
2003	43,289	14,548	101,227	36,187	71,006	15,551	11,098	4,101	74,460	28,328	1,314	262	11,595
2004	15,889	4,033	76,824	30,936	55,861	14,540	13,757	3,030	49,979	19,535	1,049	166	9,193
2005	16,896	3,681	65,081	25,712	15,798	12,284	13,356	2,515	38,536	12,229	2,397	557	5,244
2006	588	969	56,525	21,432	27,472	7,892	11,786	3,220	38,134	12,375	234	121	10,027
2007	12,226	2,624	45,972	20,514	10,548	6,037	9,672	3,753	22,244	9,498	2,689	436	6,424
2008	11,518	2,984	44,547	21,375	3,442	4,256	10,255	3,017	12,544	4,198	6,322	1,369	9,231
2009	10,536	3,435	41,517	21,492	18,364	7,615	10,686	4,032	13,904	6,366	5,141	852	11,731
2010	11,905	3,590	47,807	21,017	25,816	10,477	8,976	3,139	24,976	10,396	8,879	1,480	11,400
2011	37,384	9,983	52,194	18,682	25,323	7,814	9,514	3,192	21,065	9,422	7,359	1,233	7,616
2012	55,508	14,462	55,587	22,214	20,338	8,286	8,806	3,589	20,587	11,924	5,822	986	14,237
2013	70,411	18,128	48,825	19,097	31,702	10,248	9,847	3,303	19,198	11,722	10,765	2,127	9,792
2014	78,851	24,282	40,735	17,235	22,695	9,132	10,572	3,291	17,047	10,435	11,262	2,168	6,870
2015	99,131	25,559	35,344	16,069	22,394	9,879	13,661	4,509	16,514	11,274	13,868	3,432	10,897
2016	66,405	25,756	30,730	13,185	23,235	9,457	13,677	3,954	20,340	13,188	11,313	2,410	8,194

[1] Includes the catches of—Incluye las capturas de: BLZ, CHL, COK, CRI, ECU, EU(ESP), GTM, HND, MEX, NIC, PAN, EU(PRT), SLV, VUT

TABLE A-10. Numbers and well volumes, in cubic meters, of purse-seine and pole-and line vessels of the EPO tuna fleet. The data for 2016 and 2017 are preliminary.

TABLA A-10. Número y volumen de bodega, en metros cúbicos, de buques cerqueros y cañeros de la flota atunera del OPO. Los datos de 2016 and 2017 son preliminares.

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
1988	185	154,845	39	3,352	224	158,197
1989	176	141,956	32	3,181	208	145,137
1990	172	143,877	23	1,975	195	145,852
1991	152	124,062	22	1,997	174	126,059
1992	158	116,619	20	1,807	178	118,426
1993	151	117,593	15	1,550	166	119,143
1994	166	120,726	20	1,726	186	122,452
1995	175	123,798	20	1,784	195	125,582
1996	180	130,774	17	1,646	197	132,420
1997	194	147,926	23	2,127	217	150,053
1998	202	164,956	22	2,216	224	167,172
1999	208	178,724	14	1,642	222	180,366
2000	205	180,679	12	1,220	217	181,899
2001	204	189,088	10	1,259	214	190,347
2002	218	199,870	6	921	224	200,791
2003	214	202,381	3	338	217	202,719
2004	218	206,473	3	338	221	206,811
2005	220	212,419	4	498	224	212,917
2006	225	225,166	4	498	229	225,664
2007	227	225,359	4	380	231	225,739
2008	219	223,804	4	380	223	224,184
2009	221	224,632	4	380	225	225,012
2010	202	210,025	3	255	205	210,280
2011	208	213,237	3	339	211	213,576
2012	209	217,687	4	464	213	218,151
2013	203	212,087	3	268	206	212,355
2014	226	230,379	2	226	228	230,605
2015	244	248,428	1	125	245	248,553
2016	250	261,474	0	0	250	261,474
2017	254	263,018	0	0	254	263,018

TABLE A-11a. Estimates of the numbers and well volume (cubic meters) of purse-seine (PS) and pole-and-line (LP) vessels that fished in the EPO in 2016, by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore, the grand total may not equal the sums of the individual flags.
TABLA A-11a. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) y cañeros (LP) que pescaron en el OPO en 2016, 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	2	7	3	-	14	14,860
ECU	PS	36	33	23	10	12	114	92,832
EU(ESP)	PS	-	-	-	-	2	2	4,120
GTM	PS	-	-	-	1	-	1	1,475
MEX	PS	3	4	19	23	-	49	60,146
NIC	PS	-	-	3	3	-	6	8,478
PAN	PS	-	2	5	4	4	15	21,174
PER	PS	2	4	-	-	-	6	3,019
SLV	PS	-	-	-	-	2	2	4,473
USA	PS	9	-	1	8	9	27	30,619
VEN	PS	-	-	7	6	2	15	21,448
Grand total—Total general	PS	52	45	64	58	31	250	
Well volume—Volumen de bodega (m^3)								
Grand total—Total general	PS	13,564	27,104	71,444	87,294	62,068		261,474

- : none—ninguno

TABLE A-11b. Estimates of the numbers and well volumes (cubic meters) of purse-seine (PS) vessels that fished in the EPO in 2017, by flag and gear. Each vessel is included in the total for each flag under which it fished during the year, but is included only once in the "Grand total"; therefore, the grand total may not equal the sums of the individual flags.

TABLA A-11b. Estimaciones del número y volumen de bodega (metros cúbicos) de buques cerqueros (PS) que pescaron en el OPO en 2017, 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	2	7	3	-	14	14,860
ECU	PS	37	33	22	10	12	114	92,391
EU(ESP)	PS	-	-	-	-	2	2	4,120
MEX	PS	5	4	19	23	-	51	60,551
NIC	PS	-	-	3	3	1	7	10,648
PAN	PS	-	2	5	5	4	16	22,649
PER	PS	4	5	-	-	-	9	4,325
SLV	PS	-	-	-	-	2	2	4,473
USA	PS	9	-	2	9	7	27	30,677
VEN	PS	-	-	5	6	2	13	19,066
Grand total—Total general	PS	57	45	63	59	30	254	
Well volume—Volumen de bodega (m^3)								
Grand total—Total general	PS	14,987	27,117	70,532	88,901	61,481		263,018

- : none—ninguno

TABLE A-12. Minimum, maximum, and average capacity, in thousands of cubic meters, of purse-seine and pole-and-line vessels at sea in the EPO during 2007-2016 and in 2017, by month.

TABLA A-12. Capacidad mínima, máxima, y media, en miles de metros cúbicos, de los buques cerqueros y cañeros en el mar en el OPO durante 2007-2016 y en 2017 por mes.

Month Mes	2007-2016			2017
	Min	Max	Ave.-Prom.	
1	86.9	151.6	107.3	109.9
2	150.7	185.7	162.4	192.3
3	135.4	189.7	153.0	186.6
4	143.4	200.8	160.4	187.6
5	139.8	173.1	155.5	196.9
6	154.9	188.8	164.2	198.6
7	154.1	178.4	165.4	200.4
8	101.0	138.5	115.0	148.7
9	105.5	142.2	119.1	133.2
10	150.7	188.9	167.8	180.1
11	102.9	150.8	129.2	124.4
12	45.9	77.7	58.4	56.3
Ave.-Prom.	122.6	163.9	138.1	159.6

B. YELLOWFIN TUNA

This report presents the most current stock assessment of yellowfin tuna (*Thunnus albacares*) in the eastern Pacific Ocean (EPO). An integrated statistical age-structured stock assessment model (Stock Synthesis Version 3.23b) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO.

Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made in the eastern and western regions. Purse-seine catches of yellowfin are relatively low in the vicinity of the western boundary of the EPO at 150ºW (Figure A-1a and A-1b). The majority of the catch in the EPO is taken in purse-seine sets on yellowfin associated with dolphins, and floating objects (Figure B-1). Tagging studies of yellowfin throughout the Pacific indicate that the fish tend to stay within 1800 km of their release positions. This regional fidelity, along with the geographic variation in phenotypic and genotypic characteristics of yellowfin shown in some studies, suggests that there might be multiple stocks of yellowfin in the EPO and throughout the Pacific Ocean. This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas in the EPO. However, movement rates between these putative stocks, as well as across the 150°W meridian, cannot be estimated with currently-available tagging data.

The assessment of yellowfin tuna in the eastern Pacific Ocean in 2017 is similar to the previous assessment, with the addition of new and updated data (e.g. catches Figure B-1). There is uncertainty about recent and future levels of recruitment (Figure B-2) and biomass (Figure B-5). There have possible been three different productivity regimes since 1975, and the levels of maximum sustainable yield (MSY) and the biomasses corresponding to the MSY may differ among the regimes. The recruitment was below average until 1982, mostly above average from 1983 to 2002, and then mostly below average until 2014. The most recent annual recruitments (2015-2017) were estimated to be at or above average, because of high quarterly recruitments in 2015 (quarters 3 and 4), 2016 (quarters 2 and 4) and 2017 (quarter 1), but these estimates are highly uncertain. The recruitment estimates for 2017 might be upwardly biased, because of a retrospective pattern already noticed in previous assessments. The spawning biomass ratio (SBR) has been average or below average since 2005, except during 2008-2010. However, the SBR at the start of 2018 was estimated to be 0.29, above the MSY level (0.27), due to the above-average recruitments of 2015 and 2016, which coincided with the 2014-2016 El Niño event. Under the current (2015-2017 average) fishing mortality, the SBR is predicted to increase in the next two years because of the large recent recruitments, and level off at about MSY level if recruitment is average.

The recent fishing mortality (F) is slightly above the MSY level (F multiplier = 0.99), and the current spawning biomass (S) is estimated to be above that level (S_{recent}/S_{MSY} = 1.08) (Table B-1 and Figure B-6). The recent biomass of fish aged 3 quarters and older (B) is also higher than that corresponding to the MSY level (B_{recent}/B_{MSY} = 1.35), because of the large recent recruitments. The catches are predicted to increase in the near future (Figure B-7). As noted in Document SAC-07-05b, these interpretations are uncertain, and highly sensitive to the assumptions made about the steepness parameter (h) of the stock-recruitment relationship, the average size of the oldest fish (L_2), and the assumed levels of natural mortality (M). The results are more pessimistic if a stock-recruitment relationship is assumed, if a higher value is assumed for L_2, and if lower rates of M are assumed for adult yellowfin. Previous assessments reported that the data components diverge on their information about abundance levels: results are more pessimistic if the weighting assigned to length-frequency data is decreased, and more optimistic if the model is fitted more closely to the index of relative abundance based on the catch per unit of effort (CPUE) of the northern dolphin-associated purse-seine fishery rather than of the southern longline fishery.

The highest fishing mortality (F) has been on fish aged 11-20 quarters (2.75-5 years), and lowest for the younger fish (< 10 quarters/2.5 years). The average annual F has been increasing for all age classes since 2009, but has shown a slight decline for the 11-20 quarter age group since 2014 (Figure B-3).

Historically, the dolphin-associated and unassociated purse-seine fisheries have the greatest impact on the spawning biomass of yellowfin, followed by the floating-object fisheries (Figure B-4). In more recent years, the impact of the floating-object fisheries has been greater than that of the unassociated fisheries. The impacts of the longline and purse-seine discard fisheries are much less, and have decreased in recent years. Increasing the average weight of the yellowfin caught could increase the MSY.

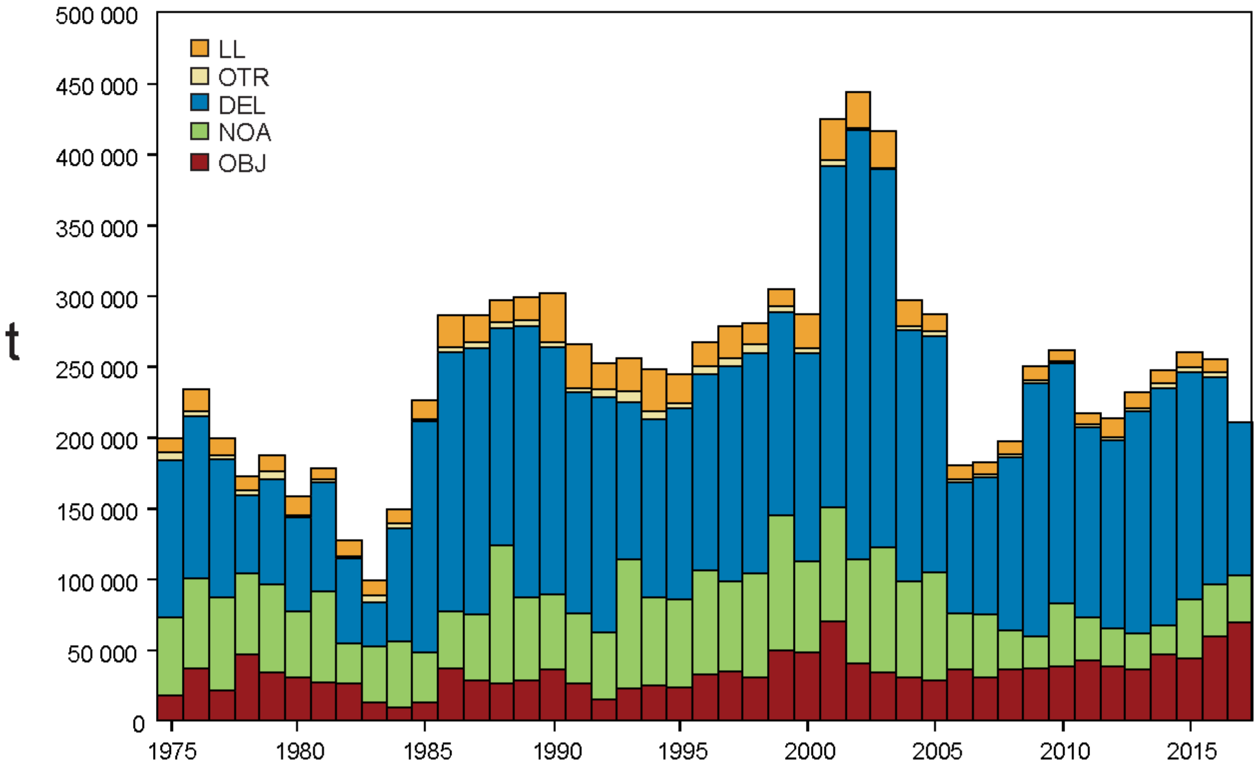

FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, and retained catches for the pole-and-line and longline fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2017. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2017 catch data are preliminary.
FIGURA B-1. Capturas totales (capturas retenidas más descartes) en las pesquerías de cerco, y capturas retenidas de las pesquerías de caña y de palangre, de atún aleta amarilla en el Océano Pacífico oriental, 1975-2017. Se ajustan las capturas de cerco a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de captura de 2017 son preliminares.

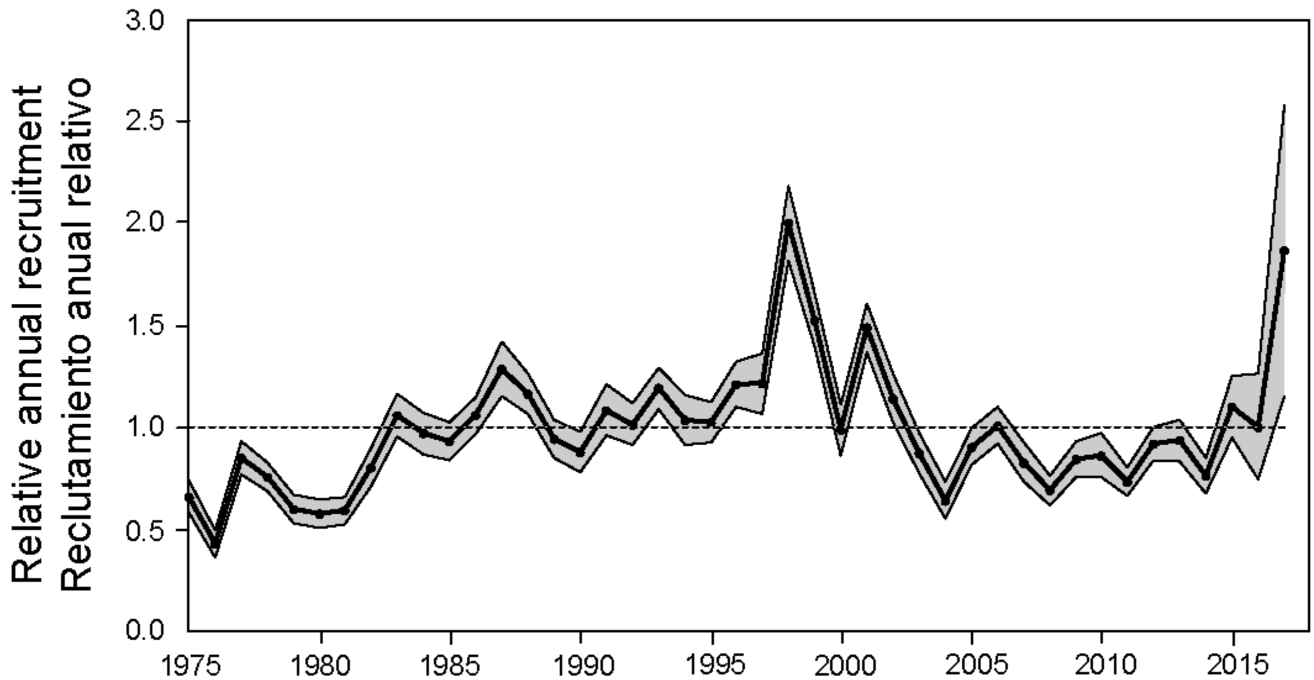

FIGURE B-2. Estimated annual recruitment at age zero of yellowfin tuna to the fisheries of the EPO. The estimates are scaled so that the average recruitment is equal to 1.0 (dashed horizontal line). The solid line illustrates the maximum likelihood estimates of recruitment, and the shaded area indicates the approximate 95% confidence intervals around those estimates.
FIGURA B-2. Reclutamiento anual estimado a edad cero de atún aleta amarilla a las pesquerías del OPO. Se ajusta la escala de las estimaciones para que el reclutamiento medio equivalga a 1.0 (línea de trazos horizontal). La línea sólida ilustra las estimaciones de verosimilitud máxima del reclutamiento, y la zona sombreada los límites de confianza de 95% aproximados de las estimaciones.

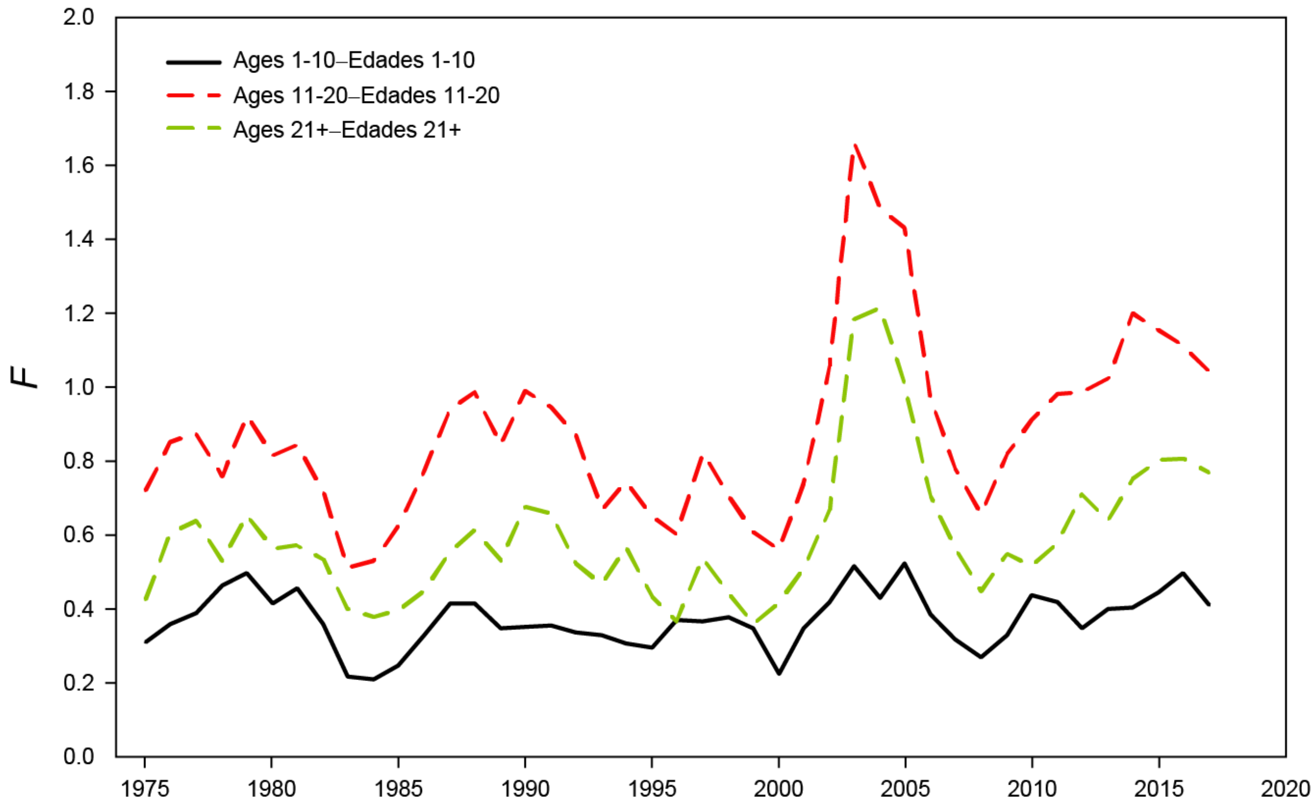

FIGURE B-3. Average annual fishing mortality (*F*) by age groups, by all gears, of yellowfin tuna recruited to the fisheries of the EPO. The age groups are defined by age in quarters.
FIGURA B-3. Mortalidad por pesca (*F*) anual media, por grupo de edad, por todas las artes, de atún aleta amarilla reclutado a las pesquerías del OPO. Se definen los grupos de edad por edad en trimestres.

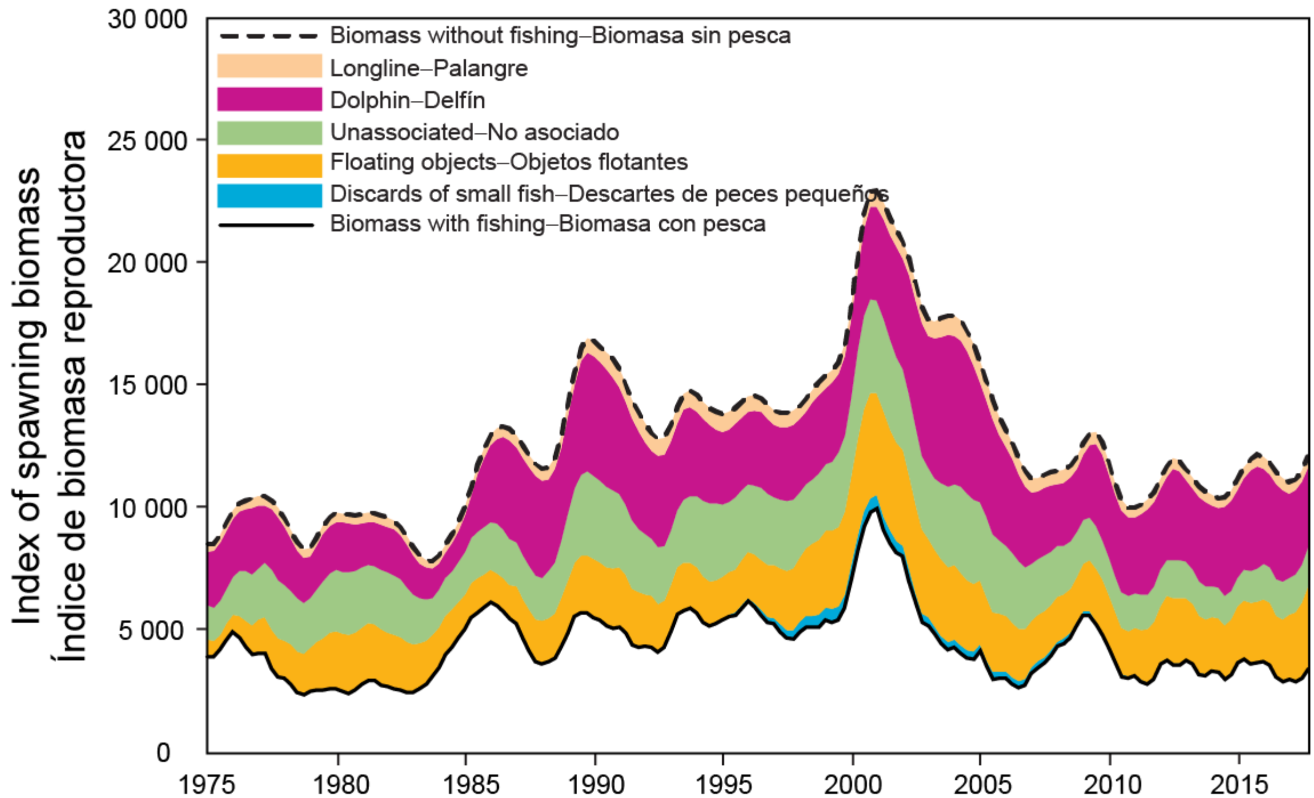

FIGURE B-4. Biomass trajectory of a simulated population of yellowfin tuna that was never exploited (dashed line) and that predicted by the stock assessment model (solid line). The shaded areas between the two lines show the portions of the fishery impact attributed to each fishing method.

FIGURA B-4. Trayectoria de la biomasa de una población simulada de atún aleta amarilla que nunca fue explotada (línea de trazos) y aquella predicha por el modelo de evaluación de la población (línea sólida). Las áreas sombreadas entre las dos líneas representan la porción del impacto de la pesca atribuida a cada método de pesca.

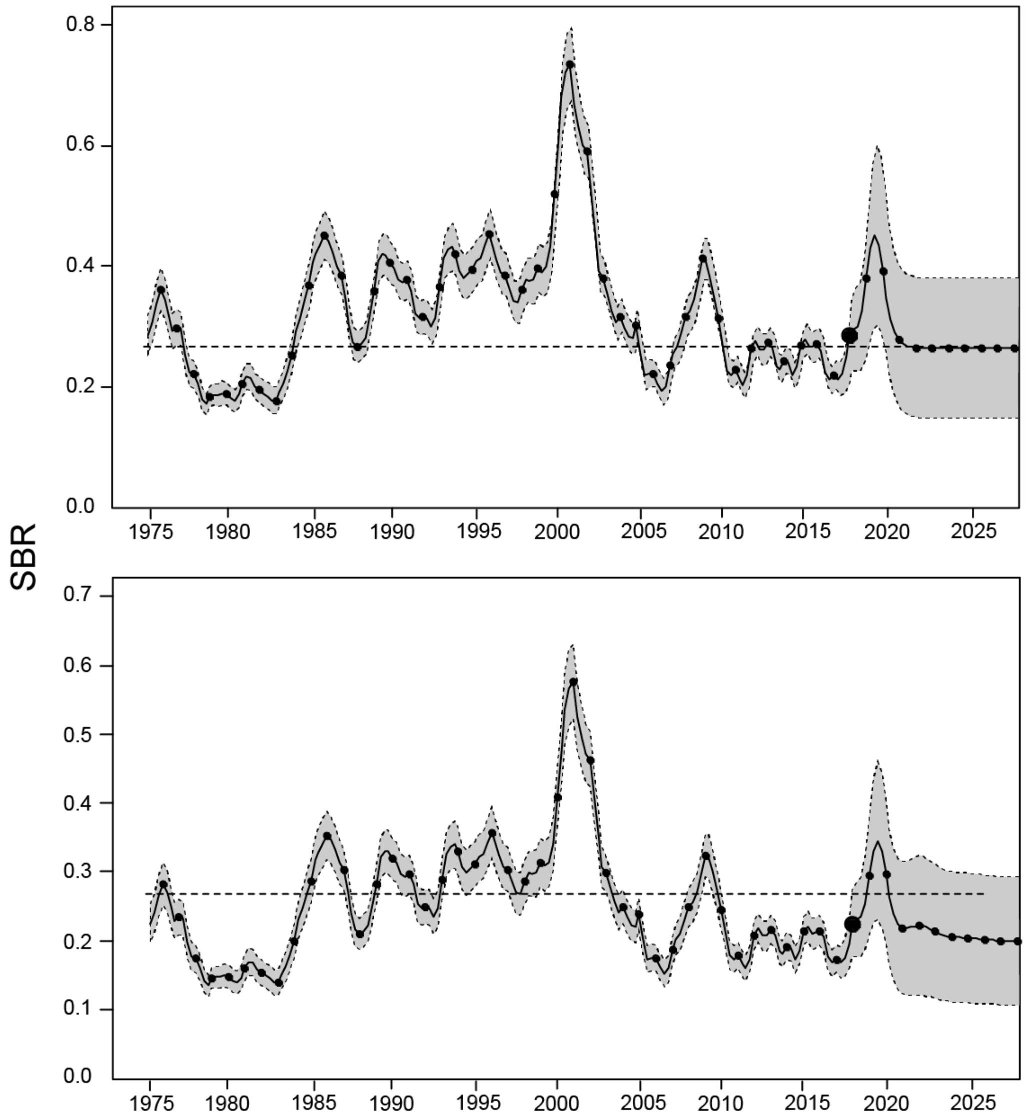

FIGURE B-5. Spawning biomass ratios (SBRs) for yellowfin tuna in the EPO, including projections for 2018-2028 based on average fishing mortality rates during 2015-2017, from the base case (top) and the sensitivity analysis that assumes a stock-recruitment relationship (h = 0.75, bottom). The dashed horizontal line (at 0.27 and 0.35, respectively) identifies the SBR at MSY. The solid curve illustrates the maximum likelihood estimates, and the estimates after 2018 (the large dot) indicate the SBR predicted to occur if fishing mortality rates continue at the average of that observed during 2015-2017, and average environmental conditions occur during the next 10 years. The shaded area indicates the approximate 95% confidence intervals around those estimates.

FIGURA B-5. Cocientes de biomasa reproductora (SBR) de atún aleta amarilla en el OPO, con proyecciones para 2018-2028 basadas en las tasas de mortalidad por pesca medias durante 2015-2017, del caso base (arriba) y el análisis de sensibilidad que supone una relación población-reclutamiento (h = 0.75, abajo). La línea de trazos horizontal (en 0.27 y 0.35, respectivamente) identifica el SBR correspondiente al RMS. La curva sólida ilustra las estimaciones de verosimilitud máxima, y las estimaciones a partir de 2018 (punto grande) indican el SBR que se predice ocurrirá con tasas de mortalidad por pesca en el promedio de aquellas observadas durante 2015-2017, y con condiciones ambientales medias durante los 10 años próximos. El área sombreada indica los intervalos de confianza de 95% aproximados alrededor de esas estimaciones.

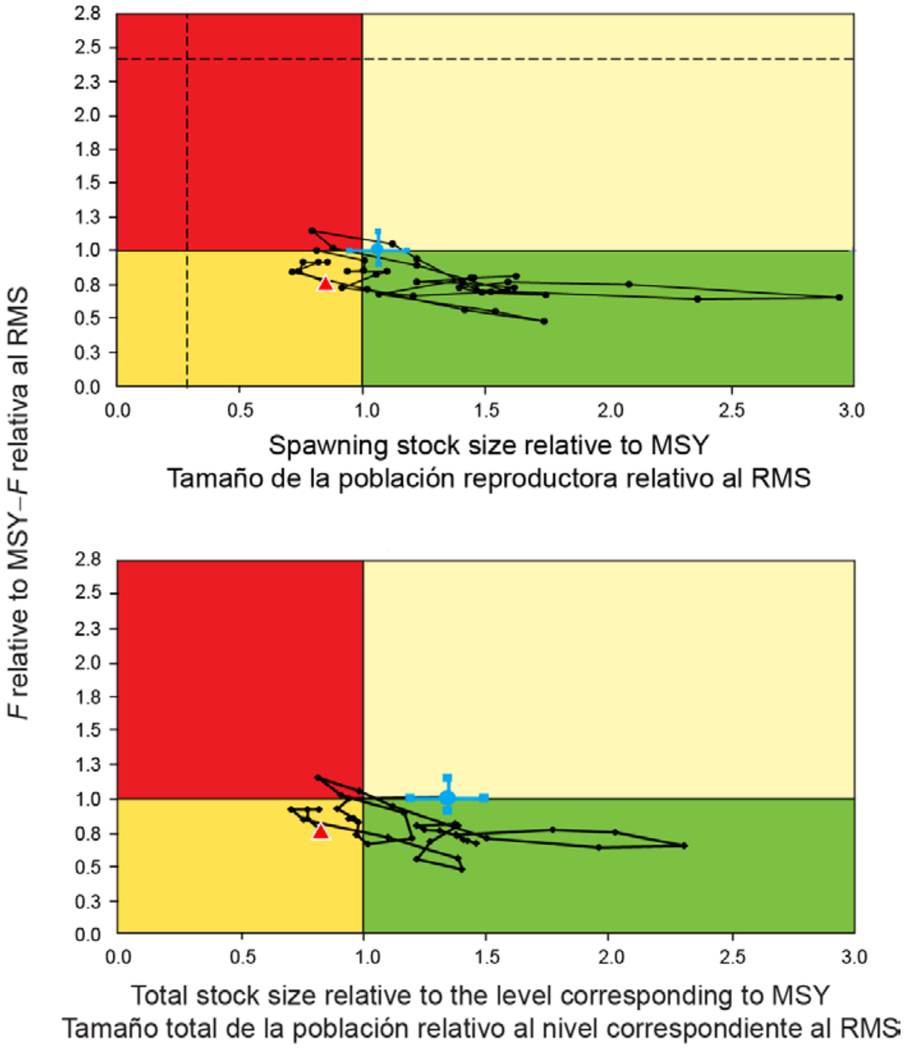

FIGURE B-6. Kobe (phase) plot of the time series of estimates of stock size (top panel: spawning biomass; bottom panel: total biomass of fish aged 3+ quarters) and fishing mortality relative to their MSY reference points. The panels represent interim target reference points (S_{MSY} and F_{MSY}). The dashed lines represent the interim limit reference points of 0.28 *S_{MSY} and 2.42*F_{MSY}, which correspond to a 50% reduction in recruitment from its average unexploited level based on a conservative steepness value (h = 0.75) for the Beverton-Holt stock-recruitment relationship. Each dot is based on the average exploitation rate over three years; the large blue dot indicates the most recent estimate. The squares around the most recent estimate represent its approximate 95% confidence interval. The triangle represents the first 3-year period (1975-1977).

FIGURA B-6. Gráfica de Kobe (fase) de la serie de tiempo de las estimaciones del tamaño de la población (panel superior: biomasa reproductora; panel inferior: biomasa total de peces de 3+ trimestres de edad) y la mortalidad por pesca en relación con sus puntos de referencia de RMS. Las líneas de trazos representan los puntos de referencia límite provisionales de 0.28*S_{RMS} y 2.42*F_{RMS}, que corresponden a una reducción de 50% del reclutamiento de su nivel medio no explotado basada en un valor cauteloso de la inclinación de la relación población-reclutamiento de Beverton-Holt (h = 0.75). Cada punto se basa en la tasa de explotación media por trienio; el punto azul grande indica la estimación más reciente. Los cuadrados alrededor de la estimación más reciente representan su intervalo de confianza de 95% aproximado. . El triángulo representa el primer trienio (1975-1977).

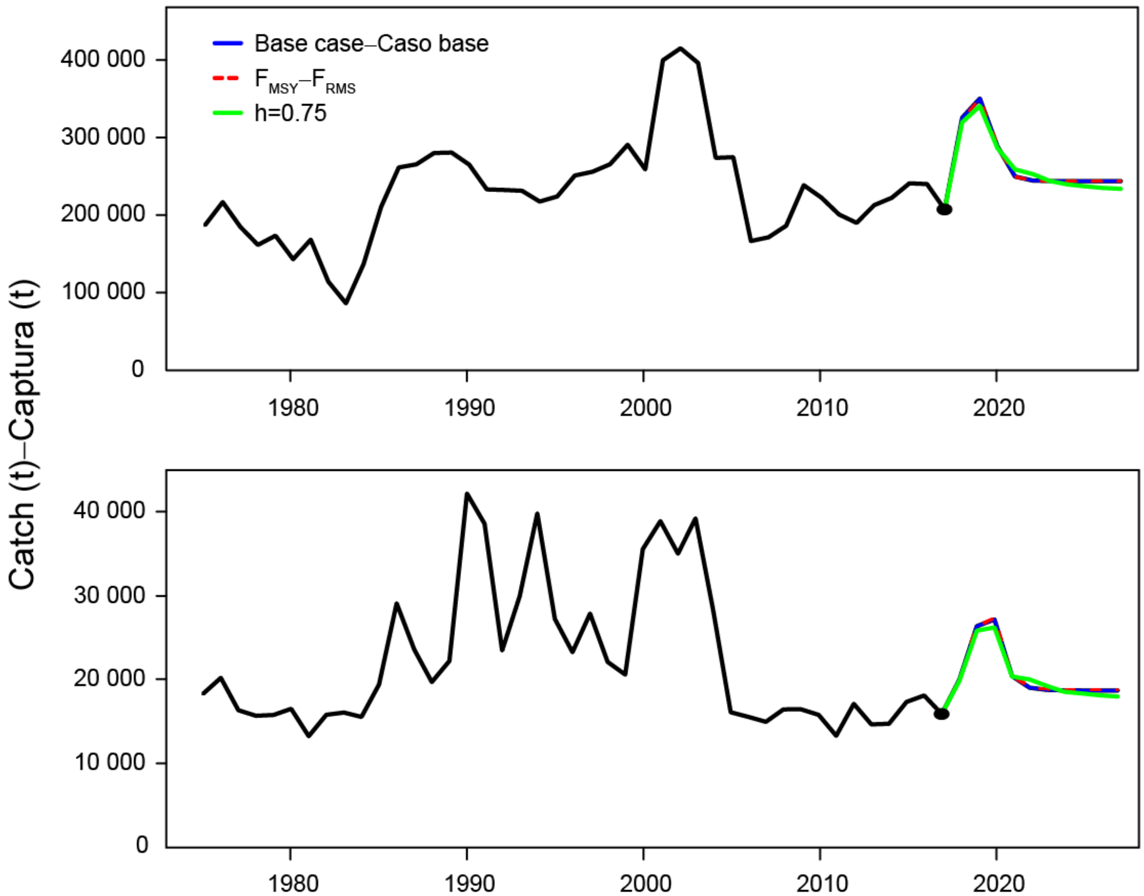

FIGURE B-7. Historic and projected annual catches of yellowfin tuna by surface (top panel) and longline (bottom panel) fisheries from the base case while fishing with the current effort, the base case while fishing at the fishing mortality corresponding to MSY (F_{MSY}), and the analysis of sensitivity to steepness (h = 0.75) of the stock-recruitment relationship while fishing with the current effort. The large dot indicates the most recent catch (2017).

FIGURA B-7. Capturas históricas y proyectadas de atún aleta amarilla de las pesquerías de superficie (panel superior) y palangre (panel inferior), del caso base con el nivel actual de esfuerzo, del caso base con la mortalidad por pesca correspondiente al RMS (F_{RMS}), y el análisis de sensibilidad a la inclinación (h = 0.75) de la relación población-reclutamiento con el nivel actual de esfuerzo. El punto grande indica la captura más reciente (2017).

TABLE B-1. MSY and related quantities for the base case and the stock-recruitment relationship sensitivity analysis, based on average fishing mortality (F) for 2015-2017. B_{recent} and B_{MSY} are defined as the biomass, in metric tons, of fish 3+ quarters old at the start of the first quarter of 2018 and at MSY, respectively, and S_{recent} and S_{MSY} are defined as indices of spawning biomass (therefore, they are not in metric tons). C_{recent} is the estimated total catch for 2017.
TABLA B-1. RMS y cantidades relacionadas para el caso base y el análisis de sensibilidad a la relación población-reclutamiento, basados en la mortalidad por pesca (F) media de 2015-2017. Se definen B_{recent} y B_{RMS} como la biomasa, en toneladas, de peces de 3+ trimestres de edad al principio del primer trimestre de 2018 y en RMS, respectivamente, y S_{recent} y S_{RMS} como índices de biomasa reproductora (por lo tanto, no se expresan en toneladas). C_{recent} es la captura total estimada de 2017.

YFT	Base case Caso base	h = 0.75
MSY-RMS	264,283	278,584
B_{MSY}- B_{RMS}	376,696	560,713
S_{MSY}- S_{RMS}	3,634	6,080
B_{MSY}/B_0- B_{RMS}/B_0	0.31	0.37
S_{MSY}/S_0- S_{RMS}/S_0	0.27	0.35
C_{recent}/MSY- C_{recent}/RMS	0.85	0.81
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	1.35	0.89
S_{recent}/S_{MSY}-S_{recent}/S_{RMS}	1.08	0.64
F multiplier-Multiplicador de F	0.99	0.64

C. SKIPJACK TUNA

Skipjack are distributed across the Pacific Ocean, and it is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at a local level, although large-scale movements are thought to be rare. The bulk of the catches of skipjack are made in the eastern and western regions; the purse-seine catches are relatively low in the vicinity of the western boundary of the EPO at 150°W. The movements of tagged skipjack generally cover hundreds, rather than thousands, of kilometers, and exchange of fish between the eastern and western Pacific Ocean appears to be limited. Movement rates between the EPO and the western Pacific cannot be estimated with currently-available tagging data.

Biomass, recruitment, and fishing mortality are estimated to be highly variable over time. However, the estimates differ among the alternative assessment methods and are uncertain because: 1) it is unknown if catch-per-day-fished for purse-seine fisheries is proportional to abundance; 2) it is possible that there is a population of large skipjack that is invulnerable to the fisheries; and 3) the structure of the EPO stock in relation to the western and central Pacific stocks is uncertain. In addition, maximum yields are estimated to be achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the fishery. Although, this is uncertain because of uncertainties in the estimates of natural mortality and growth. For this reason, no traditional reference points are available for skipjack tuna in the EPO. Consequently, indicators and reference levels have been used to evaluate the status of the stock. The data- and model-based indicators have yet to detect any adverse impacts of the fishery. The average weight has declined to levels seen in the early 1980s and was below its lower reference level in 2015 and 2016 (Figure C-1), but increased slightly to above that level in 2017. This can be a consequence of overexploitation, but it can also be caused by recent recruitments being greater than past recruitments or expansion of the fishery into areas occupied by smaller skipjack. The low levels are likely due to the large recruitments in 2015 and 2016.

Productivity and susceptibility analysis (PSA; see IATTC Fishery Status Report 12, Figure L-4) shows that skipjack has substantially higher productivity than bigeye. Biomass (B) and the fishing mortality that corresponds to MSY (F_{MSY}) are, respectively, negatively and positively correlated with productivity. Therefore, since skipjack and bigeye have about the same susceptibility, and susceptibility is related to fishing mortality, the status of skipjack can be inferred from the status of bigeye, but only if the fishing mortality of bigeye is below the MSY level (*i.e.*, $F<F_{MSY}$). Since the updated assessment of bigeye estimates that the fishing mortality is above that level ($F>F_{MSY}$), no inferences can be made about the status of skipjack. A conventional assessment of skipjack is necessary to ascertain the status of the stock, but, as noted above, this is not possible without much more extensive tagging data. Implementing the large-scale tagging program in the EPO proposed in the Strategic Science Plan for 2019-2023 is therefore critical.

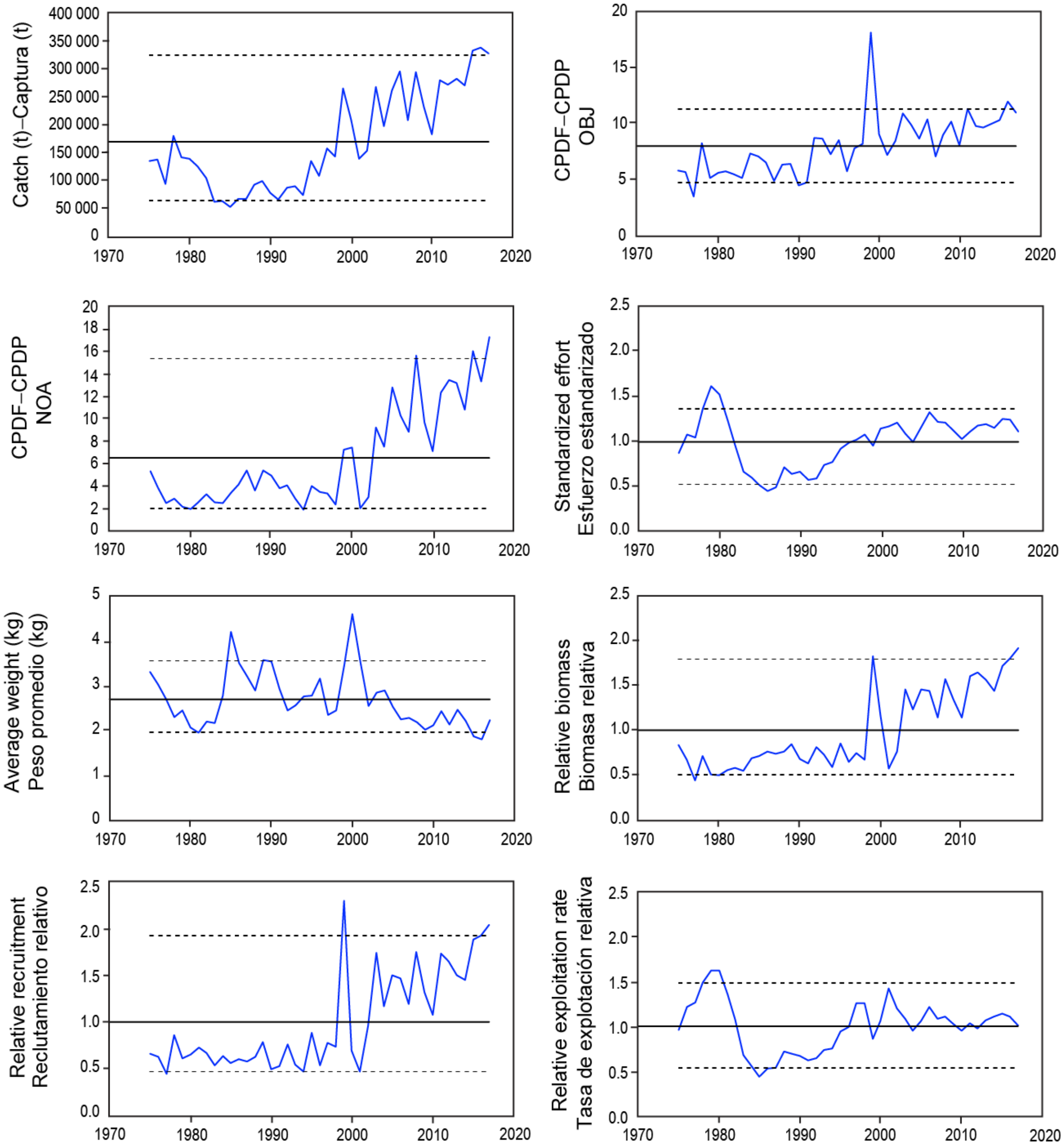

FIGURE C-1. Indicators of stock status for skipjack tuna in the eastern Pacific Ocean. OBJ: floating-object fishery; NOA: unassociated fishery; CPDF: catch per day fished. All indicators are scaled so that their average equals one.

FIGURA C-1. Indicadores del estatus de la población de atún barrilete en el Océano Pacífico oriental. OBJ: pesquería sobre objetos flotantes; NOA: pesquería no asociada; CPDP: captura por día de pesca. Se ajusta la escala de todos los indicadores para que su promedio equivalga a uno.

D. BIGEYE TUNA

The results of the update stock assessment of bigeye tuna (*Thunnus obesus*) in the eastern Pacific Ocean (EPO) conducted in 2018 using the same methodology as in previous years, revealed several uncertainties which led the staff to question its use as a basis for management advice. The staff has therefore developed a suite of stock status indicators for bigeye, as an alternative basis for management advice and for monitoring the stock and the fishery until the uncertainties in the stock assessment have been resolved.

There have been substantial changes in the bigeye tuna fishery in the EPO over recent decades (Figure D-1). Initially, most bigeye catch was taken by longline vessels. With the expansion of the fishery on fish-aggregating devices (FADs) since 1993, the purse-seine fishery has taken an increasing component of the bigeye catch. In recent years, purse-seine catches of bigeye were taken primarily between 5°N and 5°S across the equatorial Pacific as far west as the western boundary (150°W) of the EPO (Figure A-3). The longline catches of bigeye in the EPO are predominantly taken below 5°N (Figure A-4). Assessments of bigeye tuna in the EPO have been conducted as if there were a single stock of bigeye in the EPO, with minimal net movement of fish between the EPO and the western and central Pacific Ocean (WCPO). Assessment results have been consistent with the results of other analyses of bigeye tuna on a Pacific-wide basis. However, the distribution of the bigeye catches extends across the equatorial Pacific Ocean. In addition, a large amount of conventional and electronic tagging data has recently accumulated from the Pacific Tuna Tagging Programme, which has focused its bigeye tagging efforts between 180° and 140°W since 2008. The tag recoveries clearly show that there is extensive longitudinal movement of bigeye across the IATTC's management boundary at 150°W, in particular from west to east. The IATTC staff will continue to collaborate with SPC on research into a Pacific-wide stock assessment model for bigeye. This will incorporate the new tagging data in a spatially-structured population dynamics model, which will help in the ongoing evaluation of potential biases resulting from ignoring exchange of fish across the WCPO-EPO boundary in the current approach of conducting separate assessments for the EPO and WCPO.

Because of the uncertainties identified in the update assessment of bigeye tuna conducted in 2018 (SAC-09-05 and SAC-09 INF-B), the staff used stock status indicators, similar to those used for skipjack tuna (SAC-09-07), to assess the status of the stock. The staff also investigated the relationship between the number of days fished and the number of floating-object sets, using a subset of vessels that fished mainly on floating objects.

All the indicators, except catch, show strong trends over time (Figure D-2), indicating increasing fishing mortality and reduced abundance, and are at, or above, their reference levels. The increasing number of sets and the decreasing mean weight of the fish in the catch suggests that the bigeye stock in the EPO is under increasing fishing pressure, and measures additional to the current seasonal closures, such as limits on the number of floating-object sets, are required. It is not clear why the number of floating-object sets, per day and per vessel, is increasing, but it is probably due to the vessels' increased efficiency in finding FADs with tuna, due in turn to both the greater number of FADs deployed and the increased use of satellite-linked buoys equipped with fish-detecting sonar, and further investigation into this phenomenon should be conducted.

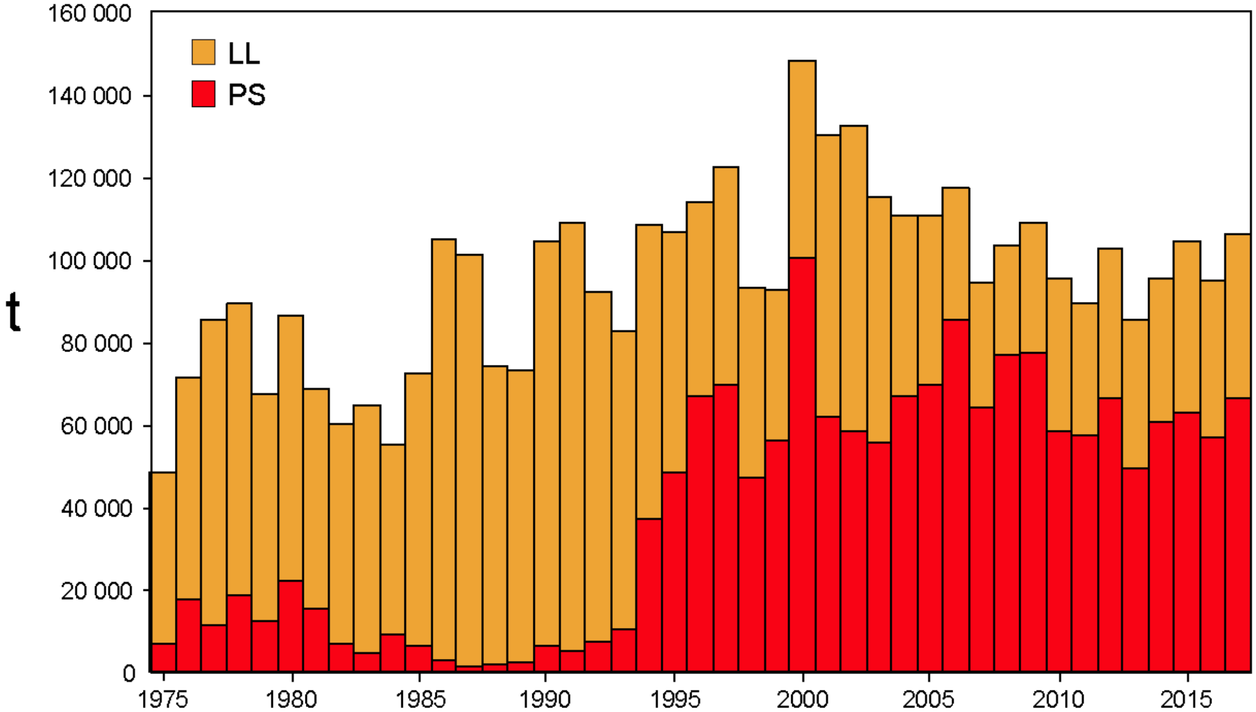

FIGURE D-1. Total catches (retained catches plus discards) of bigeye tuna by the purse-seine fisheries, and retained catches for the longline fisheries, in the eastern Pacific Ocean, 1975-2017 The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2017 catch data are preliminary.

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, 1975-2017. Se ajustan las capturas cerqueras a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de captura de 2017 son preliminares.

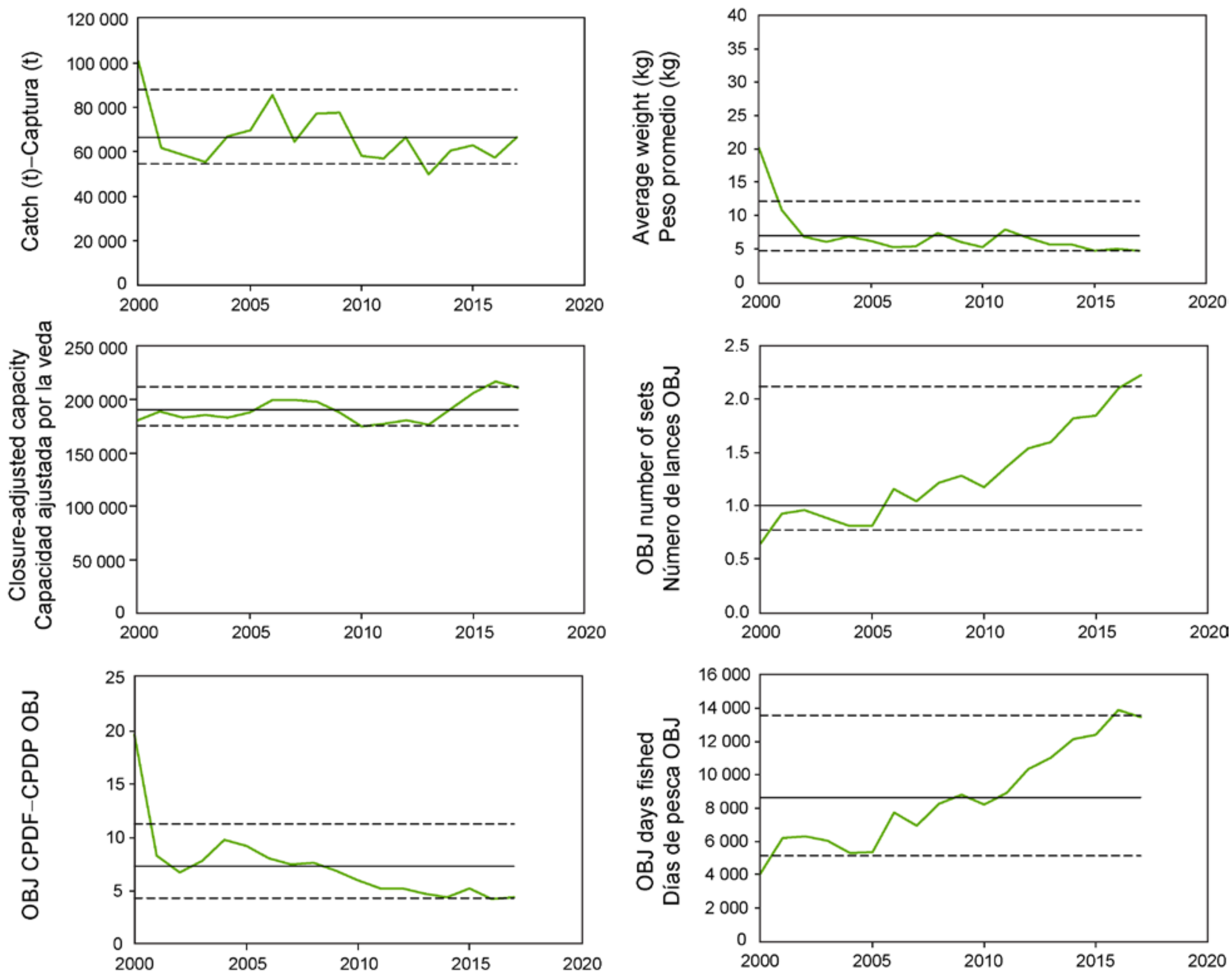

FIGURE D-2. Stock status indicators for bigeye tuna in the EPO, based on purse-seine data, 2000-2017. The dashed horizontal lines are the 5th and 95th percentiles, the solid horizontal line is the median. CPDF: catch per day fishing; OBJ: sets on floating objects.

FIGURA D-2. Indicadores de condición de población para el atún patudo en el OPO, basados en datos de cerco, 2000-2017. Las líneas horizontales de trazos representan los percentiles de 5 y 95%, y la línea horizontal sólida la mediana. CPDP: captura por día de pesca; OBJ: lances sobre objetos flotantes.

E. PACIFIC BLUEFIN TUNA

Tagging studies have shown that there is exchange of Pacific bluefin between the eastern and western Pacific Ocean. Larval, post larval, and early juvenile bluefin have been caught in the western Pacific Ocean (WPO), but not in the eastern Pacific Ocean (EPO), so it is likely that there is a single stock of bluefin in the Pacific Ocean (or possibly two stocks in the Pacific Ocean, one spawning in the vicinity of Taiwan and the Philippines and the other spawning in the Sea of Japan).

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

Bluefin are exploited by various gears in the WPO from Taiwan to Hokkaido, Japan. Age-0 fish, about 15 to 30 cm in length, are caught by the Japanese troll fishery 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 in troll fisheries 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. Additionally, small amounts of bluefin are caught near the southeastern coast of Japan by longlining. The Chinese Taipei small-scale longline fishery, which has expanded since 1996, takes bluefin tuna more than 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 WPO, while others migrate to the EPO. These migrations begin mostly during the first and second years of life. The first- and second-year migrants are exposed to various fisheries before beginning their journey to the EPO. Then, after crossing the ocean, they are exposed to commercial and recreational fisheries off California and Baja California. Eventually, the survivors return to the WPO.

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

The total catches of bluefin have fluctuated considerably during the last 50 years (Figure E-1). The 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 recruitments. The estimated impact of the fisheries on the bluefin population for the entire time period modeled (1952-2016) is substantial (Figure E-2). The WPO fisheries have had a greater impact than the EPO fisheries, and their impact increased starting in 1980s only leveling off in 2000s.

An update stock assessment was carried out by the Pacific Bluefin Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) in 2018. The assessment was conducted with Stock Synthesis 3, an integrated statistical age-structured stock assessment model. The base-case model results show that: (1) spawning stock biomass (SSB) fluctuated throughout the assessment period, (2) the SSB declined steadily from 1996 to 2010; and (3) the stock has been increasing slowly since 2010. Historical recruitment estimates have fluctuated since 1952 without an apparent trend. The low recruitment levels estimated in 2010-2014 were a concern in the 2016 assessment. The 2018 assessment estimate of 2015 recruitment is low, and similar to estimates from previous years, while the 2016 recruitment estimate is higher than the historical average. Initial data indicates that the 2017 recruitment is also high. There is no evidence of a stock-recruitment relationship. A substantial decrease in 2015-2016 in the estimated fishing mortality of fish of ages 0-2 was observed. Note that stricter management measures in WCPFC and IATTC have been in place since 2015.

The point estimate of the 2016 SSB was 3.3% of the SSB in the absence of fishing (3.3%$SSB_{F=0}$), and the 2016 fishing mortality (*F*) corresponds to *F*6.7%SPR. Because the harvest strategy contains catch limits, fishing mortality is expected to decline, *i.e*., *F*x%SPR will increase as biomass increases. No biomass-based limit or target reference points have been adopted to evaluate whether Pacific bluefin is overfished. However, the stock is overfished relative to common target reference points and to the IATTC limit reference point used for tropical tunas. Also, no fishing intensity-based limit or target reference points have been adopted to evaluate whether overfishing of Pacific bluefin is occurring, but the stock is subject to overfishing relative to most common fishing intensity-based reference points.

Resolution C-16-08 states that the Commission recognizes that the management objective of the IATTC is to maintain or restore fish stocks at levels capable of producing MSY, and shall implement a provisional rebuilding plan in part by adopting an initial (first) rebuilding target of $SSB_{med,\ 1952\text{-}2014}$ (the median point estimate for 1952-2014) to be achieved by 2024 with at least 60% probability. The IATTC has adopted resolutions to restrict the catch of bluefin tuna in the EPO. Resolution C-16-08 limits the commercial catches in the IATTC Convention Area by all CPCs to a combined total of 6,600 metric tons during 2017-2018, respectively. No CPC shall exceed 3,500 metric tons in 2017. In the event that the total actual catch in 2017 is either above or below 3,300 metric tons, the catch limit for 2018 shall be adjusted accordingly to ensure that the total catch for both years does not exceed 6,600 metric tons. Resolution C-16-08 requires that in 2018, and taking into account the outcomes of the 2nd IATTC-WCPFC NC Joint Working Group Meeting, the Commission shall adopt a second rebuilding target, to be achieved by 2030. Resolution C-16-08 also requires that no later than the IATTC meeting in 2018, taking into account the outcomes of the Joint IATTC-WCPFC NC Working Group, the Commission shall consider and develop reference points and harvest control rules for the long-term management of Pacific bluefin tuna, which should be comparable to those adopted by the WCPFC.

The Harvest Strategy proposed at the Joint WCPFC NC-IATTC WG meeting guided projections conducted by the ISC to provide catch reduction options if the projection results show that the initial rebuilding target will not be achieved at least with 60% by 2024 or to provide relevant information for a potential increase in catch if the probability of achieving the initial rebuilding target exceeds 75% by 2024. The projection based on the base-case model mimicking the current management measures by the WCPFC (CMM 2017-08) and IATTC (C-16-08) under the low recruitment scenario resulted in an estimated 98% probability of achieving the initial rebuilding target by 2024. This estimated probability is above the threshold (75% or above in 2024) prescribed by the Harvest Strategy. The low recruitment scenario is more precautionary than the recent 10 years recruitment scenario. In the Harvest Strategy, the recruitment scenario is switched from the low recruitment to the average recruitment scenario beginning in the year after achieving the initial rebuilding target. The estimated probability to achieve the second rebuilding target was evaluated 10 years after the achievement of the initial rebuilding target or by 2034, whichever is earlier, is 96%. This estimate is above the threshold (60% or above in 2034) prescribed by the Harvest Strategy. However, it should be recognized that these projection results are strongly influenced by the inclusion of the relatively high, but uncertain recruitment estimate for 2016, and does not include the initial estimates of the high recruitment in 2017.

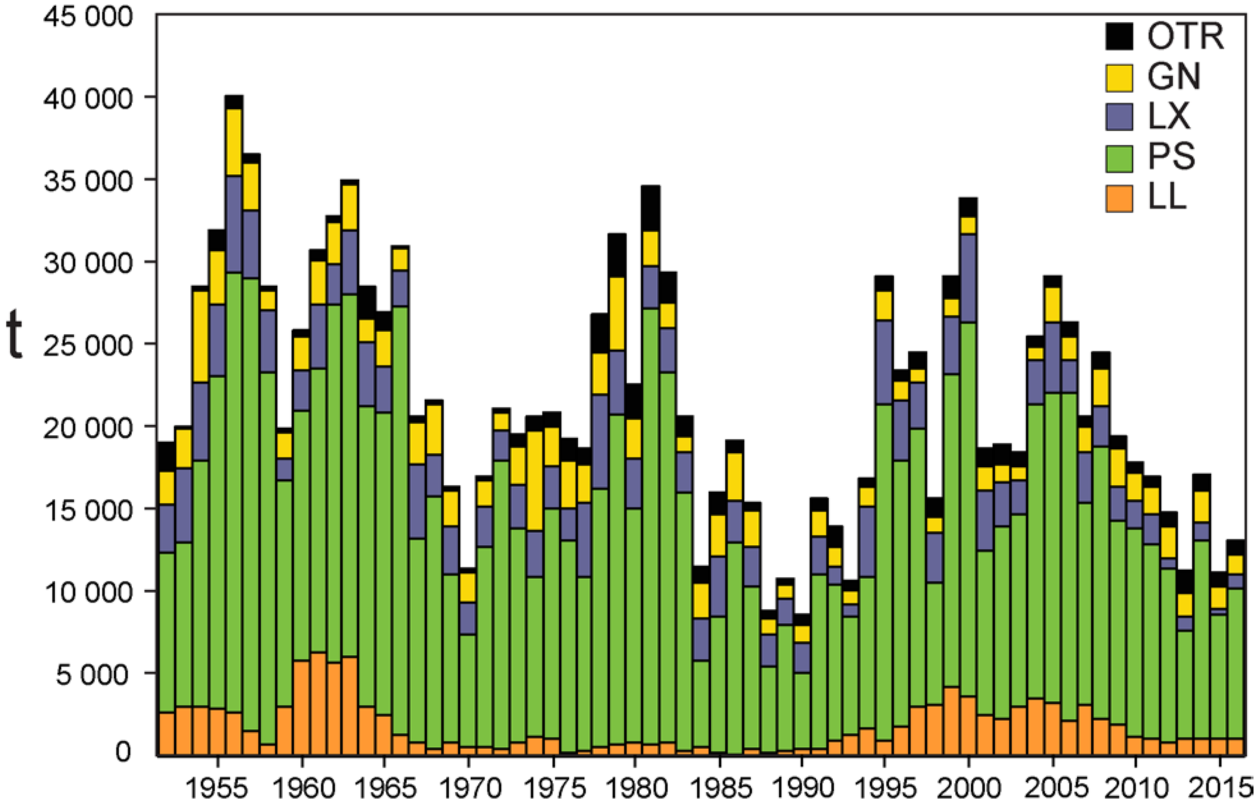

FIGURE E-1. Retained catches of Pacific bluefin tuna.
FIGURA E-1. Capturas retenidas de atún aleta azul del Pacífico.

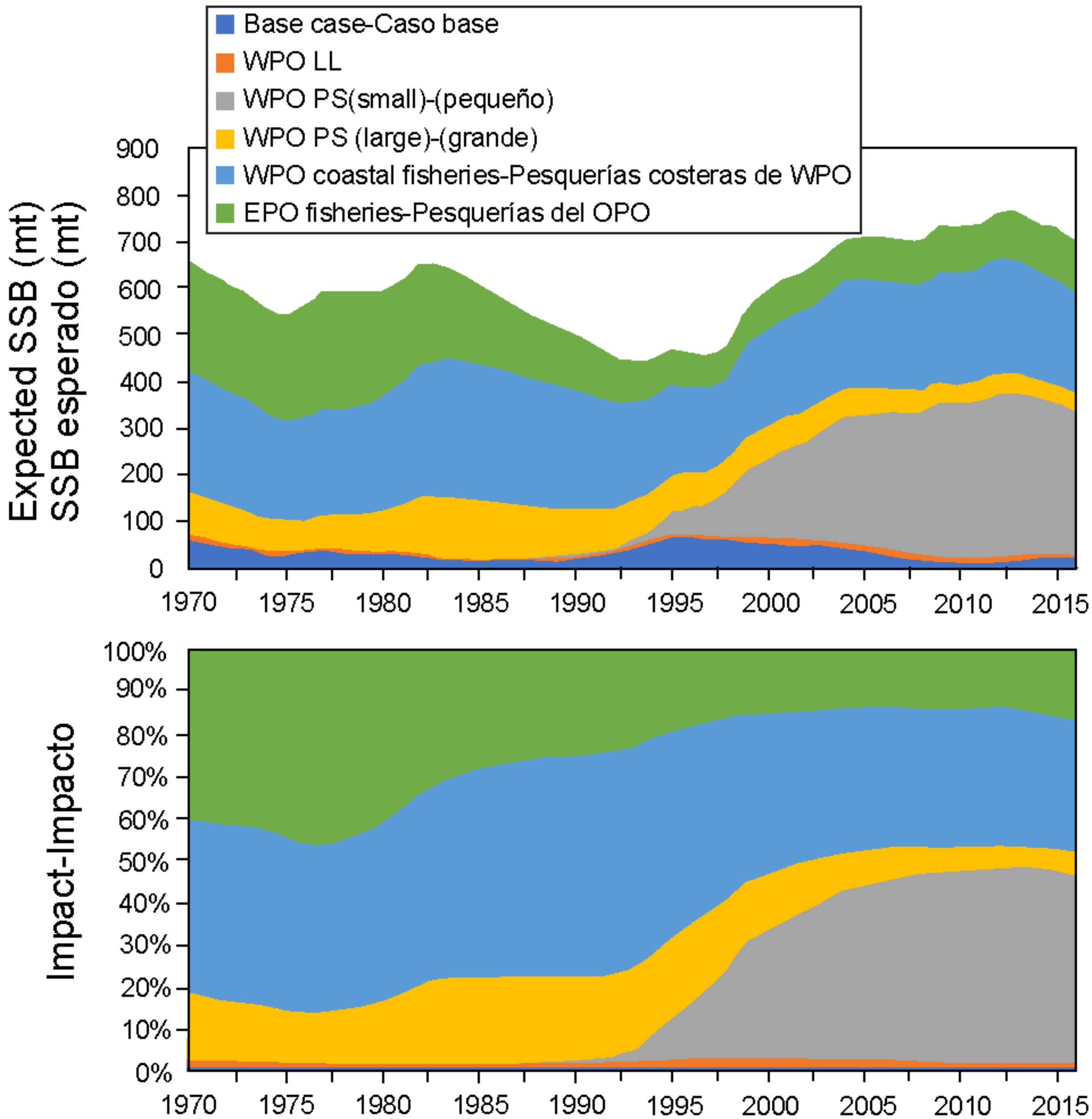

FIGURE E-2. Estimates of the impact on the Pacific bluefin tuna population of fisheries in the EPO and in the WPO (upper panel). The dashed line represents the estimated hypothetical unfished spawning biomass, and the solid line the estimated actual spawning biomass. The shaded areas indicate the impact attributed to each fishery. The lower panel presents the proportion of impact attributed to the EPO and WPO. (Figure from the draft Executive Summary of ISC 2018 stock assessment; subject to change and approval by the ISC Plenary.)

FIGURA E-2. Estimaciones del impacto sobre la población de atún aleta azul del Pacífico de las pesquerías en el OPO y en el WPO (panel superior). La línea de trazos representa la biomasa reproductora no pescada hipotética estimada, y la línea sólida la biomasa reproductora real estimada. Las áreas sombreadas indican el impacto atribuido a cada pesquería. El panel inferior ilustra la proporción del impacto atribuida al OPO y al WPO. (Figura del borrador de resumen ejecutivo de la evaluación de 2018 del ISC; sujeta a cambio y aprobación por la plenaria del ISC.)

F. ALBACORE TUNA

There are two stocks of albacore in the Pacific Ocean, one in the northern hemisphere and the other in the southern hemisphere. Albacore are caught by longline gear in most of the North and South Pacific, but not often between about 10°N and 5°S, by trolling gear in the eastern and central North and South Pacific, and by pole-and-line gear in the western North Pacific. In the North Pacific about 57% of the fish are taken in pole-and-line and troll fisheries that catch smaller, younger albacore, whereas about 95% of the albacore caught in the South Pacific are taken by longline. The total annual catches of South Pacific albacore ranged from about 25,000 to 50,000 t during the 1980s and 1990s, but increased after that, to between about 68,000 and 88,000 t during 2012-2016 (Figure F-1a), averaging about 81,000 t, of which 29% was taken in the eastern Pacific Ocean (EPO). The total annual catches of North Pacific albacore peaked in 1976 at about 125,000 t, declined to about 38,000 t in 1991, and then increased to about 122,000 t in 1999 (Figure F-1b). They declined again in the early 2000s, then recovered but during 2012-2016 they declined from about 92,000 to 58,200 t, averaging about 78,000 t, of which 27% was taken in the EPO.

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

The movements of North Pacific albacore are strongly influenced by oceanic conditions, and migrating albacore tend to concentrate along oceanic fronts in the North Pacific Transition Zone. Most of the catches are made in water temperatures between about 15º and 19.5ºC. Details of the migration remain unclear, but juvenile fish (2- to 5-year-olds) are believed to move into the eastern Pacific Ocean (EPO) in the spring and early summer, and return to the western and central Pacific, perhaps annually, in the late fall and winter, where they tend to remain as they mature. This pattern may be complicated by sex-related movements of large adult fish (fork length >125 cm), which are predominately male, to areas south of 20°N. The significance of such movements for the demographic dynamics of this stock are uncertain at present.

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

The most recent published stock assessments for the South and North Pacific stocks of albacore are from 2015 and 2017, respectively. The assessments indicate that it is not likely that either stock is overfished or that overfishing is taking place.

South Pacific albacore

The assessment of South Pacific albacore carried out in 2015 by scientists of the Secretariat of the Pacific Community using MULTIFAN-CL, covered the 1960-2013 period, and incorporated catch-and-effort, length-frequency, and tagging data, and information on biological parameters. A summary of the conclusion can be found here. The key changes from the previous assessment were the inclusion of the results of a wide-scale study of biological parameters that mainly addressed the uncertainty in growth, the use of a spatially-explicit model, and changes in the assumption about natural mortality (*M*). Although the results were sensitive to the assumed *M* and to the relative weighting of different data sets, it was concluded that the stock was most likely above both the level corresponding to the maximum sustainable yield (MSY) and the limit reference point of 20% of the spawning stock biomass (SSB) in the absence of fishing (20%$SSB_{F=0}$) adopted by the Western and Central Pacific Fisheries Commission (WCPFC), and was therefore not in an overfished state. Fishing mortality (*F*) has generally been increasing over time, but its recent (2009-2012) levels were below the MSY level ($F_{2009\text{-}2012t}/F_{MSY}$ = 0.39 for the base-case model, and ranged from 0.13 to 0.62 across the grid of models used to represent uncertainty). The current (2013) SSB was above both the

MSY level (base case SSB_{2013} /SSB_{MSY} = 2.86; range 1.74-7.03) and the limit reference point (base case SSB_{2013}/$SSB_{F=0}$ = 0.40; range 0.30-0.60), so it is not likely that overfishing is occurring. However, it is important to note that SSB_{MSY} is lower than the limit reference point. Notwithstanding these conclusions, it was recommended that longline fishing mortality and longline catch be reduced to avoid further declines in the vulnerable biomass, so that economically-viable catch rates can be maintained.

North Pacific albacore

IATTC resolution C-05-02 on North Pacific albacore, supplemented by Resolution C-13-03, requires that the total level of fishing effort for North Pacific albacore tuna in the EPO not be increased beyond the levels that were in effect at the time. During 2014-2016 the total effort was 31,604 vessel-days (95% of the 2002-2004 reference level), and the average number of vessels operating was 753 (83% of the 2002-2004 level).

An assessment of North Pacific albacore, using fisheries data through 2015, was conducted in April 2017 at a workshop of the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). The stock was assessed using an age- and sex-structured Stock Synthesis (SS version 3.24AB) model fitted to time series of standardized CPUE and size-composition data. Three major changes were made to the base case model from the previous assessment in 2014:

1. Most importantly, a new procedure was used to standardize the index (1996-2015) based on Japanese longline data used to indicate trends in adult albacore abundance, and the results represented a substantial improvement relative to previous assessments. This new index had good contrast and, based on Age-Structured Production Model (ASPM) diagnostic analyses, was informative on both population trend and scale.
2. The start year of the base case model was changed from 1966 to 1993. This eliminated both the influence of poorly-fitting Japanese longline size-composition data for 1975-1992, and the conflict between these data and the primary adult abundance indices.
3. In previous assessments, the instantaneous rate of natural mortality (M) was assumed to be 0.3 yr^{-1} for both sexes at all ages. The basis for this assumption was reviewed, and found to be poorly supported. Sex-specific M-at-age vectors were developed from a meta-analysis, with a combined-sex M that scaled with size for ages 0-2, and sex-specific M fixed at 0.39 and 0.48 yr^{-1} for age-3+ males and females, respectively.

The stock assessment results allowed for the following conclusions:

1. The base-case model estimates that the spawning stock biomass (SSB) declines during 1993-2000, after which it becomes relatively stable. The SSB has likely fluctuated between 70,000 and 140,000 t during the assessment period (1993-2015), although those estimates are highly uncertain (coefficient of variation ≈ 40%, Figure F-2), and the recruitment has averaged about 204 million fish annually during this period. Female SSB was estimated to be approximately 81,000 t (95% confidence interval 16,500 -145,000) in the terminal year of the assessment (2015), and stock depletion is estimated to be about 47% of unfished SSB.

2. The estimated current (2015) spawning potential ratio (SPR; the ratio of the expected lifetime reproductive potential of an average recruit with and without fishing) is 0.53, which corresponds to a relatively low exploitation level (*i.e.*, 1-SPR = 0.47). Instantaneous fishing mortality at age (F-at-age) is similar for both sexes through age 5, peaking at age 4 and declining to a low at age 6, after which males experience higher F-at-age than females up to age 13. Juvenile albacore (aged 2 to 4 years) comprised, on average, 70% of the annual catch during 1993-2015, reflecting the larger impact of the surface fisheries (primarily troll and pole-and-line), which catch juvenile fish, relative to longline fisheries, which catch mainly adult fish.

3. The Kobe plot (Figure F-3) depicts the status of the stock in relation to MSY-based and MSY proxy reference points from the base-case model. The plot is presented for illustrative purposes only, since the IATTC has not established biological reference points for north Pacific albacore. The ISC Working

Group concluded that the stock is likely not overfished at present, as there is little evidence from the assessment that fishing has reduced SSB below reasonable biomass-based reference points, including the limit reference point adopted by the WCPFC (20%$SSB_{F=0}$).

4. Under the base-case model, the point estimate of MSY is 132,072 t, and the point estimate of the spawning biomass that will the produce MSY (SSB_{MSY}) is 24,770 t. The ratio of current (2012-2014 average) *F* to *F* at the MSY level (F_{MSY}) is estimated to be 0.61, indicating that overfishing is not occurring. That ratio is also below the 2002-2004 level of 0.65 used as reference for IATTC conservation and management measures for North Pacific albacore
5. Two projections were conducted externally to the base case model to evaluate the impact of current *F* (2012-2014 average) and catch (2010-2014 average = 82,432 t) levels on female SSB during 2015-2025. The projections show that current *F* would reduce female SSB from about 81,000 t to 63,000 t (CI: 36,000 - 91,000 t) by 2025, with a 0.2 and <0.01% probability of being below the WCPFC limit reference point by 2020 and 2025, respectively. Catch would increase in 2017 and 2018, and then decline to about 60,000 t in 2024; on average, future catches would be below the 2010-2014 average. This result is most likely due to the low estimated recruitment in 2011, which would reduce female SSB beginning in 2015, the first year of the projection period. In contrast, current catch levels would reduce female SSB from about 81,000 t to 48,000 t (CI: 5,000 - 90,000 t) by 2025, and increase the probability that female SSB will be below the WCPFC reference point to about 3.5 and 30% in 2020 and 2025, respectively. These probabilities may be higher in reality, because the future projections do not include all the uncertainties from the base case model. It should be noted that the constant catch scenario is inconsistent with the current IATTC and WCPFC management approaches for north Pacific albacore.
6. The Working Group concluded that the north Pacific albacore stock is likely not overfished and not experiencing overfishing, based on several potential reference points. The current level of fishing mortality ($F_{2012\text{-}2014}$) is estimated to be below that of $F_{2002\text{-}2004}$, which had led previously to conservation and management measures for the stock (IATTC Resolutions C-05-02 and C-13-03 and WCPFC CMM 2005-03). There is no evidence that fishing has reduced SSB below the WCPFC limit reference point, and population dynamics in the north Pacific albacore stock are largely driven by recruitment, which is affected by both environmental changes and the stock-recruitment relationship. The Working Group concluded that the north Pacific albacore stock is healthy, and that current productivity is sufficient to sustain recent fishing mortality levels, assuming average historical recruitment in both the short and long term.
7. The Working Group noted that the lack of sex-specific size data, uncertainty in the estimates of growth and natural mortality, and the simplified treatment of the spatial structure of north Pacific albacore population dynamics are important sources of uncertainty in the assessment.

The Working Group is currently undertaking a Management Strategy Evaluation (MSE) for the North Pacific albacore stock with the assistance of an analyst recently hired by the United States. An overview of the MSE work was presented during the 9th Meeting of the Scientific Advisory Committee in May 2018.

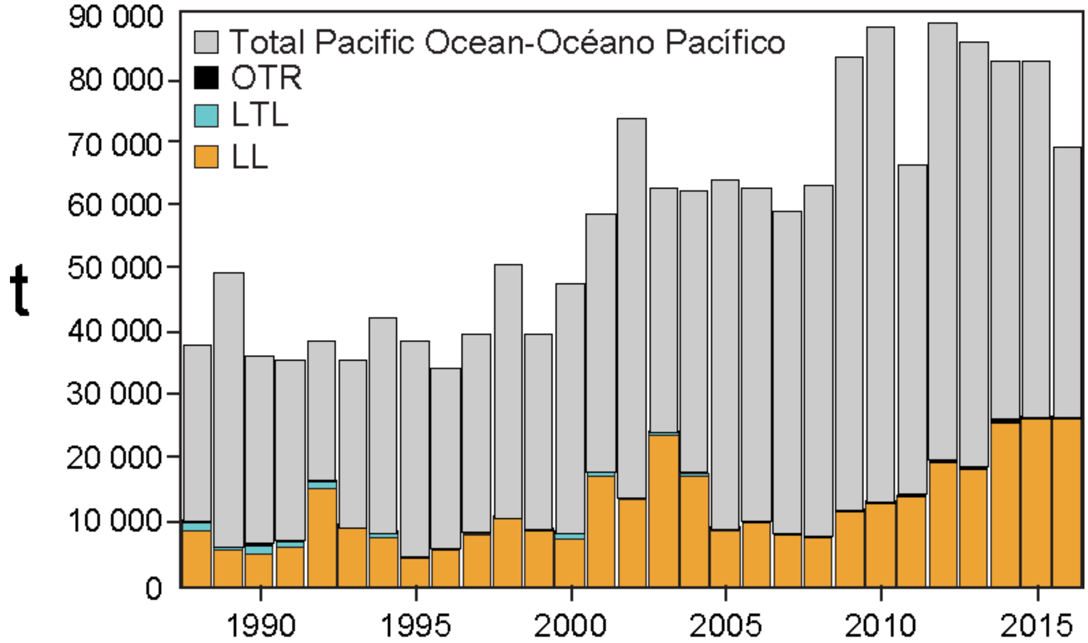

FIGURE F-1a. Retained catches of South Pacific albacore. The catches from the EPO are broken down by gear.
FIGURA F-1a. Capturas retenidas de albacora del Pacífico sur. Las capturas del OPO están desglosadas por arte.

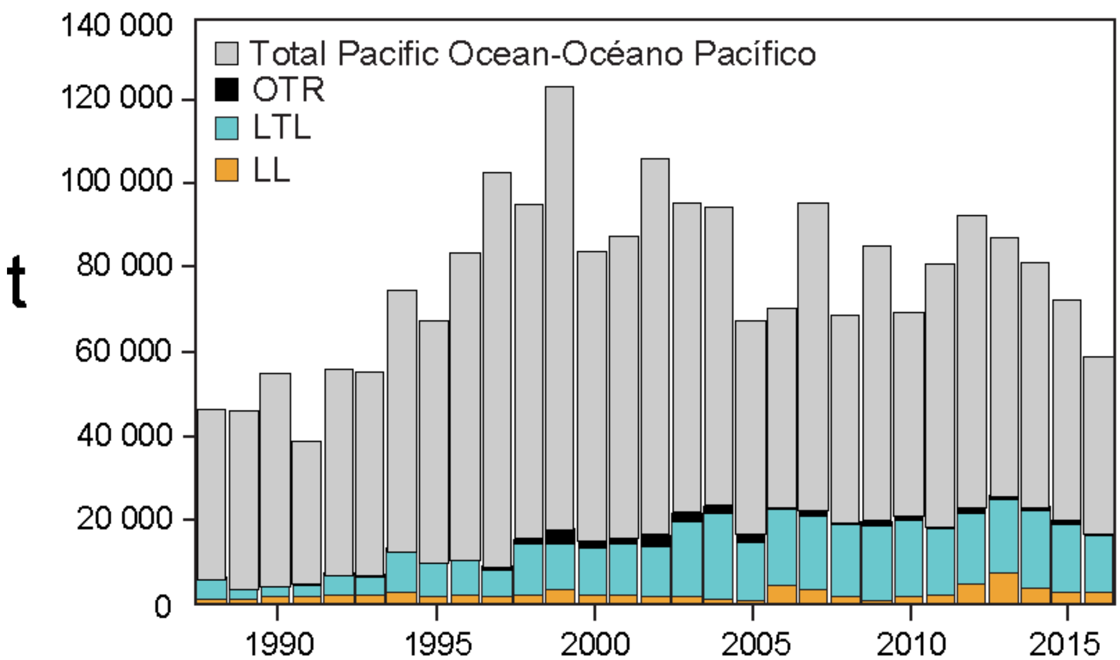

FIGURE F-1b. Retained catches of North Pacific albacore. The catches from the EPO are broken down by gear.
FIGURA F-1b. Capturas retenidas de albacora del Pacífico norte. Las capturas del OPO están desglosadas por arte.

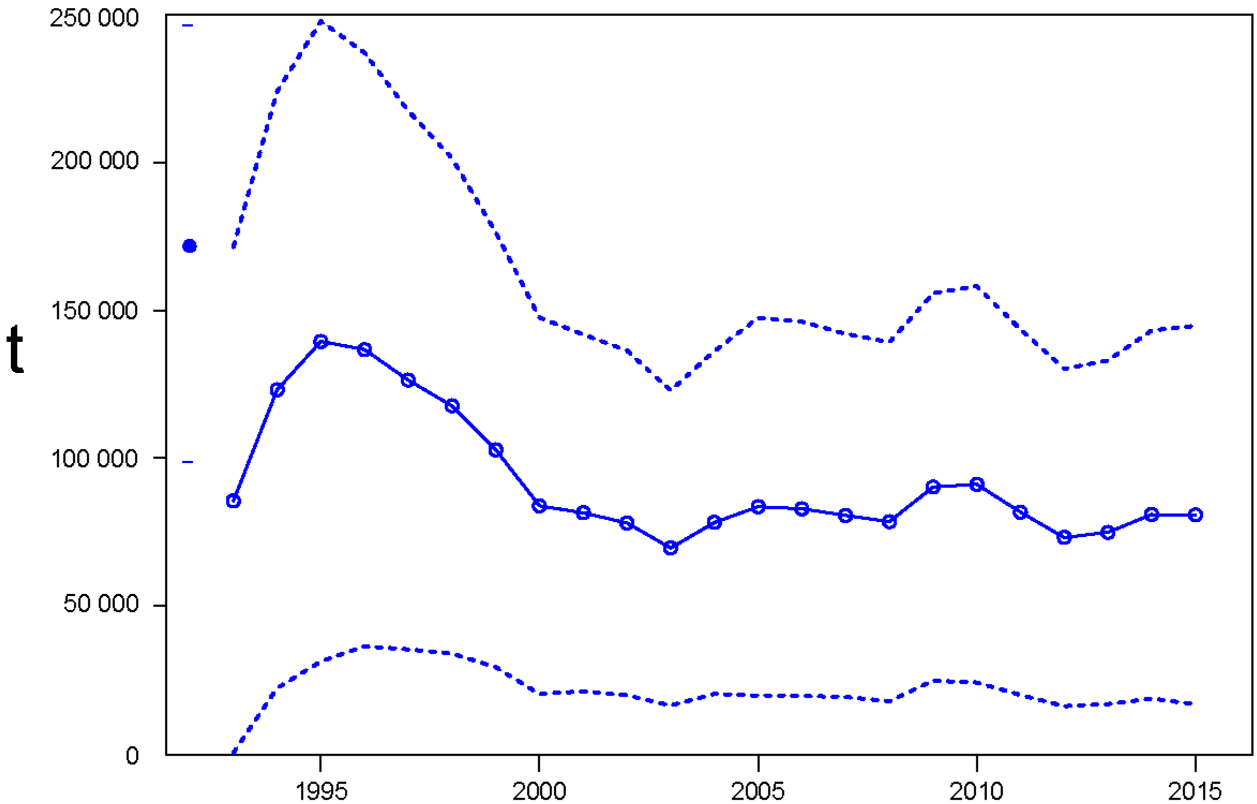

FIGURE F-2. Spawning stock biomass of North Pacific albacore tuna estimated from the North Pacific albacore base-case model for the 2017 stock assessment (point estimate and 95% confidence interval).
FIGURA F-2. Biomasa de la población reproductora del atún albacora del Pacífico norte, estimada del modelo de caso base de la evaluación de 2017 (estimación puntual e intervalo de confianza de 95%).

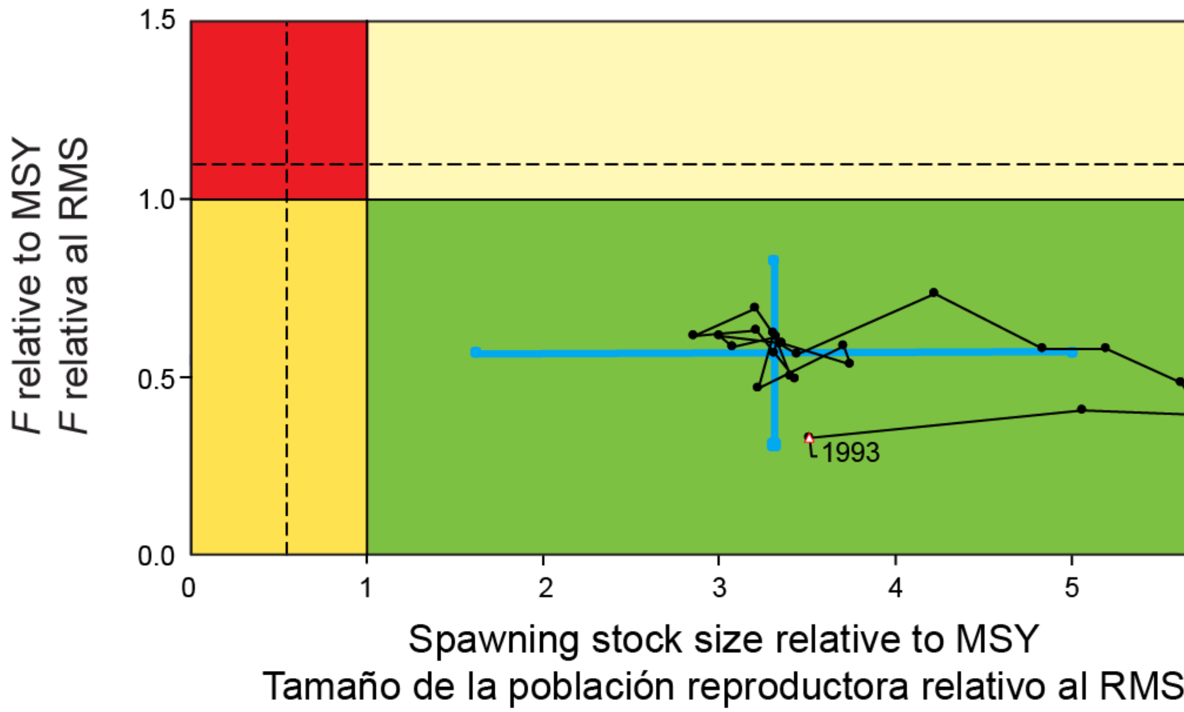

FIGURE F-3. Kobe (phase) plot for the North Pacific albacore stock from the base-case assessment model (which assumes a steepness value of 0.9). The *F* proxy is computed as (1-(Spawning biomass per recruit [year] / Spawning biomass per recruit [virgin])). The limit and target reference points are those proposed by the IATTC staff and are included here for illustrative purposes. The solid lines represent the proposed target reference point.The dashed lines represent the proposed limit reference points. The limit biomass reference point corresponds to a depletion level that causes a 50% reduction in recruitment from its average unexploited level based on a conservative steepness value (h = 0.75). The limit fishing mortality reference point corresponds to the fishing mortality that will drive the population to the limit biomass reference point. The squares around the most recent estimate represent its approximate 95% confidence interval. The triangle is the first estimate (1993).

FIGURA F-3. Gráfica de Kobe (fase) para la población de atún albacora del Pacífico norte del modelo de evaluación de caso base (que supone un valor de inclinación de 0.9). Se computa la aproximación de *F* como (1-(Biomasa reproductora por recluta [año] / Biomasa reproductora por recluta [virgen])). Los puntos de referencia límite y objetivo son los propuestos por el personal de la CIAT, y se incluyen aquí con fines ilustrativos. Las líneas de trazos representan los puntos de referencia límite propuestos Las líneas de trazos representan los puntos de referencia límite propuestos. El punto de referencia límite basado en biomasa corresponde a un nivel de merma que causa una reducción de 50% del reclutamiento relativo a su nivel medio sin explotación basado en un valor cauteloso de la inclinación (h = 0.75). El punto de referencia límite basado en mortalidad por pesca corresponde a la mortalidad por pesca que impulsará a la población al punto de referencia límite basado en biomasa. Los cuadrados alrededor de la estimación más reciente representan su intervalo de confianza de 95% aproximado. El triángulo es la primera estimación (1993).

G. SWORDFISH

Swordfish (*Xiphias gladius*) occur throughout the Pacific Ocean between about 50°N and 50°S. They are caught mostly by the longline fisheries of Far East and Western Hemisphere nations. Lesser amounts are taken by gillnet and harpoon fisheries. They are seldom caught by recreational fishermen.

Swordfish grow in length very rapidly, with both males and the faster-growing females reaching lower-jaw-fork lengths of more than a meter during their first year. Swordfish begin reaching maturity at about two years of age, when they are about 150 to 170 cm in length, and by age four all are mature. They probably spawn more than once per season. For fish greater than 170 cm in length, the proportion of females increases with increasing length.

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

The stock structure of swordfish in the Pacific is fairly well known. A number of specific regions of spawning are known, and analyses of fisheries and genetic data suggest that there is only limited exchange of swordfish between geographical areas, including between the eastern and western, and the northern and southern, Pacific Ocean.

The best available scientific information from genetic and fishery data indicate that the swordfish of the northeastern Pacific Ocean (NEPO) and the southeastern Pacific Ocean (SEPO: south of about 5°S) constitute two distinct stocks. Also, there may be occasional movement of a northwestern Pacific stock of swordfish into the EPO at various times. However, recent electronic tagging of 47 swordfish off the southern California coast suggests that there may be more mixing of fish between northern and southern regions of the EPO—and possibly eastern and western—than previously thought. To this point, however, assessments of eastern Pacific stocks did not include parameters for movements among these or other stocks.

The results of an assessment of a North Pacific swordfish stock in the area north of 10°N and west of 140°W indicate that the biomass level has been stable and well above 50% of the unexploited levels of stock biomass, indicating that these swordfish are not overexploited at current levels of fishing effort. A more recent analysis for the Pacific Ocean north of the equator, using a sex-specific age-structured assessment method, indicated that, at the current level of fishing effort, there is negligible risk of the spawning biomass decreasing to less than 40% of its unfished level. A stock assessment of the North Pacific stock is being undertaken by the ISC and will be completed sometime in 2018.

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

The most recent assessment of the stock of swordfish in the southwestern EPO was conducted with Stock Synthesis, using data that were updated as of 22 April 2011. Key results from that assessment were (1) that the swordfish stock in the southeast Pacific Ocean is not experiencing overfishing and is not overfished; (2) that the spawning biomass ratio is about 1.45, indicating that the spawning biomass is about 50 percent above the carrying capacity, and substantially above the level which is expected to produce catch at the MSY level; (3) that the recent catch levels (Figure G-2) over the past 5 years (29,293 t in 2016) were at levels at about MSY (~25,000 t); and (4) that there has been a recent series of high recruitments to the swordfish stock. There is no indication of a significant impact of fishing on this stock. The results of the assessment did suggest an expansion of the fishery onto components of the stock that were previously not, or were only lightly, exploited. This has subsequently been shown in a metadata analysis of the EPO longline fishery data (SAC-08-07b), whereby longline effort has steadily increased from 111 million hooks in 2008 to 174 million hooks in 2016.

In the northern EPO the annual longline fishing effort, though recently increasing from about 23.7 million hooks in 2007 to about 43.9 million in 2011, remains significantly below the 2001-2003 average of 70.4 million hooks. Since about 2006 the catch of swordfish has remained directly proportional to longline fishing effort. Considering the continuing relatively low fishing effort and the direct response of catch to effort, at the current level of fishing effort there is negligible risk of the spawning biomass decreasing to less than 40% of its unfished level.

In the southern EPO catches have been steadily increasing since about 2005, and recent average annual catches over the past 5 years (27,098 t) exceed the estimated MSY.

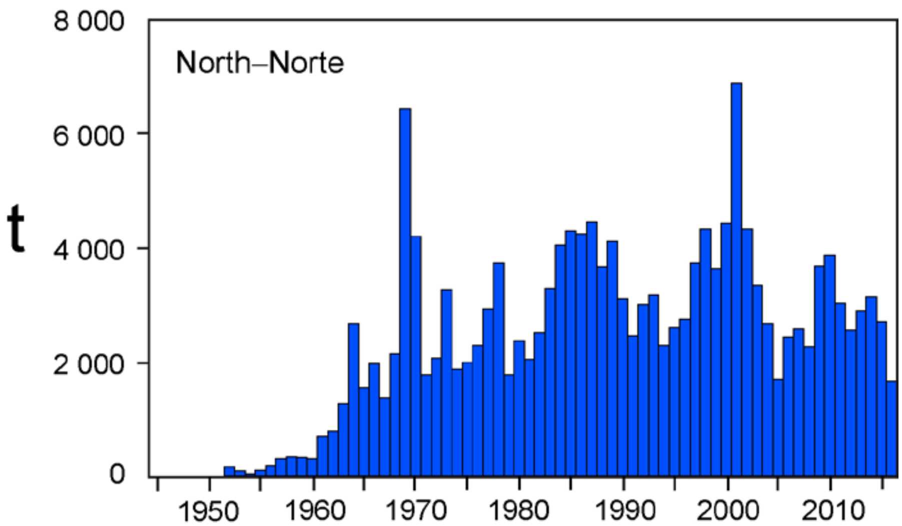

FIGURE G-1. Retained catches of swordfish in the northeastern Pacific Ocean.
FIGURA G-1. Capturas retenidas de pez espada en el Océano Pacífico noreste.

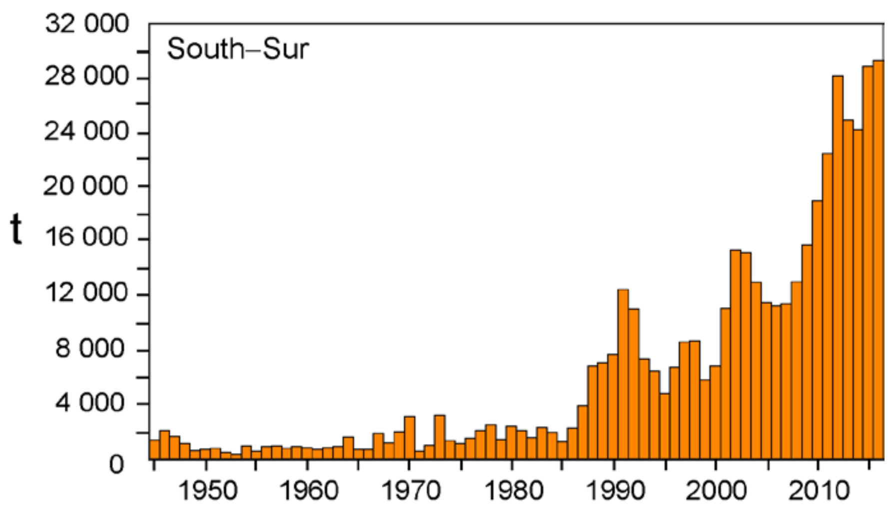

FIGURE G-2. Retained catches of swordfish in the southeastern Pacific Ocean
FIGURA G-2. Capturas retenidas de pez espada en el Océano Pacífico sudeste.

H. BLUE MARLIN

The best information 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.

Blue marlin are taken mostly in longline fisheries for tunas and billfishes between about 30°N and 30°S. Lesser amounts are taken by recreational fisheries and by various other commercial fisheries.

Small numbers of blue marlin have been tagged with conventional dart tags, mostly by recreational fishers. A few of these fish have been recaptured long distances from the locations of release. Blue marlin have been tagged with electronic pop-off satellite tags (PSATs) which collected data over periods of about 30-180 days, mostly in the Gulf of Mexico and the Atlantic Ocean, in studies of post-release survival and movement. More recently such studies have been undertaken in the Pacific Ocean.

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 at which the temperatures are within 1° to 2° of the SSTs.

The most recent full assessment of the status and trends of the species was conducted in 2013, and included data through 2011. It indicated that blue marlin in the Pacific Ocean were fully exploited, *i.e*. that the population was being harvested at levels producing catches near the top of the yield curve. Over the past five years however, annual catches have increased slightly in the EPO, averaging 4,360 t per year, indicating that catches may currently be exceeding MSY.

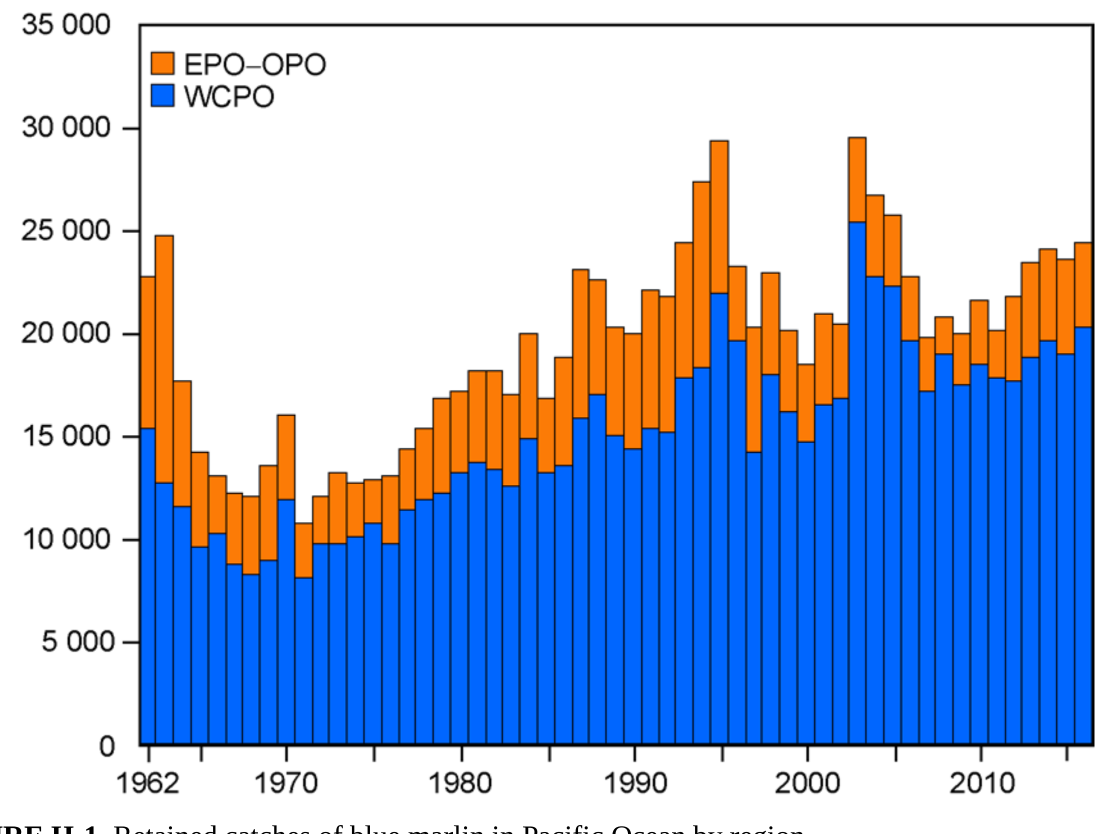

FIGURE H-1. Retained catches of blue marlin in Pacific Ocean by region.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, por región.

I. STRIPED MARLIN

Striped marlin (*Kajikia audax*) occur throughout the Pacific Ocean between about 45°N and 45°S. The assessment on which this report is based is for the stock of striped marlin in the eastern Pacific Ocean (EPO) north of 10°S, east of about 145°W north of the equator, and east of about 165°W south of the equator. Although not included in the assessment model, there may be limited exchange of fish between this stock and stocks in adjacent regions.

Significant effort has been devoted to understanding the stock structure of striped marlin in the Pacific Ocean, which is moderately well known. It is clear that there are a number of stocks. Information on movements is limited: striped marlin tagged with conventional dart tags and released off the tip of Baja California were generally recaptured near where they were tagged, but some were recaptured around the Revillagigedo Islands, a few around Hawaii, and one near Norfolk Island, off Australia. Tagging studies in the Pacific, using pop-off satellite tags, indicated that there is essentially no mixing among tagging areas, and that striped marlin maintain site fidelity. Analyses of fisheries and genetic data indicate that the northern EPO is home to a single stock, though there may be a seasonal low-level presence of juveniles from a more westerly Hawaii/Japan stock.

Historically, the majority of the catch in the EPO was taken by longline fisheries, which began expanding into the EPO in the mid-1950s, and extended throughout the region by the late 1960s. Except for a few years in the late 1960s to early 1970s in the northern EPO, these fisheries did not target billfish. More recently, catches by recreational fisheries have become important, although most fish caught are released (Figure I-1).

Fishing by artisanal longline vessels targeting tuna and other species off Central America, for which catch data are not available, appears to have increased at least over the past decade. The shifting patterns of areas fished and targeting practices increase the difficulties encountered when using fisheries data in analyses of stock status and trends. These difficulties are exacerbated when analyzing species which are not principal targets of the fishery, and further exacerbated when the total catch of the species by all fisheries is not known.

The last full assessment of striped marlin was conducted in 2008, using Stock Synthesis, and later updated with data to 30 October 2010. Key results were that (1) the stock is not overfished; (2) overfishing is not occurring; (3) the spawning stock biomass has been increasing, and is above the level that will support the MSY; and (4) average annual catches during 2013–2017 (2,109 t) have remained at about half the MSY catch level. If fishing effort and catches continue at the 2010 level (2,161 t), it is expected that the biomass of the stock will continue to increase over the near term.

The fishing effort by large longline vessels in the northern EPO has increased by about 20% since 2010, but the catch of striped marlin has remained largely unchanged. The ISC plans to complete a full assessment of the North Pacific stock of striped marlin in 2019.

The recreational fishery is believed to take most of the catch of striped marlin in the northern EPO. However, the most recent catch report was for 1990-2007, with preliminary data for 2008, and this paucity of data probably means that the catches of striped marlin in the EPO have been significantly underestimated since 2008. Also, it appears that catches of billfishes, including striped marlin, by the artisanal longline fishery operating off Central America are not reported, at least not to the IATTC. Therefore, the total catch of striped marlin in the EPO, and thus the total impact of fishing on the stock since about 2008-2009, are not known.

Efforts continue to obtain reliable catch data from all fisheries. Until the data are available and updated, and a review of the status of striped marlin in the EPO is completed, it is recommended that, as a precautionary measure, fishing effort by fisheries that take the majority of the striped marlin catch in the EPO not be increased.

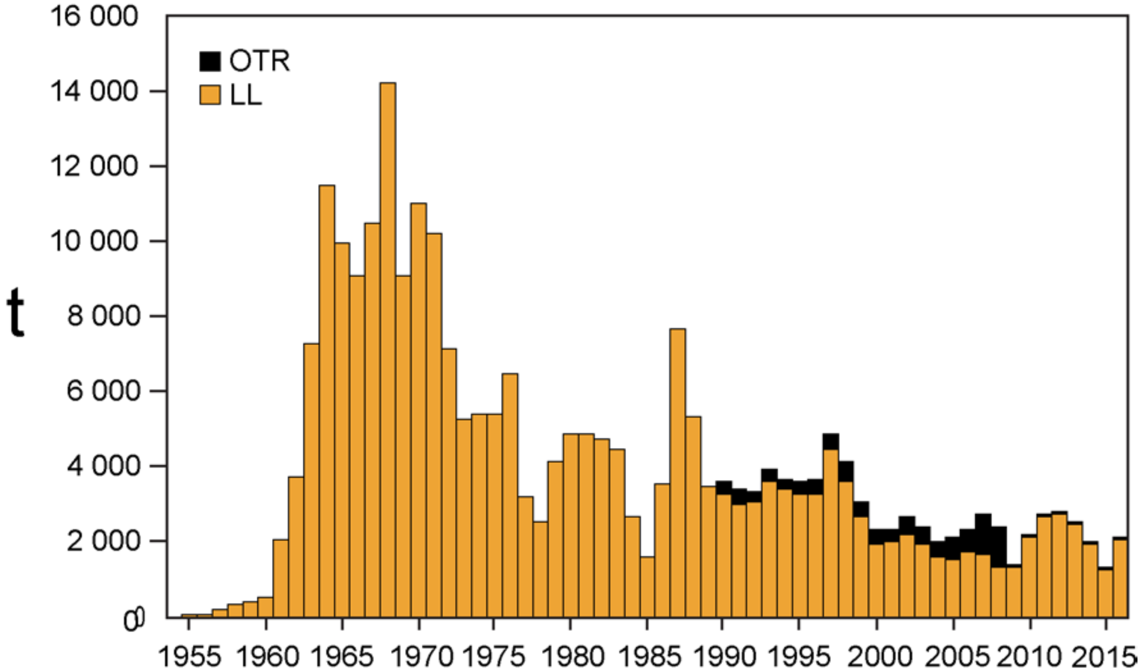

FIGURE I-1. Landings of striped marlin from the northern EPO by longline and recreational fisheries, 1954-2016. Due to unreported catches by recreational fisheries, estimates for 2009-2016 are minimums.
FIGURA I-1. Descargas de marlín rayado del OPO norte por las pesquerías palangreras y recreativas, 1954-2016. Debido a capturas no reportadas por pesquerías recreativas, las estimaciones de 2009-2016 son mínimos.

J. SAILFISH

The stock structure of sailfish (*Istiophorus platypterus*) in the Pacific Ocean is well known. The species is most abundant in waters relatively near the continents and the Indo-Pacific land masses bordering the Pacific, and infrequent in the high seas separating them. The populations in the EPO and in the western Pacific are genetically distinct.

The centers of sailfish distribution along the coast of the Americas shift in response to seasonal changes in surface and mixed-layer water temperature. Sailfish are found most often in waters warmer than about 28°C, and are present in tropical waters nearer the equator in all months of the year. Spawning takes place off the coast of Mexico during the summer and fall, and off Costa Rica during winter, and perhaps year-round in areas with suitable conditions. The sex ratio is highly skewed towards males during spawning. The known shifts in sex ratios among spawning areas, and the spatial-temporal distributions of gonad indices and size-frequency distributions, which show smaller fish offshore, suggest that there may be maturity-dependent patterns in the distribution of the species in the EPO. Sailfish can reach an age of about 11 years in the EPO.

The principal fisheries that capture sailfish in the EPO include the large-scale tuna longline fishery primarily consisting of China, Chinese Taipei, Japan, and Korea; the smaller-vessel longline fisheries targeting tuna and other species, particularly those operating off Central America; and the artisanal and recreational fisheries of Central and South America. Sailfish are also taken occasionally in the purse-seine fisheries targeting tropical tunas.

The first assessment of sailfish in the EPO was conducted in 2013. Initial analyses indicated that either this stock had uncharacteristically low productivity and high standing biomass, or—more probably—that a large amount of catch was missing in the data compiled for the assessment. We were unable to identify a means to satisfactorily estimate this catch in order to obtain reliable estimates of stock status and trends using Stock Synthesis, the preferred model for assessments. As a result, the assessment was conducted using a surplus production model, which provided results consistent with those obtained with Stock Synthesis and simplified the illustration of the issues in the assessment.

Key results:

1. It is not possible to determine the status of the sailfish stock in the EPO with respect to specific management parameters, such as maximum sustained yield (MSY), because the parameter estimates used in making these determinations in this case cannot be derived from the model results.
2. Sailfish abundance trended downward over 1994-2009, since when it has been relatively constant or slightly increasing (Figure J-1).
3. Recent reported annual catches are on the order of 500 t (Figure J-2), significantly less than the 1993-2007 average of about 2,100 t.
4. Model results suggest that there are significant levels of unreported catch, and the actual catch in earlier years was probably higher than those reported for 1993-2007. Assuming that this level of harvest has existed for many years, it is expected that the stock condition will not deteriorate if catch is not increased above current levels.
5. A precautionary approach that does not increase fishing effort directed at sailfish, and that closely monitors catch until sufficient data are available to conduct another assessment, is recommended.
6. A reliable assessment of the sailfish resources in the EPO cannot be obtained without reliable estimates of catch. It is therefore recommended that:
    a. historical data on catches of sailfish be obtained wherever possible
    b. fisheries currently reporting sailfish catches commingled with other species be required to report

catches by species.

c. existing data from small-scale fisheries, such as local longline fleets, artisanal and recreational fisheries, be compiled and that, where necessary, catch monitoring programs to identify catches by species be implemented.

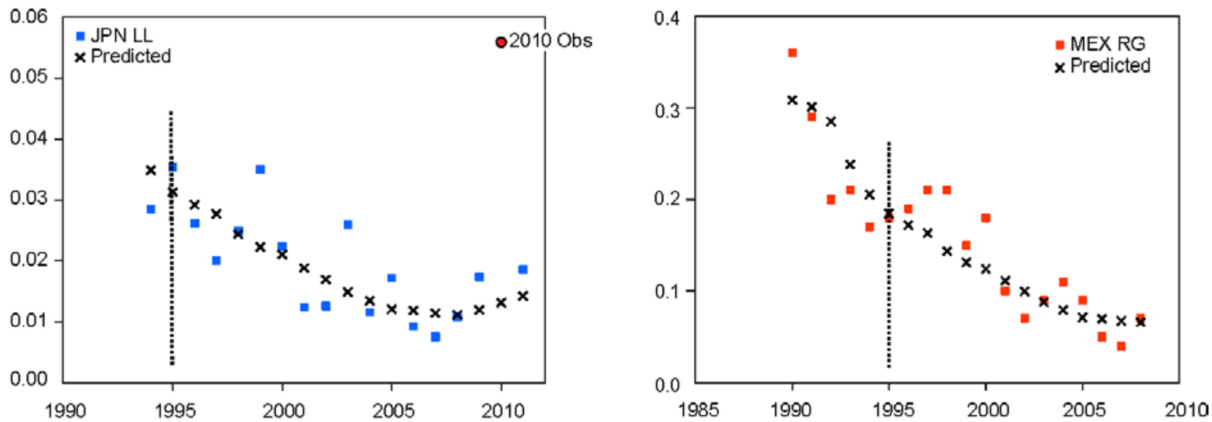

FIGURE J-1. Observed and predicted indices of relative abundance of sailfish in the EPO from Japanese longline (JPN LL) and Mexican recreational (MEX RG) fisheries. The 2010 observation in the JPN LL series was not included in the analyses.
FIGURA J-1. Indices observados y predichos de abundancia relativa del pez vela en el OPO, basados en las pesquerías palangrera japonesa (JPN LL) y recreacional mexicana (MEX RG). No se incluyó en los análisis la observación de 2010 en la serie JPN LL.

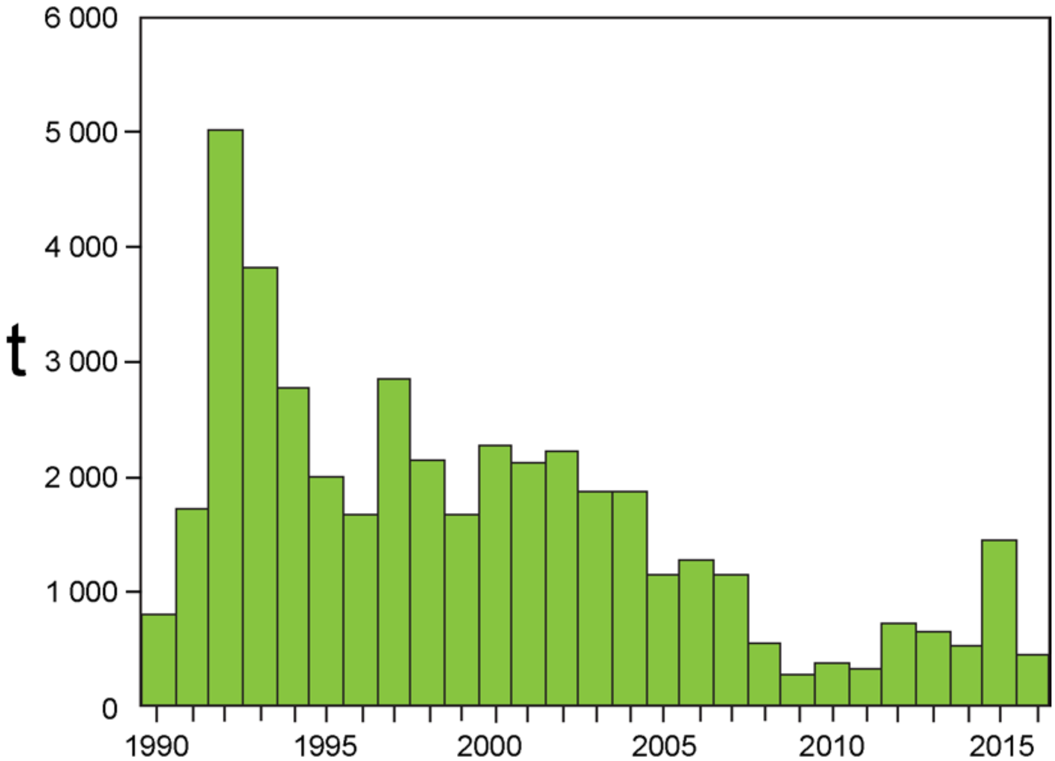

FIGURE J-2. Total reported catches of sailfish in the EPO, 1990-2016. The actual catches were probably greater.
FIGURA J-2. Capturas totales reportadas de pez vela en el OPO, 1990-2016. (Las capturas reales son probablemente mayores).

K. SILKY SHARK

Updated stock status indicators for silky sharks in the eastern Pacific Ocean (1994-2016)

An attempt by the IATTC staff in 2013 to assess the status of the silky shark (*Carcharhinus falciformis*) in the eastern Pacific Ocean (EPO), using conventional stock assessment models, was severely handicapped by major uncertainties in the fishery data, mainly regarding total catch levels in the early years for all fisheries operating in the EPO that caught silky sharks (SAC-05 INF-F). Although this stock assessment attempt produced a substantial amount of new information about the silky shark in the EPO (*e.g*., absolute and relative magnitude of the catch by different fisheries, and their selectivities), the absolute scale of population trends and the derived management quantities were compromised. Since a conventional stock assessment was not possible, in 2014 the staff proposed a suite of possible stock status (or stability) indicators (SSIs) which could be considered for managing the silky sharks in the EPO (SAC-05-11a), including standardized catch-per-set indices from the purse-seine fishery. Document SAC-09-13 presents an update of the purse-seine indices through 2017.

Following previous methodology, indices for the silky shark based on data from sets on floating objects were computed for the north and south EPO (north and south of the equator, respectively). In both the north and south EPO, the indices for large silky sharks and for all silky sharks were similar, or increased slightly, relative to their 2016 values, while the indices for medium and small silky sharks were similar, or decreased slightly, relative to their 2016 values (Figure K-1). Work subsequent to SAC-08-08a(i) supported the previous conclusions that the north EPO indices, particularly the small silky shark index, are influenced by inter-annual variability in ocean-climate forcing, and are therefore potentially biased as indicators of stock status. Future work (Project H.5.a) will attempt to adapt the current catch-per-set standardization methodology to develop indices that are less influenced by such variability, with emphasis on the indices for large silky sharks.

The IATTC staff reiterates its previous recommendation (SAC-07-06b(i), SAC-07-06b(iii)) that improving shark fishery data collection in the EPO is critical. This will facilitate the development of other stock status indicators and/or conventional stock assessments to better inform the management of the silky shark and other co-occurring shark species. Spatiotemporal models that combine data from multiple gear types to improve spatial coverage should also be explored in the future, to facilitate modeling efforts once data from other sources become available.

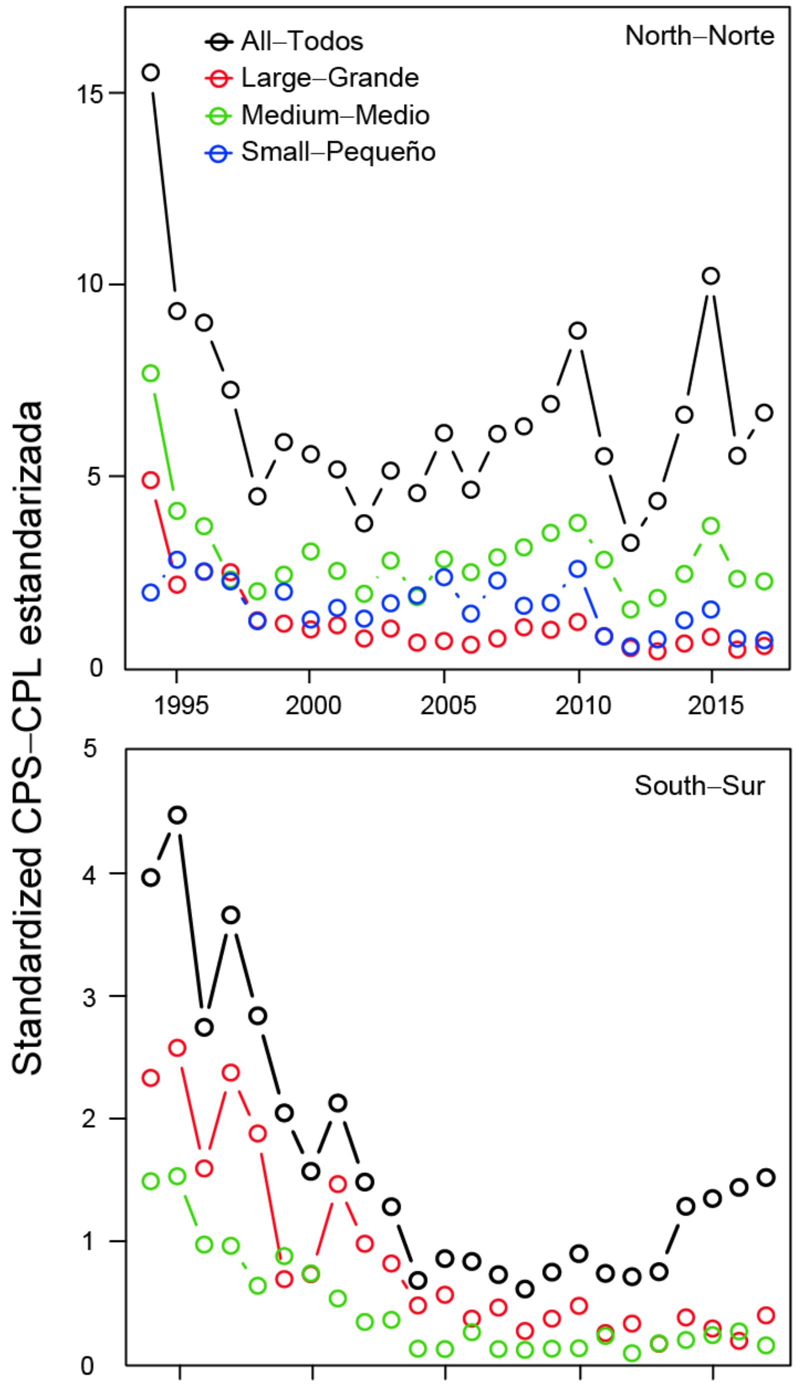

FIGURE K-1. Standardized catch-per-set (CPS; in numbers of sharks per set) of silky sharks in sets on floating objects, for the three size categories (small, medium, large), and all sizes combined, in the north (top) and south (bottom) EPO.

FIGURA K-1. Captura por lance (CPL, en número de tiburones por lance) estandarizada de tiburones sedosos en lances sobre objetos flotantes, por categoría de talla (pequeño, mediano, grande) y todas las tallas combinadas, en el OPO norte (arriba) y sur (abajo).

L. ECOSYSTEM CONSIDERATIONS

1. INTRODUCTION

The 1995 FAO Code of Conduct for Responsible Fisheries stipulates that "States and users of living aquatic resources should conserve aquatic ecosystems" and that "management measures should not only ensure the conservation of target species, but also of species belonging to the same ecosystem or associated with or dependent upon the target species"[2]. In 2001, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem elaborated these principles with a commitment to incorporate an ecosystem approach into fisheries management.

Consistent with these instruments, one of the functions of the IATTC under the 2003 Antigua Convention is to "adopt, as necessary, conservation and management measures and recommendations for species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by this Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened".

Consequently, the IATTC has recognized ecosystem issues in many of its management decisions since 2003. This report provides a brief summary of what is known about the direct and indirect impacts of tuna fisheries in the eastern Pacific Ocean (EPO) on the populations of species and ecological functional groups and the structure of the ecosystem, as controlled by the strength of predator-prey interactions.

This report does not suggest objectives for the incorporation of ecosystem considerations into the management of fisheries for tunas or billfishes, nor any new management measures. Rather, its main purpose is to demonstrate that the Commission considers the ecological sustainability of the fisheries which it manages.

However, the view that we have of the ecosystem is based on the recent past; there is almost no information available 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 (PDO) and other climate-related changes.

In addition to reporting the catches of the principal species of tunas and billfishes, the staff estimates catches (retained and discarded) of non-target species. In this report, data on those species are presented in the context of the effect of the fishery on the ecosystem. While relatively good information is available for catches of tunas and billfishes across the entire fishery, this is not the case for bycatch species. The information is comprehensive for large[3] purse-seine vessels that carry observers under the Agreement on

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[2] The Code also provides that management measures should ensure that "biodiversity of aquatic habitats and ecosystems is conserved and endangered species are protected", and that "States should assess the impacts of environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks, and assess the relationship among the populations in the ecosystem."

[3] Carrying capacity greater than 363 t

the International Dolphin Conservation Program (AIDCP), and some information on retained catches is also reported for other purse-seine vessels, and much of the longline fleet (see SAC-08-07b). There is little information available on bycatches and discards by fishing vessels that use other gear types (*e.g.* gillnet, harpoon, and recreational gear (see SAC-07-INF-C(d))).

Detailed information on past ecosystem studies can be found in documents for previous meetings of the Scientific Advisory Committee (*e.g.* SAC-08-07a), and current and planned ecosystem-related work by the IATTC staff is summarized in the Strategic Science Plan (SAC-09-01) and the Staff Activities and Research report (SAC-09-02).

2. IMPACT OF CATCHES

2.1. Single-species assessments

This report presents current information on the effects of the tuna fisheries on the stocks of individual species in the EPO. An ecosystem perspective requires a focus on how the fishery may have altered various components of the ecosystem. Sections 2.2 and 2.3 of this report refer to information on the current biomass of each stock. The influences of predator and prey abundances are not explicitly described. Sections 2.4-2.7 include estimates of catch data by vessels of the large purse-seine and large-scale longline (herein 'longline fisheries') fisheries reported to the IATTC.

Observer data were used to provide estimates of total catches (retained catches and discards) during sets by large purse-seine vessels in the EPO on floating objects (OBJ), unassociated schools (NOA), and dolphins (DEL).

Complete data are not available for small purse-seine, longline, and other types of vessels. There is considerable variability in reporting formats of longline data by individual CPCs through time, thereby limiting application of catch and effort data (SAC-08-07b, SAC-08-07d, SAC-08-07e). Some catches of non-target species by the tuna longline fisheries in the EPO are reported to the IATTC, but often in a highly summarized form (*e.g.* monthly aggregation of catch by broad taxonomic group (*e.g.* "Elasmobranchii")), often without verification of whether the reported catch has been raised to total catch (SAC-08-07b). Because of data limitations, catch data for longline fisheries were obtained using IATTC's 5°x5° catch tables following methods described in SAC-08-07b and SAC-08-07d. Such estimates must be regarded as minimum estimates only. However, due to the paucity of catch data in the IATTC longline database, a report on establishing minimum data standards and reporting requirements for longline observer programs was discussed at the Eighth Meeting of the SAC (SAC-08-07e). As data reporting improves, better estimations of catches by longline vessels will be available.

2.2. Tunas

Information on the effects of EPO fisheries on bigeye, yellowfin, and skipjack tunas is found in Documents SAC-09-05, 06, and 07, respectively. A report of the Bluefin Working Group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) and outcomes of the Joint Tuna RFMO meeting of Pacific bluefin tuna were presented at the Ninth Meeting of the SAC. The ISC Northern Albacore Working Group completed its stock assessment in 2017, and an update on management strategy evaluation (MSE) work on north Pacific albacore tuna was also presented at SAC-09.

Preliminary estimates of the catches of tunas and bonitos in the EPO during 2017 are found in Table A-2a of Document SAC-09-03.

2.3. Billfishes

Information on the effects of the tuna fisheries on swordfish, blue marlin, striped marlin, and sailfish is presented in Sections G-J of IATTC Fishery Status Report 15. Stock assessments and/or stock structure analyses for swordfish (2007, structure), eastern Pacific striped marlin (2010, assessment and structure), northeast Pacific striped marlin (2011, assessment), southeast Pacific swordfish (2012, assessment), and eastern Pacific sailfish (2013, assessment) were completed by the IATTC staff. Stock assessments of striped marlin (2015), Pacific blue marlin (2016), and north Pacific swordfish (2017) were completed by the ISC Billfish Working Group.

No stock assessments have been conducted for black marlin and shortbill spearfish, although 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 show trends in catches, effort, and catches per unit of effort (CPUEs).

Preliminary estimates of the catches of billfishes in the EPO during 2017 are found in Table A-2b of Document SAC-09-03.

2.4. 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 EPO. Purse-seine fishermen commonly set their nets around herds of dolphins and the associated schools of yellowfin tuna, and then release the dolphins while retaining the tunas. Whilst the incidental mortality of dolphins in the fishery was high during the 1960s and 1970s, it decreased precipitously since the 1980s.

TABLE 2. Interactions and mortalities of sea turtles with large purse-seine vessels in the EPO, 2017 (preliminary data).

	Interactions				Mortalities			
	Set type			Total	Set type			Total
	OBJ	NOA	DEL		OBJ	NOA	DEL	
Olive Ridley	132	16	48	196	2	-	2	4
Eastern Pacific green	29	19	30	78	-	-	-	-
Loggerhead	9	19	1	29	-	-	-	-
Hawksbill	3	1	2	6	-	-	-	-
Leatherback	1	-	1	2	-	-	-	-
Unidentified	187	23	69	279	-	-	-	-
Total	**361**	**78**	**151**	**590**	**2**	**-**	**2**	**4**

Preliminary estimates of the incidental mortality of marine mammals in the fishery in 2017 are shown in Table 1, and estimates during 1993-2017 are shown in Figure L-1. Dolphin mortality rarely occurred in sets on unassociated tuna schools and on floating objects. Decreasing mortalities were observed for northeastern spotted dolphins, whitebelly spinner dolphins, western-southern spotted dolphins, central common dolphins, and other delphinidae. Numbers of mortalities were variable for northern common dolphins and eastern spinner dolphins, and those of southern common dolphins were generally less than 40 individuals, with the exception of peaks to 220 in 2004 and about 120 in 2008.

TABLE 1. Mortality of dolphins and other marine mammals caused by the fishery in the EPO, 2017 (preliminary data).

	Incidental mortality	
Species and stock	Numbers	t
Offshore spotted dolphin		
Northeastern	92	6.0
Western-southern	178	11.6
Spinner dolphin		
Eastern	266	11.8
Whitebelly	98	5.9
Common dolphin		
Northern	26	1.8
Central	9	0.6
Southern	16	1.1
Other mammals*	3	0.2
Total	**688**	**39.1**

*"Other mammals" includes the following species and stocks, whose observed mortalities were as follows: unidentified dolphins 2 (0.1 t) and striped dolphin (*Stenella coeruleoalba*) 1 (0.06 t).

2.5. 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. The mortality rates in the EPO industrial longline fishery are likely to be lowest in "deep" sets (around 200-300 m) targeting bigeye tuna, and highest in "shallow" sets (<150 m) for albacore and swordfish. In addition, there is a sizeable fleet of artisanal longline vessels that also impact sea turtles (see

Section 9.2).

TABLE 3. Catches, in tons, of sharks and rays in the EPO by large purse-seine vessels, by set type, 2017, and by longline vessels, 2016 (preliminary data). Longline data are considered to be minimum catch estimates due to incomplete data reporting (see section 2.1)

	Purse-seine				Long-line
	OBJ	NOA	DEL	Total	
Silky shark (*Carcharhinus falciformis*)	678	7	26	711	452
Oceanic whitetip shark (*C. longimanus*)	4	<1	<1	5	65
Hammerhead sharks (*Sphyrna* spp.)	21	6	2	28	34
Thresher sharks (*Alopias* spp.)	2	3	2	7	107
Mako sharks (*Isurus* spp.)	<1	<1	0	2	340
Other sharks	89	3	3	95	841
Blue sharks (*Prionace glauca*)	-	-	-	-	1,816
Manta rays (Mobulidae)	10	30	9	49	-
Pelagic stingrays (Dasyatidae)	<1	<1	<1	<1	-

Sea turtles are occasionally caught in purse seines in the EPO tuna fishery, generally when the turtles associate with floating objects, and are captured when the object is encircled. Also, sets on unassociated tunas or tunas associated with dolphins may capture sea turtles that happen to be at those locations. Sea turtles sometimes 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 olive Ridley turtle (*Lepidochelys olivacea*) is, by far, the species of sea turtle taken most often by purse seiners. It is followed by green sea turtles (*Chelonia mydas*) and, very occasionally, by loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles (Figure L-2). Since 1990, when IATTC observers began recording this information, only three mortalities of leatherback (*Dermochelys coriacea*) turtles have been recorded. 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.

Preliminary estimates of the mortalities and interactions (in numbers) of turtles in sets by large purse-seine vessels on floating objects (OBJ), unassociated tunas (NOA), and dolphins (DEL) during 2017, based on IATTC observer data, are shown in Table 2, and for 1993-2017 in Figure L-2. Data on sea turtle interactions or mortality were deficient for the longline fisheries (SAC-08-07b).

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

2.6. Sharks and rays

Sharks are caught as bycatch or targeted catch in EPO tuna longline and purse-seine fisheries as well as multi-species and multi-gear fisheries of the coastal nations.

Stock assessments or stock status indicators (SSIs) are available for only five shark species in the EPO: silky (*Carcharhinus falciformis*) (IATTC: SAC-05 INF-F, SAC-08-08a(i), SAC-09-13), blue (*Prionace glauca*) (ISC Shark Working Group), shortfin mako (*Isurus oxyrinchus*) (ISC Shark Working Group), common thresher (*Alopias vulpinus*) (NMFS), and bigeye thresher (*Alopias superciliosus*) (FAO Common Oceans Tuna Project). A Pacific-wide assessment of the porbeagle shark (*Lamna nasus*) in the southern hemisphere was completed in late 2017 as part of the FAO Common Oceans Tuna Project. Whale shark interactions with the tuna purse-seine fishery in the EPO are summarized in Document BYC-08 INF-A. The impacts of tuna fisheries on the stocks of other shark species in the EPO are unknown.

Preliminary estimates of the catches of sharks and rays reported by observers on large purse-seine vessels in the EPO during 2017 and minimum estimates of catches by longline vessels in 2016 are shown in Table 3.

Catches of sharks and rays in the purse-seine and longline fisheries during 1993-2017 are shown in Figure L-3. Silky sharks are the most commonly-caught species of shark in the purse-seine fishery. Shark catches were generally greatest in sets on floating objects (mainly silky, oceanic whitetip (*C. longimanus*), hammerhead (*Sphyrna* spp.) and mako (*Isurus* spp.) sharks), followed by unassociated sets and, at a much lower level, dolphin sets (Figure L-3). Until about 2007, thresher sharks (*Alopias* spp.) occurred mostly in unassociated sets (Figure L-3). Historically, oceanic whitetip sharks were commonly caught in sets on floating objects, but they became much less common after 2005. In general, the bycatch rates of manta rays (Mobulidae) and stingrays (Dasyatidae) are greatest in unassociated sets, followed by dolphin sets, and lowest in floating-object sets, although catches by set type can be variable (Figure L-3). The numbers of purse-seine sets of each type in the EPO during 2002-2017 are shown in Table A-7 of Document SAC-09-03.

The reported longline catches of sharks increased sharply after 2008 with catches of silky, oceanic whitetip, and hammerhead sharks declining thereafter. Catches of thresher, mako, and blue sharks increased through 2016. These data should be interpreted with caution due to limitations in data-reporting requirements for non-target species caught in the longline fishery resulting from Resolutions C-03-05 and C-11-08 and documented in SAC-08-07b.

The small-scale artisanal longline fisheries of the coastal CPCs target sharks, tunas, billfishes and dorado (*Coryphaena hippurus*), and some of these vessels operate in areas beyond coastal waters and national jurisdictions[4]. However, essential shark data from longline fisheries is lacking, and therefore conventional stock assessments and/or stock status indicators cannot be produced (see data challenges outlined in SAC-07-06b(iii)). A project is underway to improve data collection on sharks, particularly for Central America, for the artisanal longline fleet through funding from the Food and Agriculture Organization of the United Nations (FAO) and the Global Environmental Facility (GEF) under the framework of the ABNJ Common Oceans program (SAC-07-06b(ii), SAC-07-06b(iii)). Data obtained from this project may be included in future iterations of the Ecosystem Considerations report to provide better estimates of sharks caught by the various longline fleets.

TABLE 4. Catches, in tons, of large fish species commonly caught in the EPO by large purse-seine vessels, by set type, 2017, and by longline vessels, 2016. Longline data are considered to be minimum catch estimates due to incomplete data reporting (see section 2.1)

	Purse-seine				Longline
	OBJ	NOA	DEL	Total	
Dorado (*Coryphaena* spp.)	1,865	12	<1	1,877	184
Wahoo (*Acanthocybium solandri*)	368	1	<1	368	243
Rainbow runner (*Elagatis bipinnulata*) & yellowtail (*Seriola lalandi*)	37	24	-	61	-
Pomfrets (Bramidae)	-	-	-	-	98
Opahs (*Lampris* spp.)	-	-	-	-	640

2.7. Other large fishes

Preliminary estimates of the catches of dorado (*Coryphaena* spp.) and other large fishes in the EPO by large purse-seine vessels during 2017 are shown in Table 4, along with minimum estimates from longline data in 2016. Catch trends for the most important species during 1993-2017, by set type and fishery, are shown in Figure L-4.

Dorado is the most commonly reported fish species caught incidentally in the EPO purse-seine tuna fishery. It is also one of the most important species caught in the artisanal fisheries of the coastal nations of the EPO, leading to an exploratory stock assessment (SAC-07-06a(i)) and management strategy evaluation

[4] Martínez-Ortiz, J., Aires-da-Silva, A.M., Lennert-Cody, C.E., Maunder, M.N. 2015. The Ecuadorian artisanal fishery for large pelagics: species composition and spatio-temporal dynamics. PLoS ONE 10(8): e0135136.

(MSE) in the south EPO (SAC-07-06a(ii)).

Around 2006 sharp increases were observed in longline catches of dorado, wahoo, pomfrets and opahs, although this may be related to changes in data reporting. Purse-seine catches of dorado, wahoo, rainbow runner, and yellowtail were variable, and occurred primarily in sets on floating objects.

3. OTHER FAUNA

3.1. Seabirds

There are approximately 100 species of seabirds in the tropical EPO. Some of them associate with epipelagic predators, such as fishes (especially tunas) and marine mammals, near the ocean surface. Feeding opportunities for some seabird species are dependent on the presence of tuna schools feeding near the surface. Most species of seabirds take prey, mainly squid (primarily Ommastrephidae), within half a meter of the surface, or in the air (flyingfishes, Exocoetidae). Subsurface predators, such as tunas, often drive prey to the surface to trap it against the air-water interface, where it becomes available to the birds, which also feed on injured or disoriented prey, and on scraps of large prey.

Some seabirds, especially albatrosses (waved (*Phoebastria irrorata*), black-footed (*P. nigripes*), Laysan (*P. immutabilis*), and black-browed (*Thalassarche melanophrys*)) and petrels, are susceptible to being caught on baited hooks in pelagic longline fisheries. 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 those vessels' fishing operations. Data from the US pelagic longline fishery in the north EPO indicate that bycatches of black-footed and Laysan albatrosses occur.

The IATTC has adopted two measures on seabirds (section 9.3); also, the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and BirdLife International have updated their maps of seabird distribution in the EPO, and have recommended guidelines for seabird identification, reporting, handling, and mitigation measures (SAC-05 INF-E, SAC-07-INF-C(d), SAC-08-INF-D(a), SAC-08-INF-D(b), SAC-08-INF-D(d)). Additionally, ACAP has reported on the conservation status for albatrosses and large petrels (SAC-08-INF-D(c)).

Data pertaining to interactions with seabirds is deficient in the IATTC longline database(SAC-08-07b).

3.2. Forage species

A large number of taxa occupying the middle trophic levels in the EPO ecosystem—generically referred to as "forage" species—play a key role in providing a trophic link between primary producers at the base of the food web and the upper-trophic-level predators, such as tunas and billfishes. Cephalopods, especially squids, play a central role in many marine pelagic food webs by linking the massive biomasses of micronekton, particularly myctophid fishes, to many oceanic predators. For example, the Humboldt squid (*Dosidicus gigas*) is a common prey for yellowfin and bigeye tunas and other predatory fishes, but is also a voracious predator of small fishes and cephalopods. Recent changes in the abundance and geographic range of Humboldt squid could affect the foraging behavior of the tunas and other predators, perhaps affecting their vulnerability to capture and the trophic structure of pelagic ecosystems. Given the high trophic flux passing through the squid community, concerted research on squids is important for understanding their role as key prey and predators.

Some small forage fishes are incidentally caught in the EPO by purse-seine vessels on the high seas, mostly in sets on floating objects, and by coastal artisanal fisheries, but are generally discarded at sea. Frigate and bullet tunas (*Auxis* spp.), for example, are a common prey of many high trophic level predators, and can comprise 10% or more of their diet biomass. Preliminary estimates of the catches of small fishes by large purse-seine vessels in the EPO during 2017 are shown in Table 5, and catches during 1993-2017 are shown in Figure L-5. Declines in catches of small teleost fishes over the 25-year period were observed.

TABLE 5. Catches of small fishes, in tons, by large purse-seine vessels in the EPO, 2017 (preliminary data).				
	Set type			Total
	OBJ	NOA	DEL	
Triggerfishes (Balistidae) and filefishes (Monacanthidae)	86	<1	-	87
Other small fishes	12	<1	-	12
Frigate and bullet tunas (*Auxis* spp.)	153	103	-	256

3.3. Larval fishes and plankton

Larval fishes have been collected in surface net tows in the EPO for many years by personnel of the Southwest Fisheries Science Center of the US National Marine Fisheries Service (NMFS). Of the 314 taxonomic categories identified, 17 were found to be most likely to show the effects of environmental change; however, the occurrence, abundance, and distribution of these key taxa revealed no consistent temporal trends. Research[5] has shown a longitudinal gradient in community structure of the ichthyoplankton assemblages in the eastern Pacific warm pool, with abundance, species richness, and species diversity high in the east (where the thermocline is shallow and primary productivity is high) and low but variable in the west (where the thermocline is deep and primary productivity is low).

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

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

4. TROPHIC INTERACTIONS

The following is a brief summary of current knowledge of trophic interactions. Proposed studies on trophic interactions are outlined in the IATTC's Strategic Science Plan (SAC-09-01) and the staff activities and research work plan (SAC-09-02).

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, but are required to develop models to assess fishery and climate impacts on the ecosystem. Knowledge of the trophic ecology of predatory fishes in the EPO has been derived from stomach contents analysis, and more recently from chemical indicators. Each species of tuna appears to have a generalized feeding strategy (high prey diversity and low abundance of individual prey types) that varies spatially and ontogenetically.

Stable isotope analysis can complement dietary data for delineating the trophic flows of marine food webs. While stomach contents represent a sample of the most-recent feeding events, stable carbon and nitrogen isotopes integrate all components of the entire diet into the animal's tissues, providing a history of recent trophic interactions. Finer-resolution information is provided by compound-specific isotope analysis of amino acids (AA-CSIA). For example, the trophic position of a predator in the food web can be determined from its tissues by relating "source" amino acids (*e.g.* phenylalanine) to "trophic" amino acids (*e.g.* glutamic

[5] Vilchis, L.I., L.T. Ballance, and W. Watson. 2009. Temporal variability of neustonic ichthyoplankton assemblages of the eastern Pacific warm pool: Can community structure be linked to climate variability? Deep-Sea Research Part I-Oceanographic Research Papers 56(1): 125-140

acid), which describe the isotopic values for primary producers and the predator, respectively.

Trophic studies have revealed many of the key trophic connections in the tropical pelagic EPO, and have formed the basis for representing food-web interactions in an ecosystem model (IATTC Bulletin, Vol. 22, No. 3) to explore the ecological impacts of fishing and climate change. The staff aim to continue and improve trophic data collection for many components of the EPO ecosystem, such as small and large mesopelagic fishes, which will allow the ecosystem dynamics to be better understood, but also enable the development of an improved ecosystem model that represents the entire EPO.

5. PHYSICAL ENVIRONMENT[6]

Environmental conditions affect marine ecosystems, the dynamics and catchability of tunas and billfishes, and the activities of 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.

The ocean environment varies on a variety of time scales, from seasonal to inter-annual, decadal, and longer (*e.g.* climate phases or regimes). The dominant source of variability in the upper layers of the EPO is known as the El Niño-Southern Oscillation (ENSO), an irregular fluctuation involving the entire tropical Pacific Ocean and global atmosphere. El Niño events occur at 2- to 7-year intervals, and are characterized by weaker trade winds, deeper thermoclines, and abnormally high sea-surface temperatures (SSTs) in the equatorial EPO. El Niño's opposite phase, commonly called La Niña, is characterized by stronger trade winds, shallower thermoclines, and lower SSTs. The changes in the physical and chemical environment due to ENSO have a subsequent impact on the biological productivity, feeding, and reproduction of fishes, birds, and marine mammals.

With respect to commercially important tunas and billfishes, ENSO is thought to cause considerable variability in their recruitment and availability for capture. For example, a shallow thermocline in the EPO during La Niña events can contribute to increased success of purse-seine fishing for tunas, by compressing the preferred thermal habitat of small tunas near the sea surface. In contrast, during an El Niño event, when the thermocline is deep, tunas are apparently less vulnerable to capture, and catch rates can decline. Furthermore, warmer- or cooler-than-average SSTs can also cause these mobile fishes to move to more favorable habitats.

Climate-induced variability on a decadal scale (*i.e.* 10 to 30 years) also affects the EPO and has often been described in terms of "regimes" characterized by relatively stable means and patterns in the physical and biological variables. Decadal fluctuations in upwelling and water transport coincide with higher-frequency ENSO patterns, and have basin-wide effects on the SSTs and thermocline slope that are similar to those caused by ENSO, but on longer time scales. For example, analyses by the IATTC staff have indicated that yellowfin in the EPO have experienced regimes of lower (1975-1982) and higher (1983-2001) recruitment, thought to be due to a shift in the primary productivity regime in the Pacific Ocean.

Indices of variability in oceanographic conditions—from shorter-term, inter-annual ENSO events assessed in different regions of the EPO, to the longer-term interdecadal PDO index—are used to describe SST anomalies in the Pacific Ocean. Oceanographic indices can be used to explore the influence of environmental drivers on the vulnerability of non-target species impacted by fisheries (see, for example, SAC-08-08a(i)). Some of these indices include the Oceanic Niño Index (ONI), the Índice Costero El Niño (ICEN) and the PDO. The ONI is used by the US National Oceanic and Atmospheric Administration (NOAA), and is the primary indicator of warm El Niño (ONI $\geqslant$+0.5) and cool La Niña (ONI $\leqslant$-0.5) conditions within the Niño 3.4 region in the east-central tropical Pacific Ocean between 120° and 170°W[7].

[6] Some 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.

[7] Dahlman, L. 2016. Climate Variability: Oceanic Niño Index. National Oceanic and Atmospheric Administration. https://www.climate.gov/news-features/understanding-climate/climate-variability-oceanic-ni%C3%B1o-index.

The ICEN index is used by the Comité Multisectorial para el Estudio del Fenómeno El Niño (ENFEN) to monitor the occurrence and magnitude of El Niño in the Niño 1+2 region (the smallest of the El Niño regions, from 0° to 10°S between 90° and 80°W), corresponding to the highly dynamic region along the coast of Peru. The PDO—a long-lived El Niño-like pattern of Pacific climate variability—tracks large-scale interdecadal patterns of environmental and biotic changes, primarily in the North Pacific Ocean[8], with secondary signatures in the tropical Pacific[9]. Monthly ONI[10], ICEN[11] and PDO[12] data from 1993-2017 are shown in Figure L-6 to provide a general overview of variability in these indices over the past two decades.

ICEN values have been categorized from "strong cold" events (values <-1.4) to "extraordinary warm" events (values >3)[13]. ICEN values were >3 during the 1997-1998 El Niño; values peaked to a high of 2.23 in October 2015, indicating a "very strong" event. Similarly, ONI values were >2 during the 1997-1998 and 2015-2016 El Niño events, representing "very strong" events[14]. PDO values peaked at 2.79 in August 1997, and at 2.62 in April 2016.

Maps of mean SSTs across the EPO for each year during 1993-2017 were created using NOAA_OI_SST_V2 data[15] provided by the NOAA/OAR.ESRL PSD, Boulder, Colorado, USA. Figure L-7 shows the expansion of warmer waters during the extreme El Niño events of 1997-1998 and 2015-2016.

6. ECOLOGICAL INDICATORS

Over the past two decades, many fisheries worldwide have broadened the scope of management to consider fishery impacts on non-target species and the ecosystem more generally. This ecosystem approach to fisheries management is important for maintaining the integrity and productivity of ecosystems while maximizing the utilization of commercially important assets. However, demonstrating the ecological sustainability of EPO fisheries is a significant challenge, given the wide range of species with differing life histories with which those fisheries interact. While biological reference points have been used for single-species management of target species, alternative performance measures and reference points are required for the many non-target species for which reliable catch and/or biological data are lacking; for example, incidental mortality limits for dolphins have been set in the EPO purse-seine fishery under the AIDCP.

Another important aspect of assessing ecological sustainability is to ensure that the structure and function of the ecosystem is not negatively impacted by fishing activities. Several ecosystem metrics or indicators have been proposed to address this issue, such as community size structure, diversity indices, species richness and evenness, overlap indices, trophic spectra of catches, relative abundance of an indicator species or group, and numerous environmental indicators.

Given the complexity of marine ecosystems, no single indicator can completely represent their structure and internal dynamics. In order to monitor changes in these multidimensional systems and detect the potential impacts of fishing and the environment, a variety of indicators is required. Therefore, a range of indicators that can be calculated with the ecosystem modelling software *Ecopath with Ecosim* (EwE) are used in this report to describe the long-term changes in the EPO ecosystem. The analysis covers the 1970-2014 period, and the indicators included are: mean trophic level of the catch (MTL_c), the Marine Trophic Index (MTI), the Fishing in Balance index (FIB), Kempton's Q diversity index, and three indicators that

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[8] Mantua, N.J., S.R. Hare, Y. Zhang, J.M. Wallace, and R.C. Francis. 1997. A Pacific interdecadal climate oscillation with impacts on salmon production. Bulletin of the American Meteorological Society 78: 1069-1079.

[9] Hare, S.R., and N.J. Mantua. 2000. Empirical evidence for North Pacific regime shifts in 1977 and 1989. Progress in Oceanography 47: 103-145.

[10] http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[11] http://www.met.igp.gob.pe/variabclim/indices.html

[12] http://research.jisao.washington.edu/pdo/

[13] http://www.imarpe.pe/imarpe/archivos/informes/imarpe_comenf_not_tecni_enfen_09abr12.pdf

[14] http://ggweather.com/enso/oni.htm

[15] https://www.esrl.noaa.gov/psd/data/gridded/data.noaa.oisst.v2.html

describe the mean trophic level of three components, or 'communities' (TL 2.0-3.5, 3.5-4.0, and >4.0), after fisheries have extracted biomass as catches. These indicators, and the results derived from the ecosystem model of the pelagic Eastern Tropical Pacific Ocean (ETP)[16], are summarized below.

Trophic structure of the EPO ecosystem. Ecologically-based approaches to fisheries management require accurate depictions of trophic links and biomass flows through the food web. Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms and to estimate energy flows through communities. A simplified food-web diagram, with approximate TLs, from the ETP model is shown in Figure L-8. Toothed whales (Odontoceti, average TL 5.2), large squid predators (large bigeye tuna and swordfish, average TL 5.2), and sharks (average TL 5.0) are top-level predators. Other tunas, large piscivores, dolphins (average TL 4.8), and seabirds (average TL 4.5) occupy slightly lower TLs. Smaller epipelagic fishes (*e.g. Auxis* spp. and flyingfishes, average TL 3.2), cephalopods (average TL 4.4), and mesopelagic fishes (average TL 3.4) are the principal forage of many of the upper-level predators in the ecosystem. Small fishes and crustaceans prey on two zooplankton groups, and the herbivorous micro-zooplankton (TL 2) feed on the producers, phytoplankton and bacteria (TL 1).

Ecological indicators. In exploited pelagic ecosystems, fisheries that target large piscivorous fishes act as the system's apex predators. Over time, fishing can cause the overall size composition of the catch to decrease, and, in general, the TLs of smaller organisms are lower than those of larger organisms. The mean trophic level of the catch (MTL_c) by fisheries can be a useful metric of ecosystem change and sustainability, because it integrates an array of biological information about the components of the system. MTL_c is also an indicator of whether fisheries are changing their fishing or targeting practices in response to changes in the abundance or catchability of traditional target species. For example, declines in the abundance of large predatory fish by overfishing has resulted in fisheries progressively targeting species at lower trophic levels in order to remain profitable. Studies that have documented this phenomenon, referred to as 'fishing down the food web', have shown that the MTL_c decreased by around 0.1 of a trophic level per decade.

The Marine Trophic Index (MTI) is essentially the same as MTL_c, but it includes only high trophic level species—generally TL>4.0—that are the first indicator of 'fishing down the food web'. Some ecosystems, however, have changed in the other direction, from lower to higher TL communities, sometimes as a result of improved technologies to allow exploitation of larger species—referred to as 'fishing up the food web'—but it can also result from improved catch reporting, as previously unreported catches of discarded predatory species, such as sharks, are recorded.

The Fishing in Balance (FIB) index indicates whether fisheries are balanced in ecological terms and not disrupting the functionality of the ecosystem (FIB = 0). A negative FIB indicates overexploitation, when catches do not increase as expected given the available productivity in the system, or if the effects of fishing are sufficient to compromise the functionality of the ecosystem, while a positive FIB indicates expansion of a fishery, either spatially, or through increased species richness of the catch.

Kempton's Q index measures the diversity and evenness in the ecosystem of species or functional groups with a trophic level greater than 3. Because the number of functional groups defined by an ecosystem model is fixed, a decrease in the index indicates that the relative contribution of each group to the overall biomass has changed relative to a reference year.

In contrast to MTL_c, the mean trophic level of the community essentially describes what the expected trophic level of components of the ecosystem is after fishing has extracted biomass as catches. There are three components—referred to as "communities"—that aggregate the biomass of functional groups in the model by trophic level: 2.0-3.5 ($MTL_{2.0}$), 3.5-4.0 ($MTL_{3.5}$), and >4.0 ($MTL_{4.0}$). These indicators can be used in unison to detect trophic cascades, whereby a decline in biomass of $MTL_{4.0}$ due to fishing would reduce predation pressure on $MTL_{3.5}$ and thus increase its biomass, which would in turn increase predation pressure

[16] Olson, R.J., and G.M. Watters. 2003. A model of the pelagic ecosystem in the eastern tropical Pacific Ocean. Inter-American Tropical Tuna Commission, Bulletin 22(3): 133-218.

on $MTL_{2.0}$ and reduce its biomass.

Monitoring the EPO ecosystem using ecological indicators. Given the potential utility of combining ecological indicators for describing the various structures and internal dynamics of the EPO ecosystem, annual indicator values were estimated from a 1970-2014 time series of annual catches and discards, by species, for three purse-seine fishing modes, the pole-and-line fishery, and the longline fishery in the EPO. The estimates were made by assigning the annual catch of each species from the IATTC tuna, bycatch, and discard databases to a relevant functional group defined in the ETP ecosystem model, and refitting the Ecosim model to the time series of catches to estimate MTL_c and the other aforementioned ecological indicators.

Values for MTL_c and MTI increased from 4.63 in 1970 to 4.66 in 1993, the year for which the ecosystem model was characterised, and coincidentally the year when the purse-seine fishing effort on FADs increased significantly (Figure L-9). After 1993, MTL_c continued to increase, to a peak of 4.72 in 1997, due to the expansion of the FAD fishery, which increased bycatches of other high trophic level species that also aggregate around floating objects (*e.g.* sharks, billfishes, wahoo and dorado). This expansion is seen in the positive FIB index during the same period, and also a change in the composition of the community indicated by Kempton's Q index. After 1997, MTL_c, MTI, FIB and Kempton's Q index all show a gradual decline (Figure L-9). Since its peak in 1997, MTL_c declined by 0.08 of a trophic level in the subsequent 18 years, or 0.044 trophic levels per decade.

The above indicators generally describe the change in the exploited components of the ecosystem, whereas community biomass indicators describe changes in the structure of the ecosystem once biomass has been removed due to fishing. The biomass of the $MTL_{4.0}$ community peaked at 4.444 in 1993, but has continued to decline, to 4.439 in 2014 (Figure L-9). As a result of changes in predation pressure on lower trophic levels, between 1993 and 2014 the biomass of the $MTL_{3.0}$ community increased from 3.799 to 3.800, while that of the $MTL_{2.0}$ community decreased from 3.306 to 3.305.

Together, these indicators show that the ecosystem structure has likely changed over the 44-year analysis period. However, these changes, even if they are a direct result of fishing, are not considered ecologically detrimental, but the patterns of changes, particularly in the mean trophic level of the communities, certainly warrant the continuation, and possible expansion, of monitoring programs for fisheries in the EPO.

7. ECOLOGICAL RISK ASSESSMENT

The primary goal of ecosystem-based fisheries management is to ensure the long-term sustainability of all species impacted—directly or indirectly—by fishing. However, this is a significant challenge for fisheries that interact with many non-target species with diverse life histories, for which sufficiently reliable catch and biological data for single-species assessments are lacking. An alternative approach for such data-limited situations is Ecological Risk Assessment (ERA), a tool for prioritizing management action or further data collection and research for potentially vulnerable species.

'Vulnerability' is defined here as the potential for the productivity of a stock to be diminished by direct and indirect fishing pressure. The IATTC staff has applied an ERA approach called 'productivity-susceptibility analysis' (PSA) to estimate the vulnerability of data-poor, non-target species caught in the EPO purse-seine fishery by large (Class-6) vessels in 2010 and in the longline fishery in 2017. PSA considers a stock's vulnerability as a combination of its susceptibility to being captured by, and incur mortality from, a fishery and its capacity to recover, given its biological productivity.

Purse-seine fishery. A preliminary evaluation of three purse-seine "fisheries" in the EPO was made in 2014, using 32 species (3 target tunas, 4 billfishes, 3 dolphins, 7 large fishes, 3 rays, 9 sharks, 2 small fishes and 1 turtle) that comprised the majority of the biomass removed by the purse-seine fleet during 2005-2013 (Table L-1). The overall productivity (*p*) and susceptibility (*s*) values that contributed to the overall vulnerability score (*v*) are shown in Table L-1. Vulnerability was highest for the shortfin mako shark (*Isurus oxyrinchus*), bigeye thresher shark (*Alopias superciliosus*), pelagic thresher shark (*A. pelagicus*), giant manta ray (*Manta birostris*), hammerhead sharks (*Sphyrna mokarran*, *S. lewini*, and *S. zygaena*), and silky shark (*Carcharhinus falciformis*). Billfishes, dolphins, rays, and turtles were all moderately vulnerable, while small fishes, most large fishes, and two of the three target tuna species had the lowest vulnerability scores (Table L-1; Figure L-10a).

Large-scale tuna longline fishery. A preliminary assessment of the longline fishery in the EPO was undertaken for 2016 for 68 species that had some level of interaction (captured, discarded, or impacted) with the fishery. There were 12, 38, and 18 species classified as having low, moderate, and high vulnerability, respectively (Figure L-10b; Table L-2). Of the 18 highly vulnerable species, 13 were elasmobranchs—with the bigeye thresher, tiger, porbeagle and blue sharks identified as most vulnerable—and 5 were commercially important tunas and billfishes (albacore, Pacific bluefin, and yellowfin tunas, swordfish, and striped marlin). Other tuna-like and mesopelagic species were classified as either having moderate or low vulnerability in the fishery, although four species—wahoo, snake mackerel, and the two species of dorado—had *v* scores close to 2.0, in close vicinity to being highly vulnerable (Figure L-10b; Table L-2).

In response to requests by participants at SAC-07 in 2016 to expand the ERA to other fisheries operating in the EPO, the IATTC staff produced three documents for SAC-08, covering (1) methodological improvements to PSA by resolving redundancy in productivity attributes (SAC-08-07c), (2) a metadata review for the large-scale longline fishery in the EPO (SAC-08-07b) to establish a list of impacted species and susceptibility parameters required for PSAs, and (3) a preliminary PSA for the large-scale longline fishery in the EPO (SAC-08-07d). Responding to requests for more quantitative cumulative ecological assessments for the EPO has been a priority for IATTC staff, and has led to the development of a new flexible spatially-explicit approach that quantifies the cumulative impacts of multiple fisheries on data-poor species (SAC-09-12). A demonstration of a preliminary form of the method was presented at SAC-09.

8. ECOSYSTEM MODELING

Although ERA approaches can be useful for assessing the ecological impacts of fishing, they generally do not consider changes in the structure and internal dynamics of an ecosystem. As data collection programs improve and ecological studies (*e.g.* on diet) are conducted on components of the ecosystem, more data-rich ecosystem models can be employed that quantitatively represent ecological interactions among species or ecological ‘functional groups’. These models are most useful as descriptive devices for exploring the potential impacts of fishing and/or environmental perturbations on components of the system, or the ecosystem structure as a whole.

The IATTC staff has developed a model of the pelagic ecosystem in the tropical EPO (IATTC Bulletin, Vol. 22, No. 3) to explore how fishing and climate variation might affect the animals at middle and upper trophic levels. The ecosystem model has 38 components, including the principal exploited species (*e.g.* tunas), functional groups (*e.g.* sharks and flyingfishes), and species of conservation importance (*e.g.* sea turtles). Fisheries landings and discards are included as 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 included.

The model has been calibrated to time series of biomass and catch data for a number of target and non-target species for 1961-1998. There have been significant improvements in data collection programs in the EPO since 1998, and these new data may allow the model to be calibrated to the most recent data.

One shortcoming of the model is that it describes only the tropical component of the EPO ecosystem, and results cannot be reliably extrapolated to other regions of the EPO. Therefore, future work may aim to update the model to a spatially-explicit model that covers the entire EPO. This is a significant undertaking, but it would allow for an improved representation of the ecosystem and the potential fishery and climate impact scenarios that may be modelled to guide ecosystem-based fisheries management.

9. ACTIONS BY THE IATTC AND THE AIDCP ADDRESSING ECOSYSTEM

CONSIDERATIONS

Both the IATTC's Antigua Convention and the AIDCP have objectives that involve the incorporation of ecosystem considerations into the management of the tuna fisheries in the EPO. Actions taken in the past include:

9.1. Dolphins

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

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

9.2. Sea turtles

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

b. Resolution C-04-07 on a three-year program to mitigate the impact of tuna fishing on sea turtles was adopted by the IATTC in June 2004; it includes requirements for data collection, mitigation measures, industry education, capacity building, and reporting.

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

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

9.3. Seabirds

a. Recommendation C-10-02, adopted by the IATTC in October 2010, reaffirmed the importance that IATTC Parties and cooperating non-Parties, fishing entities, and regional economic integration organizations implement, if appropriate, the FAO International Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries ("IPOA-Seabirds").

b. Resolution C-11-02, adopted by the IATTC in July 2011, reaffirmed the importance of implementing the IPOA-Seabirds (see 9.3.a) and provides that Members and Cooperating non-Members (CPCs) shall require their longline vessels of more than 20 meters length overall and that fish for species covered by the IATTC in the EPO to use at least two of the specified mitigation measures, and establishes minimum technical standards for the measures.

9.4. Other species

a. Resolution C-00-08, adopted in June 2000, establishes guidelines on live release of sharks, rays, billfishes, dorado, wahoo, and other non-target species.

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

c. Resolution C-11-10, adopted in July 2011, prohibits retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of oceanic whitetip sharks in the fisheries covered by the Antigua Convention, and to promptly release unharmed, to the extent practicable, oceanic whitetip sharks when brought alongside the vessel.

d. Resolution C-15-04, adopted in July 2015, prohibits retaining onboard, transshipping, landing, storing, selling, or offering for sale any part or whole carcass of manta rays (Mobulidae) (which includes *Manta birostris* and *Mobula* spp.) and requires vessels to release all mobulid rays alive wherever possible.

e. Resolution C-16-05, adopted in July 2016, states that the IATTC scientific staff shall develop a workplan for completing full stock assessments for the silky shark (*Carcharhinus falciformis*) and hammerhead sharks (*i.e.*, *Sphyrna lewini*, *S. zygaena* and *S. mokarran*). CPCs shall require their fishers to collect and submit catch data for silky and hammerhead sharks, and shall submit the data to the IATTC in accordance with IATTC data reporting requirements.

f. Resolution C-16-06, adopted in July 2016, prohibits retaining on board, transshipping, landing, or storing, in part or whole, carcasses of silky sharks caught by purse-seine vessels in the IATTC Convention Area.

9.5. Fish-aggregating devices (FADs)

a. Resolution C-16-01, adopted in July 2016, amends and replaces Resolution C-15-03, adopted by the IATTC in July 2015. It requires all purse-seine vessels, when fishing on FADs in the IATTC Convention Area, to collect and report FAD information including an inventory of the FADs present on the vessel, specifying, for each FAD, identification, type, and design characteristics. To reduce entanglement of sharks, sea turtles, or any other species, principles for the design and deployment of FADs are specified. Setting a purse seine on tuna associated with a live whale shark is prohibited, if the animal is sighted prior to the set. A working group on FADs is established and its objectives are to collect and compile information on FADs, review data collection requirements, compile information regarding developments in other tuna-RFMOs on FADs, compile information regarding developments on the latest scientific information on FADs, including information on non-entangling FADs, prepare annual reports for the SAC, and identify and review possible management measures.

b. Resolution C-17-02, adopted in July 2017, specifies measures for the fishery on FADs, including the number of allowable active FADs.

9.6. 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.

e. Requirements have been adopted for the CPCs to ensure that, from 1 January 2013, at least 5% of the fishing effort made by its longline vessels greater than 20 m length overall carry a scientific observer.

10. FUTURE DEVELOPMENTS

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

An ecosystem-based approach to fisheries management may be best facilitated through a multi-faceted approach involving the development and monitoring of biologically and ecologically meaningful indicators for key indicator species and ecosystem integrity. Ecological indicators may be aggregate indices describing the structure of the entire ecosystem (*e.g.* diversity), or specific components (*e.g.* trophic level of the catch). Biological indicators may generally relate to single species—perhaps those of key ecological importance or 'keystone' species—and be in the form of commonly-used fishery reference points (*e.g.* F_{MSY}), CPUE, or other simple measures such as changes in size spectra. However, the indicator(s) used depend heavily on the reliability of the information available at the species to ecosystem level.

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 the 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.

Future ecosystem work is described in the IATTC Strategic Science Plan (SAC-09-01) and staff activities report (SAC-09-02). Briefly, this work will include improving ERAs, developing and maintaining databases of key biological and ecological parameters (*e.g.* growth parameters), developing research proposals for biological sampling, ecosystem monitoring and field-based research on consumption and evacuation experiments, development of a spatially-explicit ecosystem model of the EPO and ecological indicators, and continued reporting of bycatch estimates.

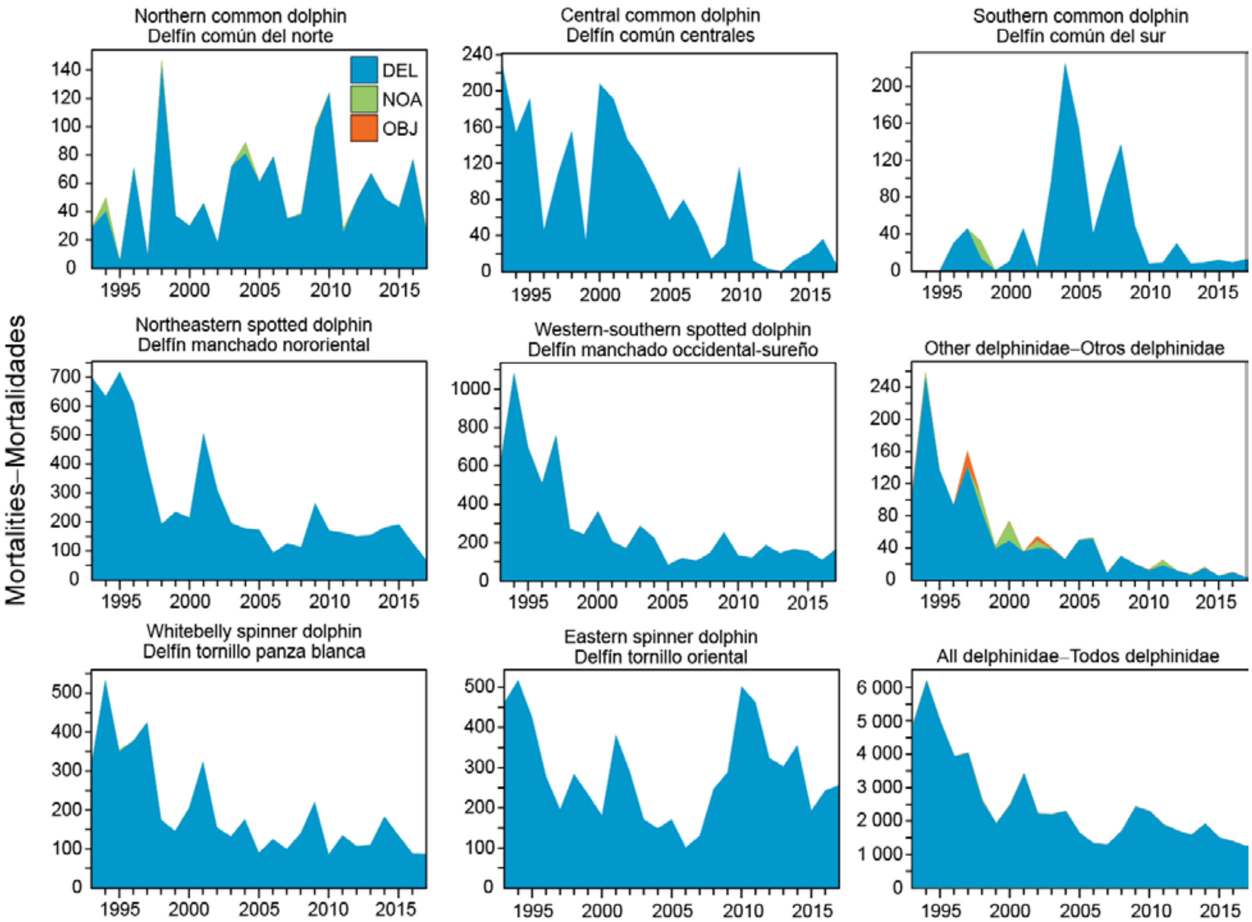

FIGURE L-1. Incidental dolphin mortalities, in numbers of animals, reported by observers on large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)). Data for 2017 are preliminary.

FIGURA L-1. Mortalidades incidentales de delfines, en número de animales, reportadas por observadores en buques cerqueros grandes, 1993-2017, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)). Los datos de 2017 son preliminares.

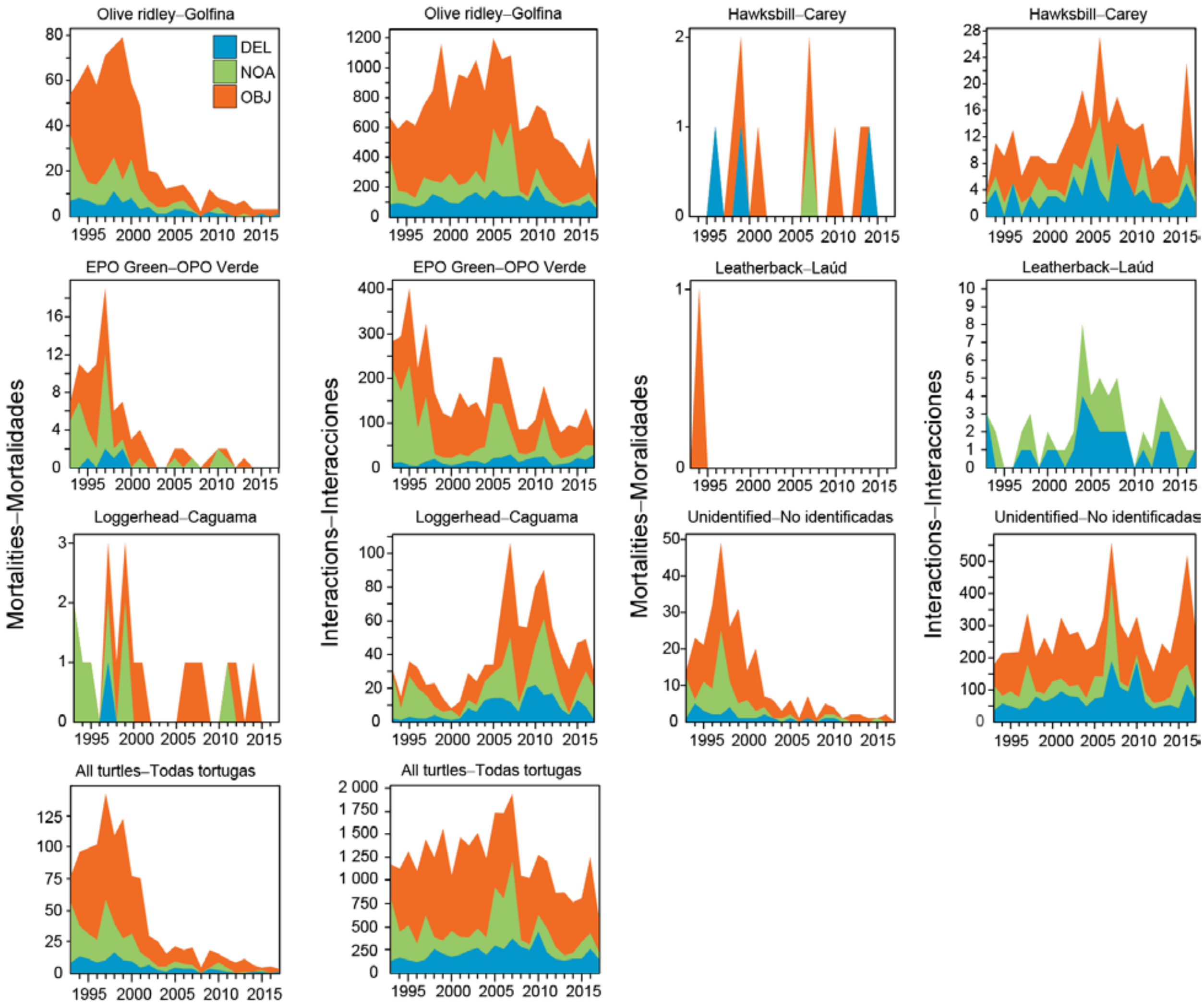

FIGURE L-2. Sea turtle interactions and mortalities, in numbers of animals, reported by observers on large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)). Data for 2017 are preliminary.

FIGURA L-2. Interacciones y mortalidades incidentales de tortugas marinas, en número de animales, reportadas por observadores en buques cerqueros grandes, 1993-2017, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)). Los datos de 2017 son preliminares.

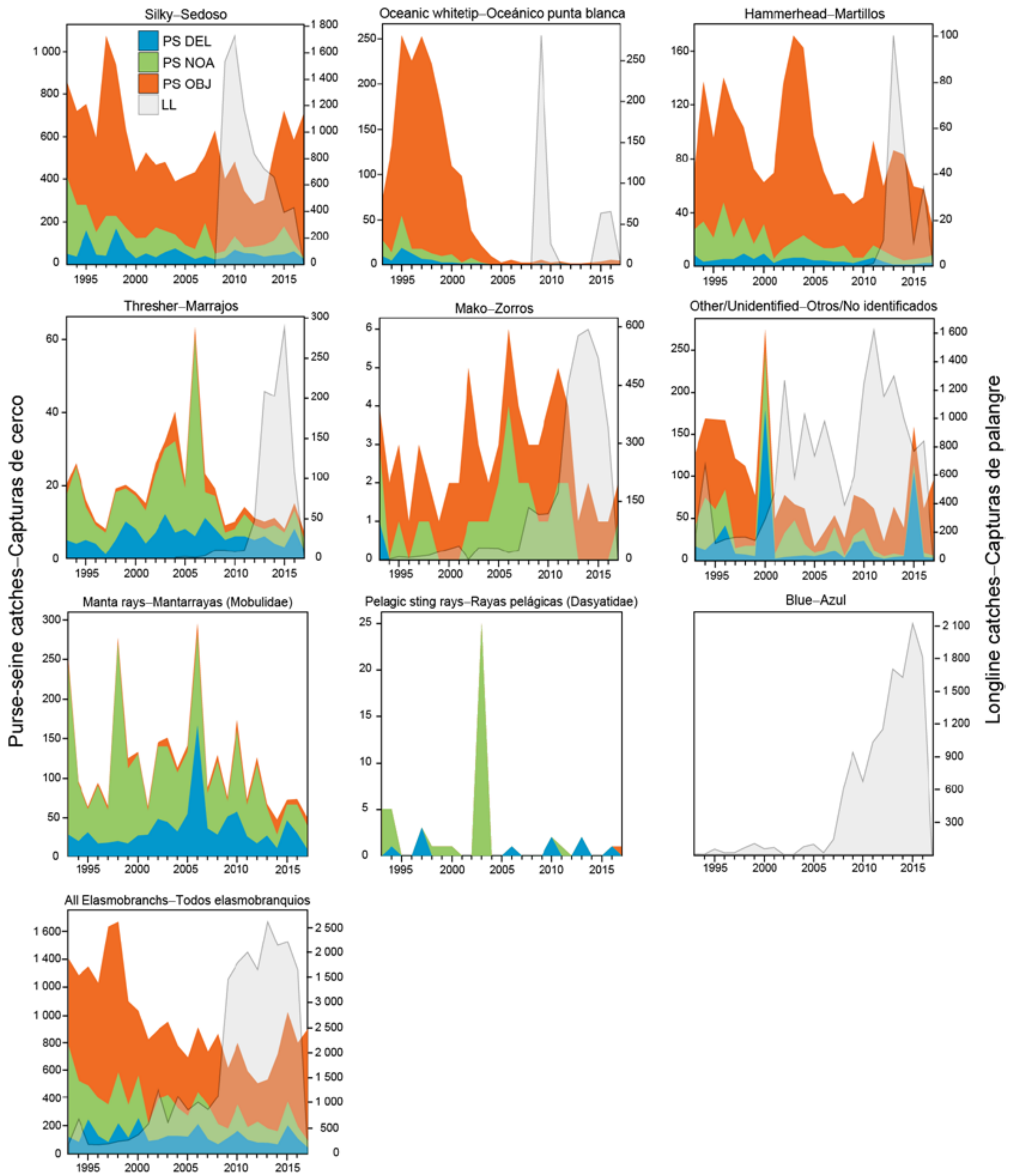

FIGURE L-3. Retained and discarded catches, in tons, of sharks and rays reported by observers on large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating-object (OBJ)) (left y-axis). Longline data (right y-axis) are considered minimum catch estimates, using available IATTC 5°x5° data, due to incomplete reporting (see section 2.1 and SAC-08-07b for limitations associated with longline data). Purse-seine data for 2017 are preliminary; longline data for 2017 not available.

FIGURA L-3. Capturas retenidas y descartadas, en toneladas, de tiburones y rayas reportadas por observadores en buques cerqueros grandes, 1993-2017, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)) (eje *y* izquierdo). Los datos de palangre (eje *y* derecho) son considerados estimaciones mínimas de la captura, usando datos disponibles de 5°x5° de la CIAT, debido a informes incompletos (ver sección 2.1 y SAC-08-07b para limitaciones asociadas a los datos de palangre). Los datos de cerco de 2017 son preliminares; datos de palangre para 2017 no disponibles.

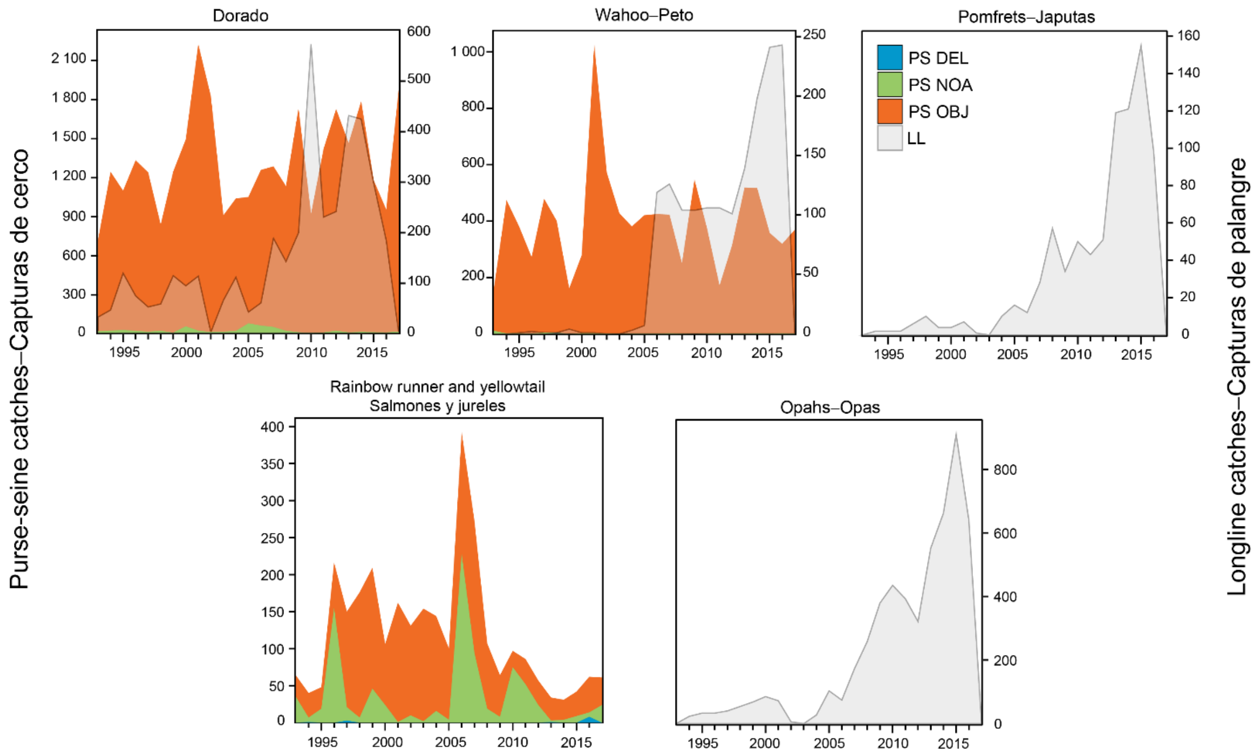

FIGURE L-4. Catches, in tons, of commonly-caught fishes by large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)) (left y-axis). Longline data (right y-axis) are considered minimum catch estimates using available IATTC 5°x5° data, due to incomplete reporting (see section 2.1 and SAC-08-07b for limitations associated with longline data). Purse-seine data for 2017 are preliminary; longline data for 2017 not available.

FIGURA L-4. Capturas, en toneladas, de peces capturados comúnmente por buques cerqueros grandes, 1993-2017, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)) (eje *y* izquierdo). Los datos de palangre (eje *y* derecho) son considerados estimaciones mínimas de la captura, usando datos disponibles de 5°x5° de la CIAT, debido a informes incompletos (ver sección 2.1 y SAC-08-07b para limitaciones asociadas a los datos de palangre). Los datos de cerco de 2017 son preliminares; datos de palangre para 2017 no disponibles.

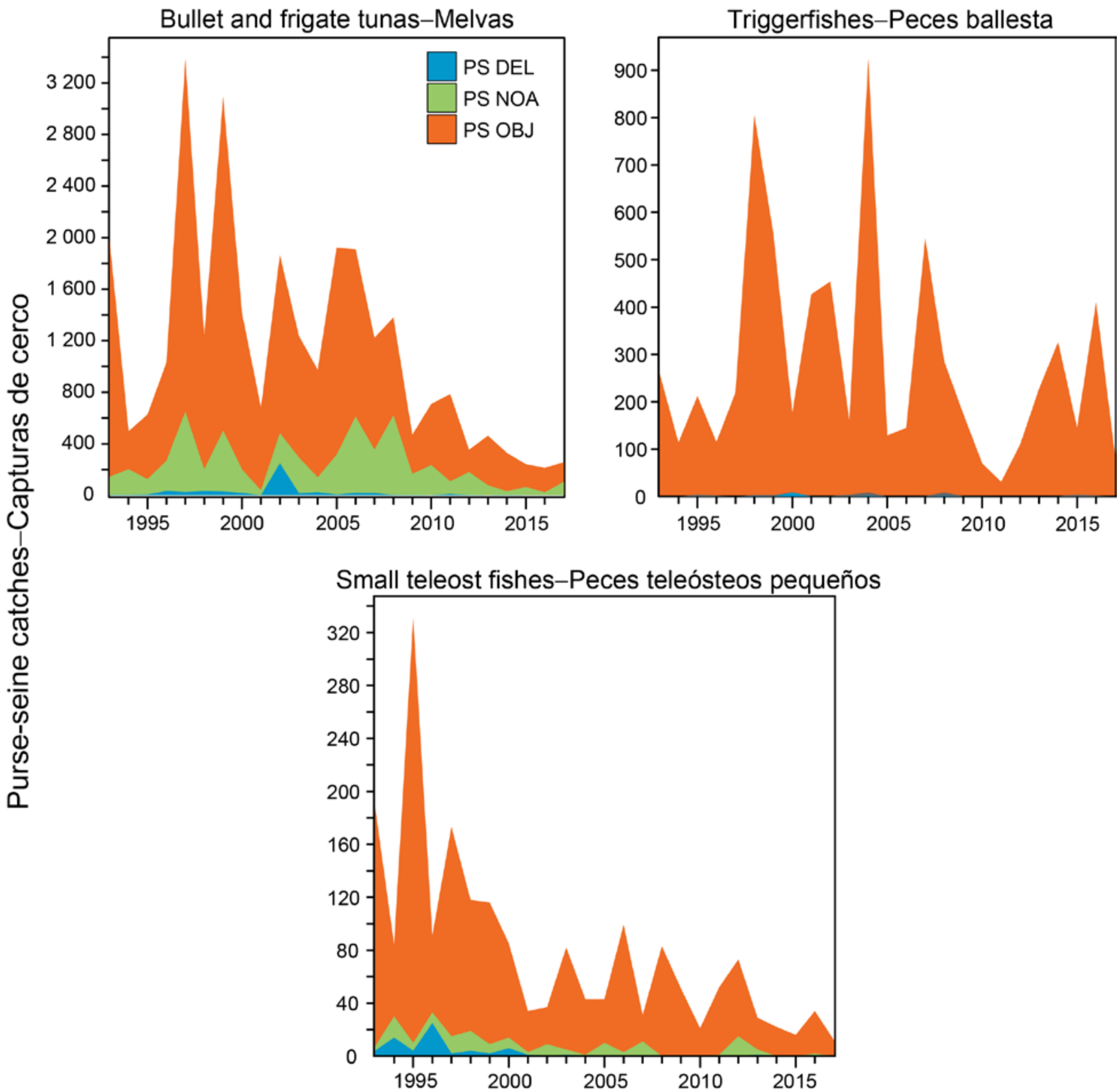

FIGURE L-5. Catches, in tons, of forage fishes by large purse-seine vessels, 1993-2017, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)). Data for 2017 are preliminary.

FIGURA L-5. Capturas, en toneladas, de peces de alimento por buques cerqueros grandes, 1993-2017, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)). Los datos de 2017 son preliminares.

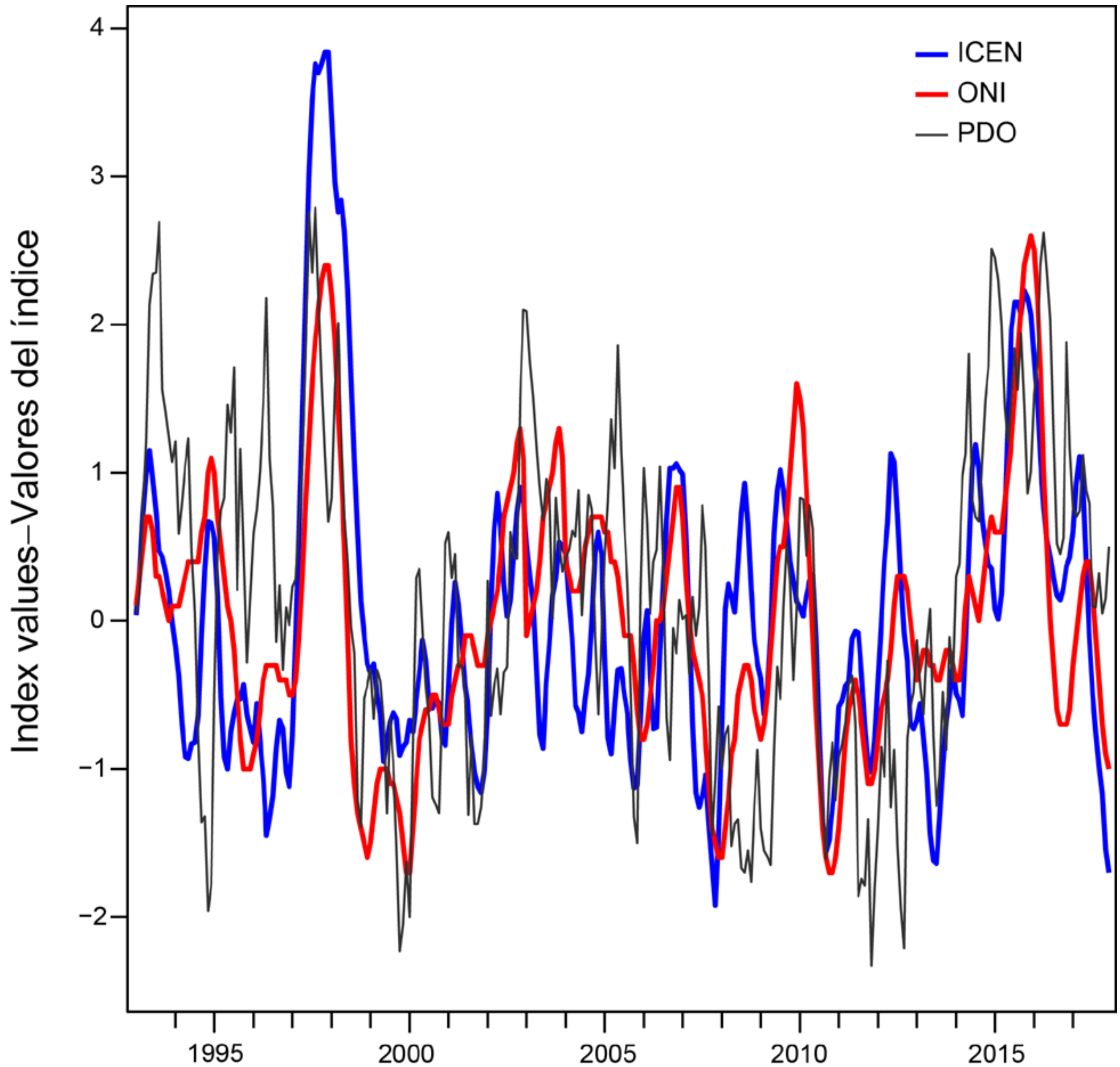

FIGURE L-6. Oceanographic indices used to characterize SST anomalies and El Niño-Southern Oscillation (ENSO) events in the Pacific Ocean, 1993-2017. ICEN: Índice Costero El Niño; ONI: Oceanic Niño Index; PDO: Pacific Decadal Oscillation. See section 5 of text for details.

FIGURA L-6. Índices oceanográficos usados para caracterizar las anomalías de las TSM y los eventos de El Niño-Oscilación del Sur (ENOS) en el Océano Pacífico, 1993-2017. ICEN: Índice Costero El Niño; ONI: Índice Oceánico del Niño; PDO: Oscilación Decadal del Pacífico. Ver detalles en la sección 5 del texto.

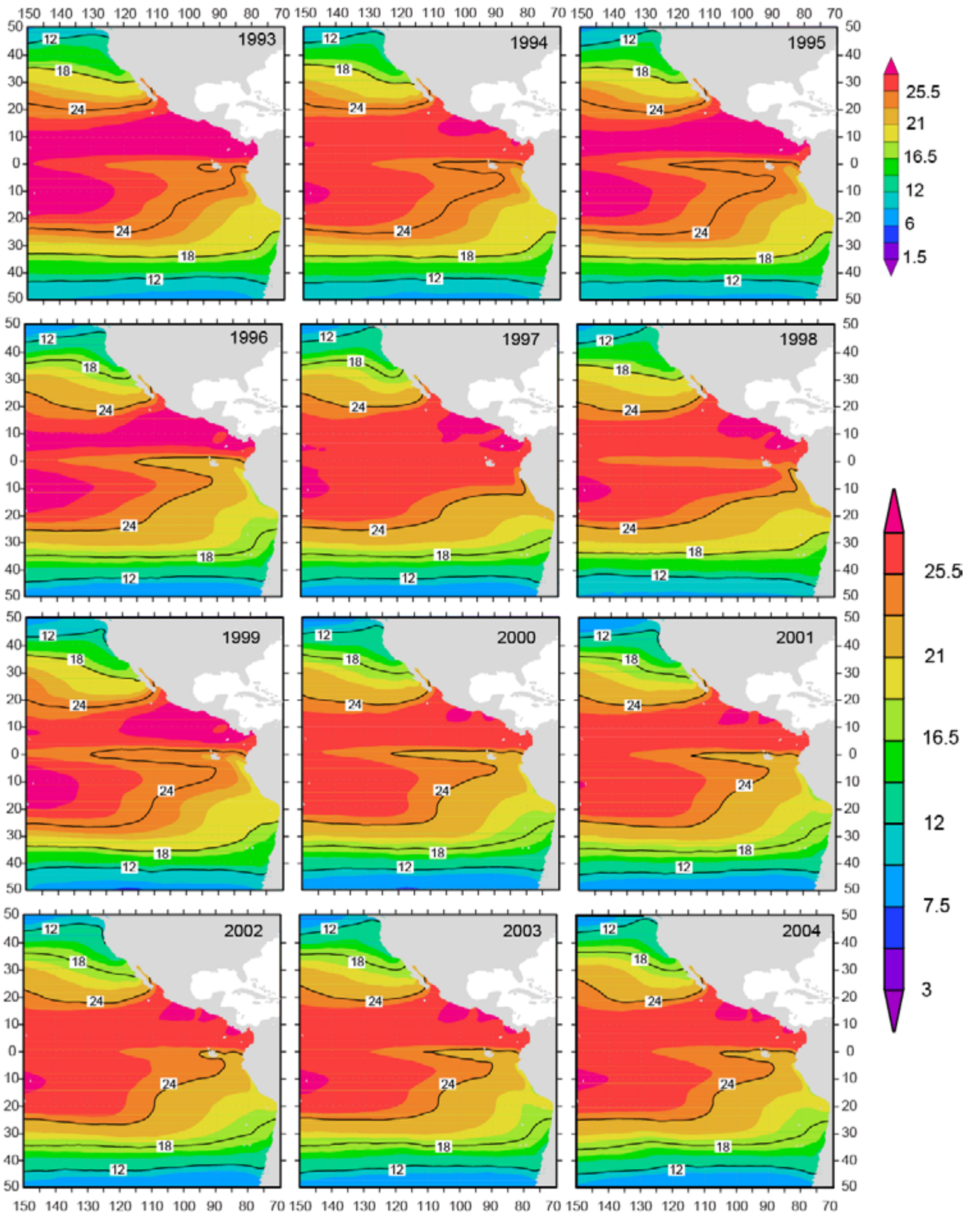

FIGURE L-7a. Mean annual SSTs in the EPO, 1993-2004. See section 5 of text for details.
FIGURA L-7a. TSM anuales medias en el OPO, 1993-2004. Ver detalles en la sección 5 del texto.

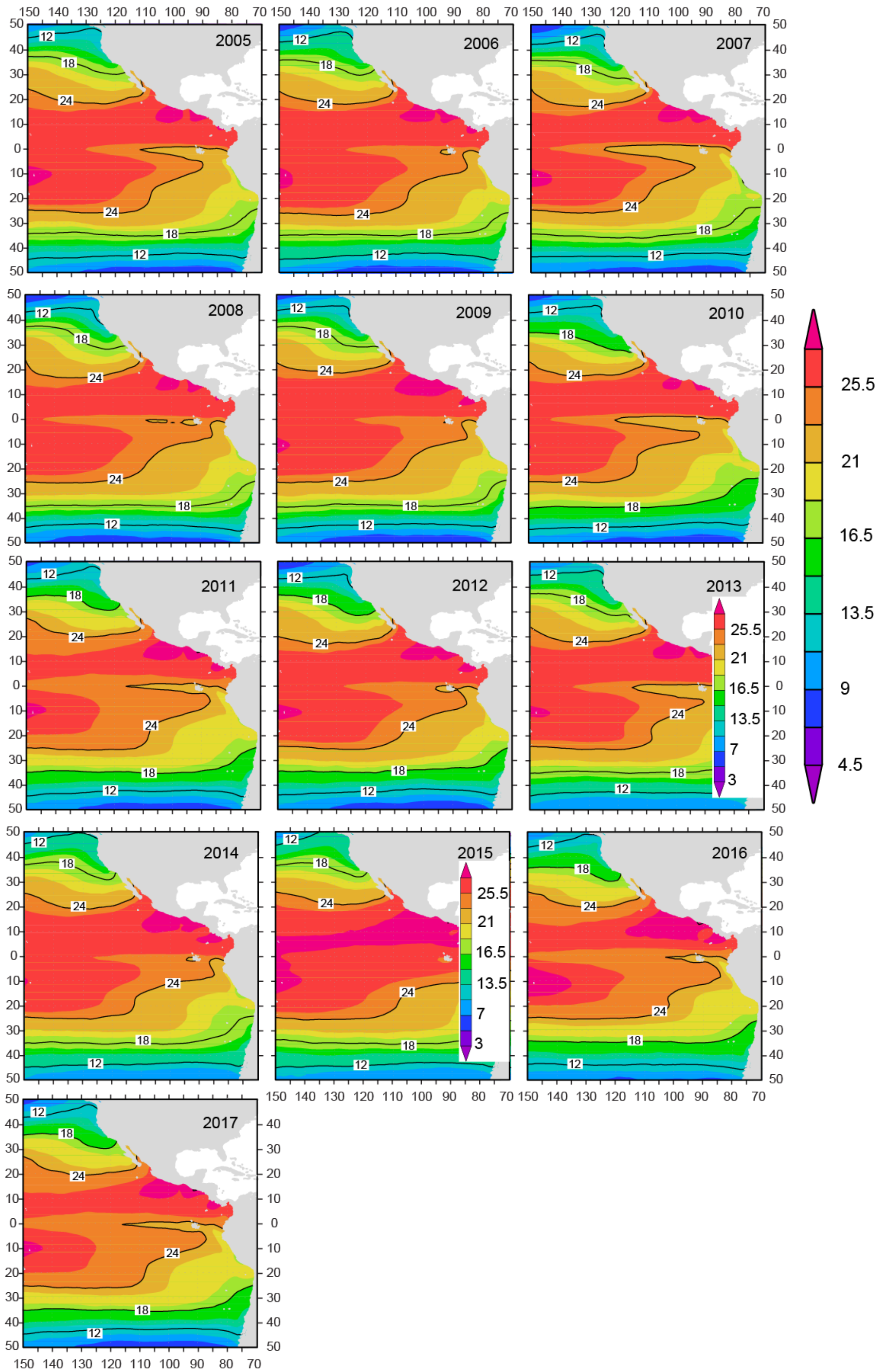

FIGURE L-7b. Mean annual SSTs in the EPO, 2005-2017. See section 5 of text for details.
FIGURA L-7b. TSM anuales medias en el OPO, 2005-2017. Ver detalles en la sección 5 del texto.

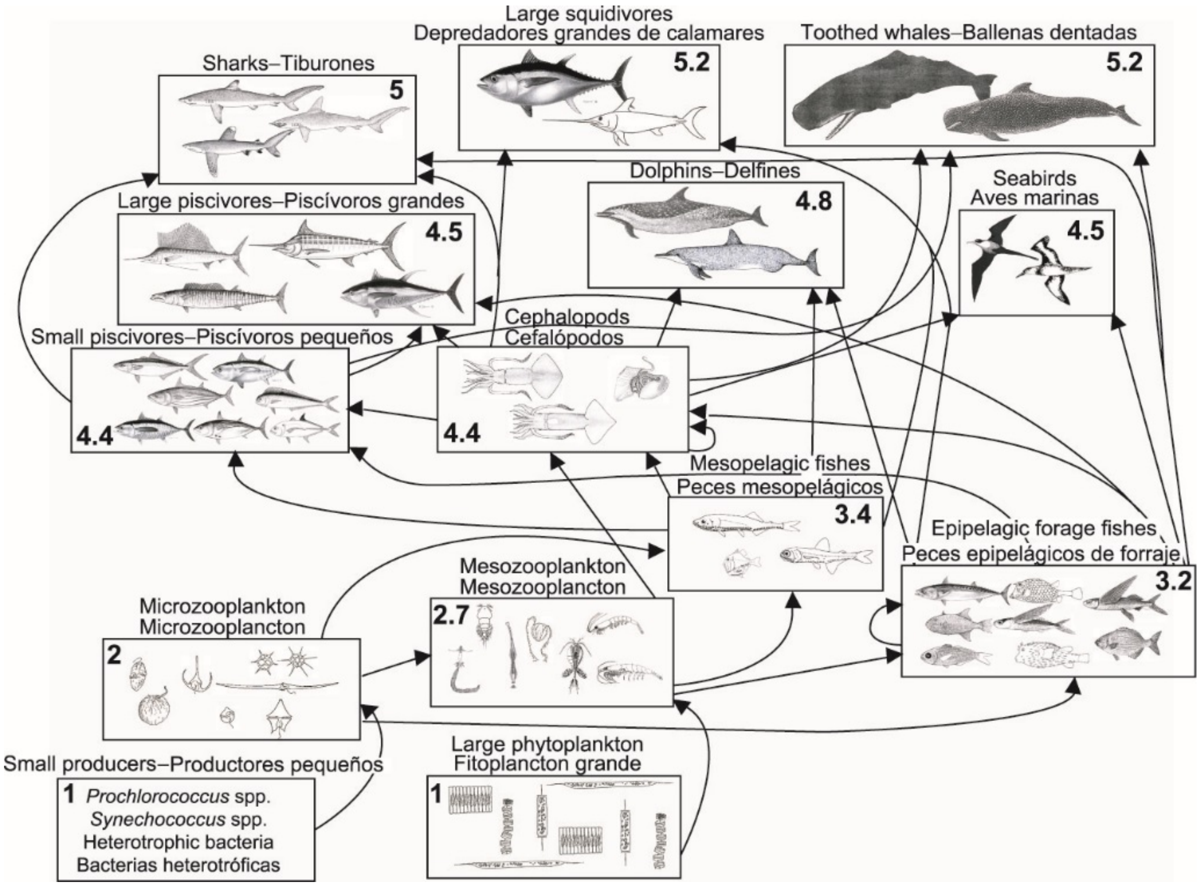

FIGURE L-8. Simplified food-web diagram of the pelagic ecosystem in the tropical EPO. The numbers inside the boxes indicate the approximate trophic level of each group.
FIGURA L-8. Diagrama simplificado de la red trófica del ecosistema pelágico en el OPO tropical. Los números en los recuadros indican el nivel trófico aproximado de cada grupo.

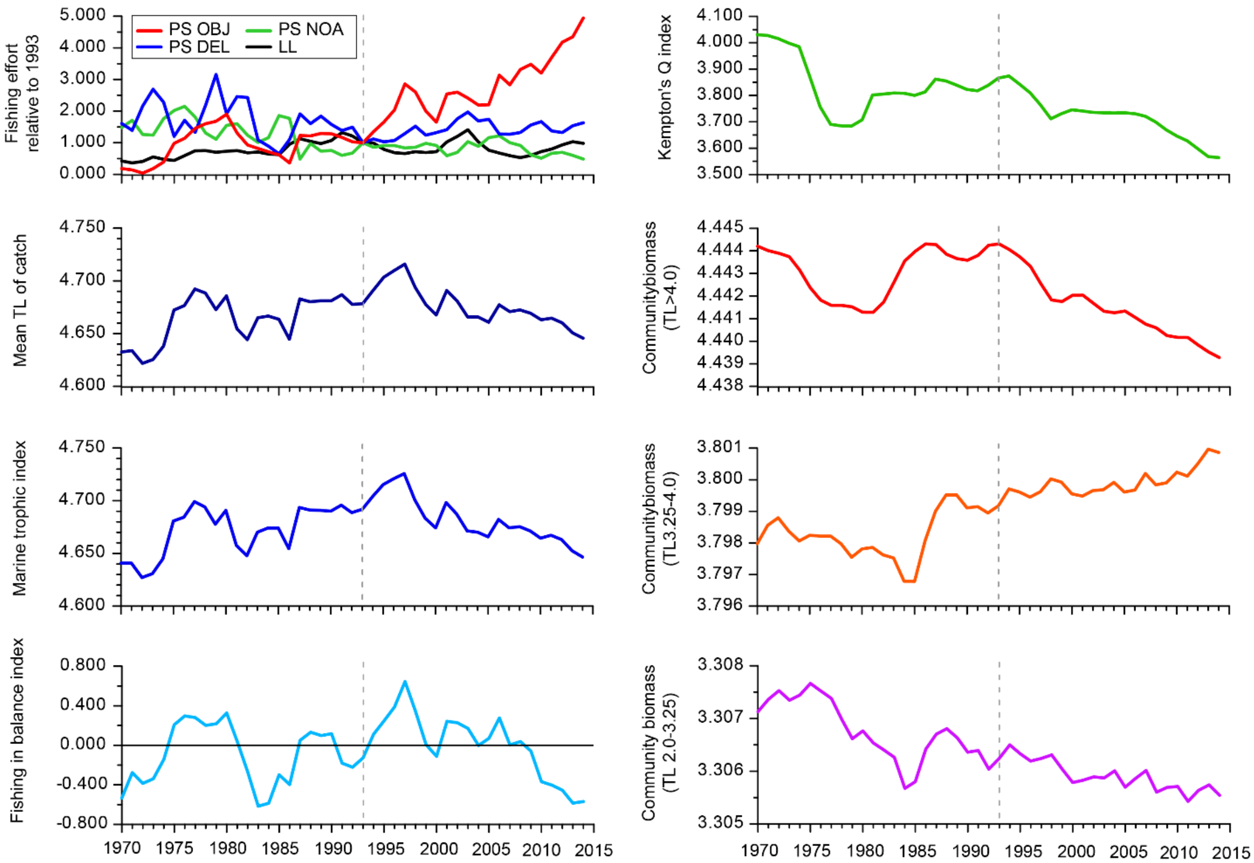

FIGURE L-9. Annual values for seven ecological indicators of changes in different components of the tropical EPO ecosystem, 1970-2014 (see Section 6 of text for details), and an index of longline (LL) and purse-seine (PS) fishing effort, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)), relative to the model start year of 1993 (vertical dashed line), when the expansion of the purse-seine fishery on FADs began.

FIGURA L-9. Valores anuales de siete indicadores ecológicos de cambios en diferentes componentes del ecosistema tropical del OPO, 1970-2014 (ver detalles en la sección 6 del texto), y un índice de esfuerzo palangrero (LL) y cerquero (PS), por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)) relativo al año de inicio del modelo de 1993 (línea de trazos vertical), cuando comenzó la expansión de la pesquería cerquera sobre plantados.

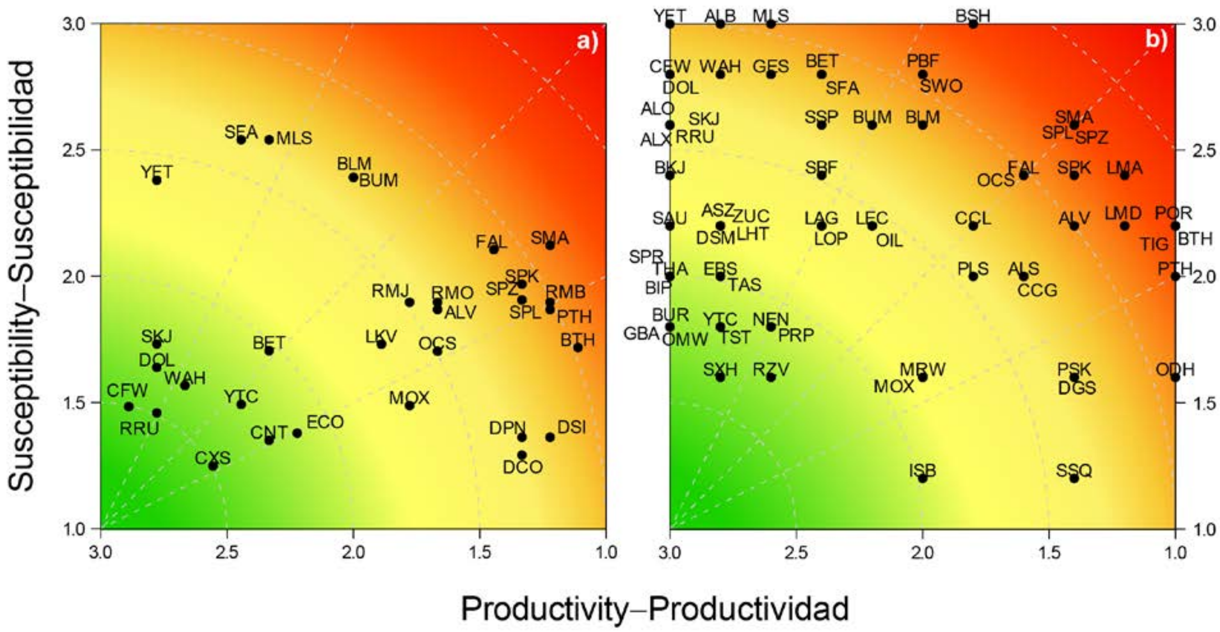

FIGURE L-10. Productivity and susceptibility x-y plot for target and bycatch species caught by the purse-seine fishery (a) and the longline fishery (b) in the EPO during 2005-2013 and 2017, respectively. See Tables L-1 and L-2 for species codes for each fishery.

FIGURA L-10. Gráfica x-y de productividad y susceptibilidad de especies objetivo y de captura incidental capturadas por la pesquería cerquera (a) y la pesquería palangrera (b) en el OPO durante 2005-2000 y 2017, respectivamente. Ver códigos de especies para cada pesquería en las Tablas L-1 y L-2.

TABLE L-1. Productivity (*p*) and susceptibility (*s*) scores used to compute the overall vulnerability measure *v* for the tuna purse-seine fishery of large vessels in the eastern Pacific Ocean. Susceptibility (*s*) scores are shown for each fishery (dolphin (DEL), unassociated (NOA), floating object (OBJ)) and as a weighted combination of the individual fishery values. Vulnerability scores rated as low (green), medium (yellow), and high (red).
TABLA L-1. Puntuaciones de productividad (*p*) y susceptibilidad (*s*) usadas para computar la medida general de vulnerabilidad *v*. D. Se señalan las puntuaciones de susceptibilidad para cada pesquería (DEL: delfín; NOA: no asociada; OBJ: objeto flotante) y como combinación ponderada de los valores de las pesquerías individuales. Puntuaciones de vulnerabilidad clasificadas de baja (verde), mediana (amarillo), y alta (rojo).

Group / Grupo	Scientific name / Nombre científico	Common name	Nombre común	Code / Código	*s* by fishery / *s* por pesquería DEL	NOA	OBJ	*p*	*s*	*v*
Tunas Atunes	*Thunnus albacares*	Yellowfin tuna	Atún aleta amarilla	YFT	2.38	2.38	2.38	2.78	2.38	1.4
	Thunnus obesus	Bigeye tuna	Atún patudo	BET	1	2.23	2.38	2.33	1.7	0.97
	Katsuwonus pelamis	Skipjack tuna	Atún barrilete	SKJ	1	2.38	2.38	2.78	1.73	0.76
Billfishes Peces picudos	*Makaira nigricans*	Blue marlin	Marlín azul	BUM	2.23	2.23	2.69	2	2.39	1.71
	Istiompax indica	Black marlin	Marlín negro	BLM	2.23	2.23	2.69	2	2.39	1.71
	Kajikia audax	Striped marlin	Marlín rayado	MLS	2.54	2.54	2.54	2.33	2.54	1.68
	Istiophorus platypterus	Indo-Pacific sailfish	Pez vela indopacífico	SFA	2.54	2.54	2.54	2.44	2.54	1.64
Dolphins Delfines	*Stenella longirostris*	Unidentified spinner dolphin	Delfín tornillo no identificado	DSI	1.77	1	1	1.22	1.36	1.82
	Stenella attenuata	Unidentified spotted dolphin	Delfín manchado no identificado	DPN	1.77	1	1	1.33	1.36	1.71
	Delphinus delphis	Common dolphin	Delfín común	DCO	1.62	1	1	1.33	1.29	1.7
Large fishes Peces grandes	*Coryphaena hippurus*	Common dolphinfish	Dorado	DOL	1	2	2.31	2.78	1.64	0.68
	Coryphaena equiselis	Pompano dolphinfish	Dorado pompano	CFW	1	1	2.38	2.89	1.48	0.5
	Acanthocybium solandri	Wahoo	Peto	WAH	1	1	2.62	2.67	1.57	0.66
	Elagatis bipinnulata	Rainbow runner	Salmón	RRU	1	1	2.31	2.78	1.46	0.51
	Mola mola	Ocean sunfish, Mola	Pez luna	MOX	1	1.92	1.92	1.78	1.49	1.31
	Caranx sexfasciatus	Bigeye trevally	Jurel voráz	CXS	1	2.38	1	2.56	1.25	0.51
	Seriola lalandi	Yellowtail amberjack	Medregal rabo amarillo	YTC	1	2.08	1.85	2.44	1.49	0.75
Rays Rayas	*Manta birostris*	Giant manta	Mantarraya gigante	RMB	1.92	2.08	1.77	1.22	1.9	1.99
	Mobula japanica	Spinetail manta		RMJ	1.92	2.08	1.77	1.78	1.9	1.51
	Mobula thurstoni	Smoothtail manta		RMO	1.92	2.08	1.77	1.67	1.9	1.6
Sharks Tiburones	*Carcharhinus falciformis*	Silky shark	Tiburón sedoso	FAL	2.08	2.08	2.15	1.44	2.1	1.91
	Carcharhinus longimanus	Oceanic whitetip shark	Tiburón oceánico punta blanca	OCS	1.69	1	2.08	1.67	1.7	1.5
	Sphyrna zygaena	Smooth hammerhead shark	Cornuda común	SPZ	1.77	1.92	2.08	1.33	1.91	1.9
	Sphyrna lewini	Scalloped hammerhead shark	Cornuda gigante	SPL	1.77	1.92	2.08	1.33	1.91	1.9
	Sphyrna mokarran	Great hammerhead shark	Cornuda cruz	SPK	2.08	1.77	1.92	1.33	1.97	1.93
	Alopias pelagicus	Pelagic thresher shark	Tiburón zorro pelágico	PTH	1.92	1.92	1.77	1.22	1.87	1.98
	Alopias superciliosus	Bigeye thresher shark	Tiburón zorro ojón	BTH	1.77	2.08	1.46	1.11	1.72	2.02
	Alopias vulpinus	Common thresher shark	Tiburón zorro	ALV	1.92	1.92	1.77	1.67	1.87	1.59

Group / Grupo	Scientific name / Nombre científico	Common name	Nombre común	Code / Código	*s* by fishery / *s* por pesquería DEL	NOA	OBJ	*p*	*s*	*v*
	Isurus oxyrinchus	Short fin mako shark	Tiburón marrajo dientuso	SMA	2.23	2.23	1.92	1.22	2.12	2.1
Small fishes	*Canthidermis maculatus*	Ocean triggerfish	Pez ballesta oceánico	CNT	1	1	2	2.33	1.35	0.76
Peces pequeños	*Sectator ocyurus*	Bluestriped chub	Chopa	ECO	1	1	2.08	2.22	1.38	0.87
Turtles-Tortugas	*Lepidochelys olivacea*	Olive ridley turtle	Tortuga golfina	LKV	1.62	2.23	1.62	1.89	1.73	1.33

TABLE L-2. Species included in the productivity-susceptibility analysis for the large-scale tuna longline fishery in the eastern Pacific Ocean, showing average productivity (*p*) and susceptibility (*s*) scores used to compute the overall vulnerability score (*v*) for each species, rated as low (green), medium (yellow), and high (red).

TABLA L-2. Especies incluidas en el análisis de productividad-susceptibilidad de la pesquería atunera palangrera a gran escala en el Océano Pacífico oriental. indicado las puntuaciones promedio de productividad (*p*) y susceptibilidad (*s*) usadas para calcular la puntuación general de vulnerabilidad (*v*) para cada especie, clasificada como baja (verde), mediana (amarillo), y alta (rojo).

Group / Grupo	Scientific name / Nombre científico	Common name	Nombre común	Code / Código	*p*	*s*	*v*
Billfishes	*Istiompax indica*	Black marlin	Marlín negro	BLM	2.00	2.60	1.89
Peces picudos	*Istiophorus platypterus*	Indo-Pacific sailfish	Pez vela indopacífico	SFA	2.40	2.80	1.90
	Kajikia audax	Striped marlin	Marlín rayado	MLS	2.60	3.00	2.04
	Makaira nigricans	Blue marlin	Marlín azul	BUM	2.20	2.60	1.79
	Tetrapturus angustirostris	Shortbill spearfish	Marlín trompa corta	SSP	2.40	2.60	1.71
	Xiphias gladius	Swordfish	Pez espada	SWO	2.00	2.80	2.06
Tunas	*Katsuwonus pelamis*	Skipjack	Barrilete	SKJ	3.00	2.60	1.60
Atunes	*Thunnus alalunga*	Albacore	Albacora	ALB	2.80	3.00	2.01
	Thunnus albacares	Yellowfin	Aleta amarilla	YFT	3.00	3.00	2.00
	Thunnus maccoyii	Southern bluefin	Aleta azul del sur	SBF	2.40	2.40	1.52
	Thunnus obesus	Bigeye	Patudo	BET	2.40	2.80	1.90
	Thunnus orientalis	Pacific bluefin	Aleta azul del Pacífico	PBF	2.00	2.80	2.06
Elasmobranchs	*Alopias pelagicus*	Pelagic thresher shark	Zorro pelágico	PTH	1.00	2.00	2.24
Elasmobranquios	*Alopias superciliosus*	Bigeye thresher shark	Zorro ojón	BTH	1.00	2.20	2.33
	Alopias vulpinus	Common thresher shark	Zorro	ALV	1.40	2.20	2.00
	Carcharhinus albimarginatus	Silvertip shark	Tiburón de puntas blancas	ALS	1.60	2.00	1.72
	Carcharhinus falciformis	Silky shark	Tiburón sedoso	FAL	1.60	2.40	1.98
	Carcharhinus galapagensis	Galapagos shark	Tiburón de Galápagos	CCG	1.60	2.00	1.72

Group / Grupo	Scientific name / Nombre científico	Common name	Nombre común	Code / Código	*p*	*s*	*v*
	Carcharhinus limbatus	Blacktip shark	Tiburón macuira	CCL	1.80	2.20	1.70
	Carcharhinus longimanus	Oceanic whitetip shark	Tiburón oceánico punta blanca	OCS	1.60	2.40	1.98
	Galeocerdo cuvier	Tiger shark	Tintorera tigre	TIG	1.00	2.20	2.33
	Prionace glauca	Blue shark	Tiburón azul	BSH	1.80	3.00	2.33
	Pteroplatytrygon violacea	Pelagic stingray		PLS	1.80	2.00	1.56
	Isurus oxyrinchus	Shortfin mako shark	Marrajo dientuso	SMA	1.40	2.60	2.26
	Isurus paucus	Longfin mako shark	Marrajo carite	LMA	1.20	2.40	2.28
	Lamna ditropis	Salmon shark	Marrajo salmón	LMD	1.20	2.20	2.16
	Lamna nasus	Porbeagle shark	Marrajo sardinero	POR	1.00	2.20	2.33
	Odontaspis noronhai	Bigeye sand tiger shark	Solrayo ojigrande	ODH	1.00	1.60	2.09
	Pseudocarcharias kamoharai	Crocodile shark	Tiburón cocodrilo	PSK	1.40	1.60	1.71
	Sphyrna lewini	Scalloped hammerhead shark	Cornuda común	SPL	1.40	2.60	2.26
	Sphyrna mokarran	Great hammerhead	Cornuda gigante	SPK	1.40	2.40	2.13
	Sphyrna zygaena	Smooth hammerhead	Cornuda cruz	SPZ	1.40	2.60	2.26
	Isistius brasiliensis	Cookie cutter shark	Tollo cigarro	ISB	2.00	1.20	1.02
	Squalus acanthias	Picked dogfish, Spiny dogfish	Mielga	DGS	1.40	1.60	1.71
	Zameus squamulosus	Velvet dogfish		SSQ	1.40	1.20	1.61
Mesopelagic fishes Peces mesopelágicos	*Alepisaurus brevirostris*	Short snouted lancetfish		ALO	3.00	2.60	1.60
	Alepisaurus ferox	Long snouted lancetfish	Lanzón picudo	ALX	3.00	2.60	1.60
	Eumegistus illustris	Brilliant pomfret		EBS	2.80	2.00	1.02
	Taractes asper	Rough pomfret		TAS	2.80	2.00	1.02
	Taractichthys steindchneri	Sickle Pomfret	Tristón segador	TST	2.80	1.80	0.82
	Gempylus serpens	Snake mackerel	Escolar de canal	GES	2.60	2.80	1.84
	Lepidocybium flavobrunneum	Escolar	Escolar negro	LEC	2.20	2.20	1.44
	Nesiarchus nasutus	Black gemfish	Escolar narigudo	NEN	2.60	1.80	0.89
	Promethichthys prometheus	Roudi escolar	Escolar prometeo	PRP	2.60	1.80	0.89
	Ruvettus pretiosus	Oilfish	Escolar clavo	OIL	2.20	2.20	1.44
	Lampris guttatus	Opah	Opa	LAG	2.40	2.20	1.34
	Lophotus capellei	Crestfish		LOP	2.40	2.20	1.34
	Masturus lanceolatus	Sharptail mola		MRW	2.00	1.60	1.17
	Mola mola	Sunfish	Pez luna	MOX	2.00	1.60	1.17

Group Grupo	Scientific name Nombre científico	Common name	Nombre común	Code Código	*p*	*s*	*v*
	Ranzania laevis	Slender sunfish		RZV	2.60	1.60	0.72
	Omosudis lowii	Omosudid (Hammerjaw)		OMW	3.00	1.80	0.80
	Scombrolabrax heterolepis	Longfin escolar		SXH	2.80	1.60	0.63
	Desmodema polystictum	Polka-dot ribbonfish		DSM	2.80	2.20	1.22
	Zu cristatus	Scalloped ribbonfish		ZUC	2.80	2.20	1.22
	Assurger anzac	Razorback scabbardfish	Sable aserrado	ASZ	2.80	2.20	1.22
	Trachipterus fukuzakii	Tapertail ribbonfish		LHT	2.80	2.20	1.22
Tuna-like species Especies afines a los atunes	*Elagatis bipinnulata*	Rainbow runner	Salmón	RRU	3.00	2.60	1.60
	Seriola lalandi	Yellowtail amberjack	Medregal rabo amarillo	YTC	2.80	1.80	0.82
	Opisthonema oglinum	Atlantic thread herring	Machuelo hebra atlántico	THA	3.00	2.00	1.00
	Sprattus sprattus	European sprat	Espadín	SPR	3.00	2.00	1.00
	Coryphaena equiselis	Pompano dolphinfish	Dorado pompano	CFW	3.00	2.80	1.80
	Coryphaena hippurus	Common dolphinfish	Dorado	DOL	3.00	2.80	1.80
	Pomadasys jubelini	Sompat grunt	Ronco sompat	BUR	3.00	1.80	0.80
	Scomberesox saurus	Atlantic saury	Paparda del Atlántico	SAU	3.00	2.20	1.20
	Acanthocybium solandri	Wahoo	Peto	WAH	2.80	2.80	1.81
	Euthynnus lineatus	Black skipjack	Barrilete negro	BKJ	3.00	2.40	1.40
	Sarda orientalis	Striped bonito	Bonito mono	BIP	3.00	2.00	1.00
	Sphyraena barracuda	Great barracuda	Picuda barracuda	GBA	3.00	1.80	0.80