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REPORT ON THE TUNA FISHERY, STOCKS, AND ECOSYSTEM IN THE EASTERN PACIFIC OCEAN IN 2019

INTRODUCTION

This report provides a summary of the catches and effort in 2019 of the fishery for tunas in the eastern Pacific Ocean (EPO), for whose management the Inter-American Tropical Tuna Commission (IATTC) is responsible. It is based on data available to the IATTC staff in March 2020; therefore, some of the data for 2019 are incomplete, and all data for 2018 and 2019 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]
UNK	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
CHL	Chile
CHN	China
COL	Colombia
CRI	Costa Rica
ECU	Ecuador
EUR	European Union
EU (CYP)	Cyprus
EU (ESP)	Spain
EU (PRT)	Portugal
FRA	France
FRA (PYF)	French Polynesia
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 flag codes	
COK	Cook 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

INTRODUCTION

This document summarizes the catches and effort of the fisheries for species covered by the IATTC's Antigua 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) in 2019. The most important of these species are the scombrids (family Scombridae), which include tunas, bonitos, seerfishes, and some mackerels. The principal species of tunas caught are the three tropical tuna species (yellowfin, skipjack, and bigeye), followed by the temperate tunas (albacore, and lesser catches of Pacific bluefin); other scombrids, such as bonitos and wahoo, are also caught.

There are important fisheries for dorado, sharks, and other species and groups that interact with the tuna fisheries in the EPO and are thus within the IATTC's remit. This document therefore also covers other species such as billfishes (swordfish, marlins, shortbill spearfish, and sailfish), carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes. Additional information on these species is provided in Document SAC-11-13, *Ecosystem considerations*.

Access to the fisheries is regulated by Resolution C-02-03, which allows only vessels on the IATTC Regional Vessel Register to fish for tunas in the EPO. Vessels are authorized to fish by their respective flag governments, and only duly authorized vessels are included in the Register. The Register lists, in addition to a vessel's name and flag, its fishing gear, dimensions, carrying capacity, date of construction, ownership, home port, and other characteristics. However, this requirement has not been applied to the thousands of small artisanal vessels, called *pangas*, that are known to catch tunas, among other species, in coastal waters of the EPO, but data on their numbers, effort, and catches are incomplete or unavailable. A pilot program, focused on sharks, to collect data on these fisheries in Central America has been completed (SAC-11-14), and a long-term sampling program is scheduled to commence in 2020.

The IATTC staff has collected and compiled data on the longline fisheries since 1952, on catches of yellowfin and skipjack since 1954, bluefin since 1973, and bigeye since 1975. The data in this report, which are as accurate and complete as possible, are derived from various sources, including vessel logbooks, on-board observer data, unloading records provided by canners and other processors, export and import records, reports from governments and other entities, and the IATTC species and size composition sampling program.

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

Almost all the catches in the EPO are made by the purse-seine and longline fleets; pole-and-line vessels, and various artisanal and recreational fisheries, account for a small percentage of the total catches. The IATTC staff compiles catch data for all fishing gears, including trolls, harpoons, and gillnets.

Detailed catch data are available for the purse-seine fishery, which takes over 90% of the total reported catches; the data for the other fisheries are incomplete. Purse-seine data for 2018 and 2019, and 2017-2019 data for longlines and other gears, are preliminary.

Since 1993 all Class-6[2] purse-seine vessels carry observers, who collect detailed data on catches, including those discarded at sea. Estimates of the "retained" catch (the portion of the total catch that is landed) are based principally on data collected during vessel unloadings.

Longline vessels, particularly the larger ones, fish primarily for bigeye, yellowfin, albacore, and swordfish. Data on the retained catches of most of the larger longline vessels are obtained from the vessels' flag governments; data for smaller longliners, artisanal vessels, and other vessels that fish for species covered by the Antigua Convention are incomplete or unavailable, but some are obtained from vessel logbooks, or from governments or governmental reports.

Data for the western and central Pacific Ocean (WCPO) are taken from the Tuna Fishery Yearbook for 2018, published by the Western and Central Pacific Fisheries Commission (WCPFC).

This report summarizes data from all the above sources. The estimated total catches of tropical tunas (yellowfin, skipjack, and bigeye) in the entire Pacific Ocean are shown in Table A-1 and are discussed further in the sections below.

Estimates of the annual retained and discarded catches of tunas and other species taken by tuna-fishing vessels in the EPO during 1990-2019 are shown in Tables A-2a-c.

The catches of tropical tunas during 1990-2019, by flag, are shown in Tables A-3a-e, and the purse-seine catches and landings of tunas during 2018-2019 are summarized by flag in Tables A-4a-b.

2. CATCHES BY SPECIES

2.1. Yellowfin tuna

The total annual catches of yellowfin in the Pacific Ocean during 1990-2019 are shown in Table A-1. The 2019 EPO catch of 228 thousand t is 8% less than the average of 248 thousand t for the previous 5-year period (2014-2018). In the WCPO, the catches of yellowfin reached a record high of 692 thousand t in 2017.

The annual retained catches of yellowfin in the EPO, by gear, during 1990-2019 are shown in Table A-2a. Over the most recent 15-year period (2004-2018), the annual retained purse-seine and pole-and-line catches have fluctuated around an average of 224 thousand t (range: 167 to 274 thousand t). The preliminary estimate of the retained catch in 2019, 228 thousand t, is 5% less than that of 2018, but 2% greater than the 2004-2018 average. On average, about 0.5% (range: 0.1 to 1.1%) of the total purse-seine catch of yellowfin was discarded at sea during 2004-2018 (Table A-2a).

During 1990-2004, annual longline catches in the EPO averaged about 23 thousand t (range: 12 to 35 thousand t), or about 8% of the total retained catches of yellowfin. They then declined sharply, to an annual average of 10 thousand t (range: 8 to 13 thousand t), or about 4% of the total retained catches, during 2005-2018. Catches by other fisheries (recreational, gillnet, troll, artisanal, *etc.*), whether incidental or targeted, are shown in Table A-2a, under "Other gears" (OTR); during 2005-2018 they averaged about 2 thousand t.

2.2. Skipjack tuna

The total annual catches of skipjack in the Pacific Ocean during 1990-2019 are shown in Table A-1. Most of the catch is taken in the WCPO. Prior to 1998, WCPO catches averaged about 900 thousand t; subsequently, they increased steadily, from 1.2 million t to an all-time high of 2 million t in 2014. In the EPO, the greatest catches occurred between 2003 and 2019, ranging from 153 to 350 thousand t, the record catch in 2019.

[2] Class 6: carrying capacity greater than 363 metric tons (t)

The annual retained catches of skipjack in the EPO, by gear, during 1990-2019 are shown in Table A-2a. During 2004-2018 the annual retained purse-seine and pole-and-line catch averaged 267 thousand t (range: 147 to 338 thousand t). The preliminary estimate of the retained catch in 2019, 347 thousand t, is 30% greater than the 15-year average for 2004-2018.

Discards of skipjack at sea decreased each year during the period, from 8% in 2004 to a low of less than 1% in 2018, averaging about 2% of the total catch of the species (Table A-2a).

Catches of skipjack in the EPO by longlines and other gears are negligible (Table A-2a).

2.3. Bigeye tuna

The total annual catches of bigeye in the Pacific Ocean during 1990-2019 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased, but with considerable fluctuations. In the WCPO they averaged more than 77 thousand t during the late 1970s, decreased during the early 1980s, and then increased steadily to 119 thousand t in 1992; they jumped to 168 thousand t in 1998, and reached a high of 180 thousand t in 2004, since when they have fluctuated between 123 and 156 thousand t. In the EPO, the average catch during 1990-2019 was 105 thousand t, with a low of 83 thousand t in 1993 and a high of 149 thousand t in 2000.

The annual retained catches of bigeye in the EPO by purse-seine and pole-and-line vessels during 1990-2019 are shown in Table A-2a. The introduction of fish-aggregating devices (FADs), placed in the water by fishers to attract tunas, in 1993 led to a sudden and dramatic increase in the purse-seine catches. Prior to 1993, 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. During 1997-2018 it has fluctuated between 44 and 95 thousand t; the preliminary estimate for 2019 is 71 thousand t.

During 2000-2019 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, averaging about 1.7%.

Before the expansion of the FAD fishery, longliners caught almost all the bigeye in the EPO, averaging 88 thousand t annually during 1985-1992. Since 1993, the annual average catch has declined by 50%, to 44 thousand t, and the preliminary estimate for 2019 is less than 25 thousand t (Table A-2a).

Small amounts of bigeye are caught in the EPO by other gears (Table A-2a).

2.4. Pacific bluefin tuna

The catches of Pacific bluefin in the entire Pacific Ocean, by flag and gear, as reported by the vessels' flag governments to the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), are shown in Table A-5a.

The catches of Pacific bluefin in the EPO during 1990-2019, by gear, are shown in Table A-2a. In recent years, purse-seine vessels accounted for over 90% of the annual catch. The 1990-2018 average EPO retained catch is 3.6 thousand t (range: 400 t to 9.9 thousand t); the preliminary estimate for 2019 is 2.5 thousand t (Table A-2a).

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; the data are therefore converted to weights for inclusion in the EPO catch totals. The original catch data for 1990-2019, in numbers of fish, are presented in Table A-5b.

2.5. Albacore tuna

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

2.6. Other tunas and tuna-like species

While yellowfin, skipjack, and bigeye tunas comprise the great majority of the retained purse-seine catches in the EPO, other tunas and tuna-like species, such as black skipjack, bonito, frigate and bullet tunas, contribute to the overall harvest. The estimated annual retained and discarded catches of these species during 1990-2019 are shown in Table A-2a. The catches reported in the “unidentified tunas” (TUN) category in Table A-2a contain some catches reported by species (frigate and bullet tunas) along with the unidentified tunas. The total retained catch of these other species by the purse-seine fishery in 2019 was 12.2 thousand t, more than the 2004-2018 average of 8.0 thousand t (range: 1 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.

2.7. 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 1999-2013 the longline catch averaged 15 thousand t, but during 2014-2016 this increased by about 50%, to over 23 thousand t, possibly due to increased abundance of swordfish, increased effort directed toward the 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 2004-2018 were about 3.3 thousand and 1.8 thousand t, respectively. Smaller amounts of other billfishes are taken by longline.

Little information is available on the recreational catches of billfishes, but, the retained catches are believed to be substantially less than the commercial catches for all species, due to catch-and-release practices.

Billfishes are caught incidentally in the purse-seine fisheries, which during 2003-2017 accounted for about 1% of the total catch of billfishes in the EPO. Prior to 2011, they were all classified as discarded dead; however, the growing rate of retention of such bycatches made it important to reflect this in the data, and since 2011 retained catch and discards are reported separately in Table A-2b.

2.8. Other species

Data on catches of carangids (yellowtail, rainbow runner, jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), and other fishes caught in the EPO tuna fisheries, are shown in Table A-2c. The purse-seine data are from three different sources: estimates of retained and discarded catches by Class-6 vessels recorded by on-board observers, who cover all trips by such vessels; reported retained and discarded catch for Class-5 vessels, but only for the very small proportion of their trips covered by observers; and catches recorded in the logbooks of Class 1-5 vessels, which include only retained catches, not discards. The data for Class 1-5 vessels have not been raised to the total effort of the fleet, so they are considered minimum estimates only. The data for 2018-2019 are preliminary.

In previous reports, much of the catch of elasmobranchs was allocated to ‘other gears’ (OTR) in Table A-2c. However, it has been determined that many of these catches from 2006 onward were in fact made with longlines, and in this report they have been transferred to the correct column (LL) in the table.

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 15 thousand t in 2016.

3. CATCHES AND FISHING EFFORT

3.1. Purse seine

Estimates of the numbers of purse-seine sets of each type (associated with dolphins (DEL), associated with floating objects (OBJ), and unassociated (NOA)) in the EPO during 2004-2019, and the retained catches from those sets, are shown in Table A-7 and Figure 1.[3] The estimates for Class 1-5[4] vessels were calculated from logbook data in the IATTC statistical data base, and those for Class-6 vessels from the observer data bases of the IATTC, Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, the United States, and Venezuela.

Since the introduction of artificial fish-aggregating devices (FADs) in the mid-1990s, they have become predominant in the floating-object fishery, and now account for an estimated 98% of all floating-object sets by Class-6 vessels (Table A-8).

3.2. 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.

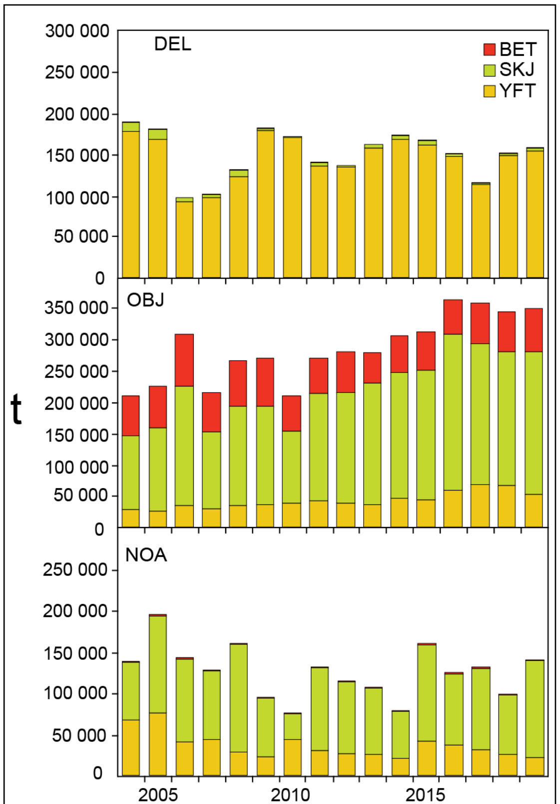


FIGURE 1. Purse-seine catches of tunas, by species and set type, 2004-2019

4. DISTRIBUTIONS OF THE CATCHES OF TROPICAL TUNAS

4.1. Purse-seine catches

The average annual distributions of purse-seine catches, by set type, of tropical tunas (yellowfin, skipjack, and bigeye) in the EPO during 2014-2018 are shown in Figures A-1a, A-2a, and A-3a, respectively, and preliminary estimates for 2019 are shown in Figures A-1b, A-2b, and A-3b.

Yellowfin: The majority of catches in 2019 were taken in sets associated with dolphins in three main areas: south of Mexico from 125°W to 145°W, north and east from the Galapagos Islands to the coast, and offshore west of 120°W. As in 2018, larger-than-normal catches of yellowfin were taken in dolphin sets far offshore around the equator. Lesser amounts were taken in floating-object sets throughout the EPO south of 10°N, with a singular concentration around 150°W and the equator (Figure A-1b).

Skipjack catches in 2019 were more evenly distributed throughout the EPO than in previous years, with most of the catch taken in floating-object sets throughout the EPO. Catches around the Galapagos Islands decreased from 2018, while catches near the coast of Peru increased, due to higher catches in unassociated sets (Figure A-2b).

Bigeye are not often caught north of about 7°N in the EPO, and almost all of the 2019 catches were taken in sets on FADs. More of the catch was taken far offshore than in previous years, concentrated mainly west of 120°W just north of the equator (Figure A-3b).

[3] The catch data for 2004-2019 incorporate previously unavailable data, and are thus different from the corresponding data presented in previous publications.

[4] ≤363 t carrying capacity

4.2. Longline catches

Since 2009, the IATTC has received tuna catch and effort data from Belize, China, France (French Polynesia), Japan, the Republic of Korea, Panama, 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 2014-2018 are shown in Figure A-4.

5. SIZE COMPOSITIONS OF THE CATCHES OF TUNAS

5.1. 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, primarily the integrated modeling that the staff uses to assess the status of the stocks (see Stock Assessment Reports). Length-frequency samples are obtained from the catches of purse-seine vessels in the EPO by IATTC personnel at ports of landing in Ecuador, Mexico, Panama, and Venezuela. 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.

Historical long-term time series of size-composition data for yellowfin and bigeye are available in the Stock Assessment Reports, and average length stock status indicators (SSIs) are available for yellowfin, bigeye and skipjack (SAC-11-05). In this report, data on the size composition of the catches during 2014-2019 are presented (Figures A-6 to A-8), with two sets of length-frequency histograms for each species: the first shows the data for 2019 by stratum (gear type, set type, and area), and the second the combined data for each year of the 2014-2019 period.

Yellowfin: nine purse-seine fisheries (four associated with floating objects (OBJ), three associated with dolphins (DEL), and two unassociated (NOA)) and one pole-and-line (LP) fishery, which includes all 13 sampling areas) are defined (Figure A-5). Of the 971 wells sampled during 2019, 728 contained yellowfin. The estimated size compositions of the fish caught are shown in Figure A-6a. Most of the yellowfin catch was taken in the DEL fisheries during the first half of the year, with smaller amounts taken in the NOA-N fishery in the second quarter and in the OBJ fisheries throughout the year. The largest yellowfin (>120 cm) were caught in the DEL-N fishery throughout the year, and in the NOA-N fishery. Smaller yellowfin (<60 cm) were taken in the OBJ fishery, primarily in the second, third and fourth quarters.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2014-2019 are shown in Figure A-6b. The average weight of yellowfin in 2019, 8.1 kg, continued the increase from previous years, and the size distribution also showed a trend toward larger fish, with the greatest quantity around the 140 cm length interval.

Skipjack: seven purse-seine fisheries (four OBJ, two NOA, one DEL) and one LP fishery are defined (Figure A-5); the last two include all 13 sampling areas. Of the 971 wells sampled, 668 contained skipjack. The estimated size compositions of the fish caught during 2019 are shown in Figure A-7a. Most of the skipjack catch was taken in the OBJ fisheries in the second, third and fourth quarters, and in the NOA-S fishery in the first and second quarters. Large skipjack (65-80 cm) were caught in the NOA-N fishery in the second quarter, close to 150°W between the equator and 10°N (Figure A-2b); the smallest (<40 cm) were caught primarily in the OBJ-N and OBJ-S fisheries in the second and fourth quarters.

The estimated size compositions of the skipjack caught by all fisheries combined during 2014-2019 are shown in Figure A-7b. The average weight of skipjack in 2019 (2.0 kg) was consistent with previous years (1.8-2.2 kg).

Bigeye: six purse-seine fisheries (four OBJ, one NOA, one DEL) and one LP fishery are defined (Figure A-

5); all except the OBJ fisheries include all 13 sampling areas. Of the 971 wells sampled, 202 contained bigeye. The estimated size compositions of the fish caught during 2019 are shown in Figure A-8a. Most of the 2019 catch of bigeye was taken in the OBJ-N and OBJ-S fisheries throughout the year, with lesser amounts caught in the OBJ-E fishery.

The estimated size compositions of bigeye caught by all fisheries combined during 2014-2019 are shown in Figure A-8b. The average weight of bigeye in 2019 (5.0 kg) was slightly higher than the previous four years (4.7-4.9 kg), but lower than the 2014 average of 5.6 kg. As in previous years, most of the bigeye caught was in the 40-80 cm range.

Pacific bluefin are caught by purse-seine and recreational gears off California and Baja California, historically from about 23°N to 35°N, but only between 28°N and 32°N in recent years. Also, the purse-seine fishing season has started earlier than previously: in 2019, bluefin were first caught in February, and the fishery was closed in March, when the annual catch limit was reached. Most of the catch is transported live to grow-out pens near the coast of Mexico. Mexico's National Fisheries Institute (INAPESCA) provided length-composition data for purse-seine catches during 2014-2019 (Figure A-9); the average weight for 2019 calculated from these length data, 42.3 kg, was lower than for 2017 and 2018 (55.4 and 55.7 kg, respectively), due to a sharp reduction in fish larger than 120 cm, but higher than for 2014-2016 (25.6-33.5 kg).

5.2. Longline fishery

The size compositions of yellowfin and bigeye caught by the Japanese longline fleet (commercial and training vessels) in the EPO during 2014-2018 are shown in Figures A-10 and A-11. The average annual weight during that period ranged from 35.1 to 61.0 kg for yellowfin, and from 60.7 kg to 66.2 kg for bigeye.

5.3. Catches of tunas, by flag and gear

The annual retained catches of tunas in the EPO during 1990-2019, by flag and gear, are shown in Tables A-3a-e. The purse-seine catches of tunas in 2018 and 2019, by flag and species, are summarized in Table A-4a. Of the nearly 653 thousand t of tunas caught in 2019, 46% were caught by Ecuadorian vessels, and 20% by Mexican vessels. Other countries with significant catches included Panama (10%), Colombia (7%), Venezuela (5%), United States (5%), Nicaragua (3%) and Peru (2%). The purse-seine landings of tunas in 2018 and 2019, by species and country of landing, are summarized in Table A-4b. Of the more than 622 thousand t of tunas landed in the EPO in 2019, 64% were landed in Ecuadorian ports, and 21% in Mexican ports. Other countries with landings of tunas in the EPO included Colombia (3%), Peru (4%) and the United States (2%).

6. THE FLEETS

6.1. Purse seine

The IATTC Regional Vessel Register contains detailed records of all purse-seine vessels that are authorized to fish for tunas in the EPO. However, only vessels that fished for yellowfin, skipjack, bigeye, and/or Pacific bluefin tuna in the EPO in 2019 are included in the following description of the purse-seine fleet.

The IATTC uses well volume, in cubic meters (m^3), to measure the carrying capacity of purse-seine vessels. Reliable well volume data are available for almost all purse-seine vessels; the well volume of vessels lacking such data is calculated by applying a conversion factor to their capacity in tons (Table A-10; Figure 2).

The 2018 and preliminary 2019 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 2019, the fleet was dominated by Ecuadorian and Mexican vessels, with about 34% and 23%, respectively, of the total well volume; they were followed by the United States (11%), Panama (9%), Venezuela (7%), Colombia (6%), Nicaragua (3%), El Salvador (2%), Peru (2%) and the European Union (Spain) (2%).[5]

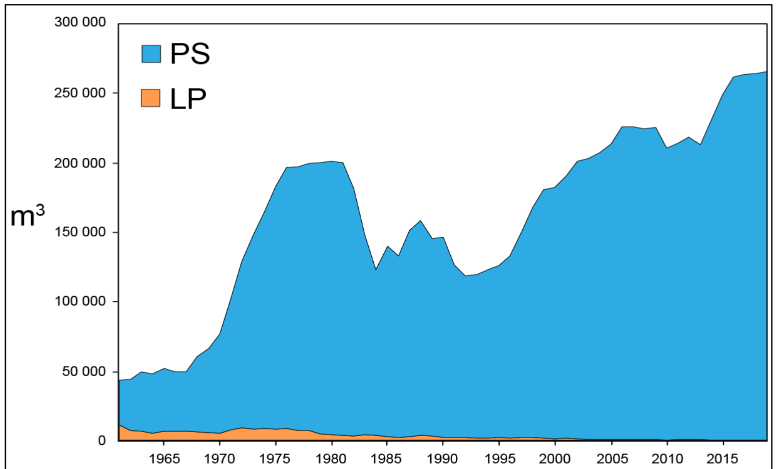


FIGURE 2. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2019

The cumulative capacity at sea during 2019 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 2009-2018, and the 2019 values, are shown in Table A-12. The monthly values are averages of the VAS estimated at weekly intervals by the IATTC staff. The average VAS values for 2009-2018 and 2019 were slightly over 141 thousand m^3 (60% of total capacity) and about 146 thousand m^3 (55% of total capacity), respectively.

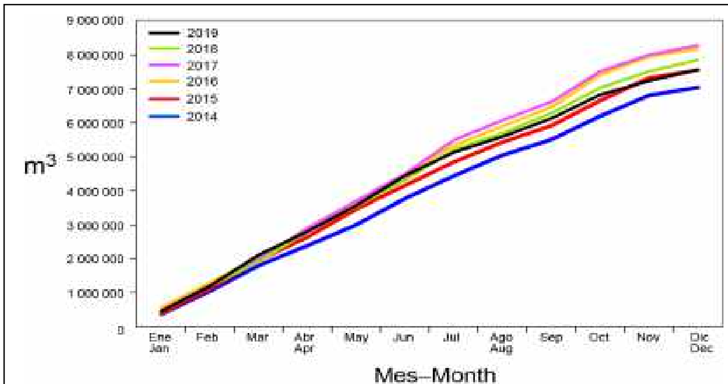


FIGURE 3. Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2014-2019

6.2. Other fleets of the EPO

Information on other types of vessels that are authorized to fish in the EPO is available in the IATTC's Regional Vessel Register. 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 2019, or ever.

[5] The sum of the percentages may not add up to 100% due to rounding.

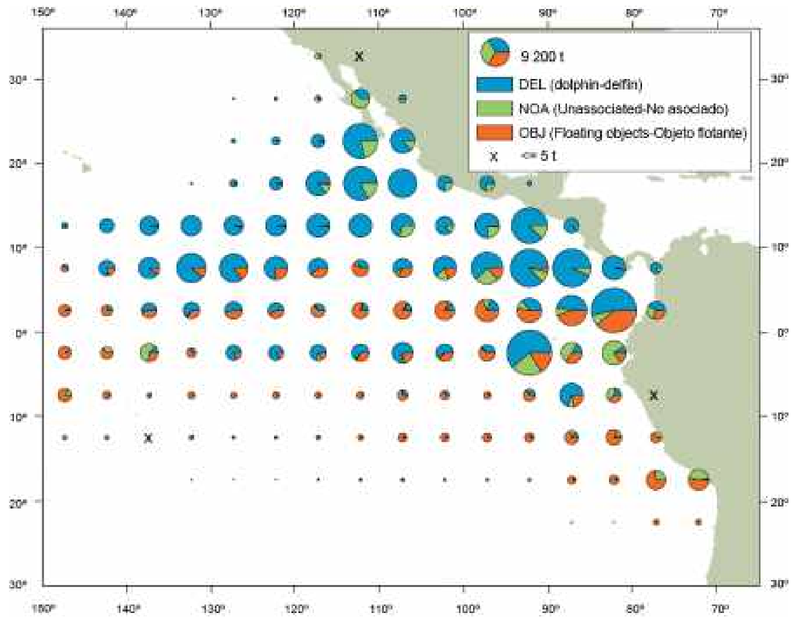


FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 2014-2018. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2014-2018. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

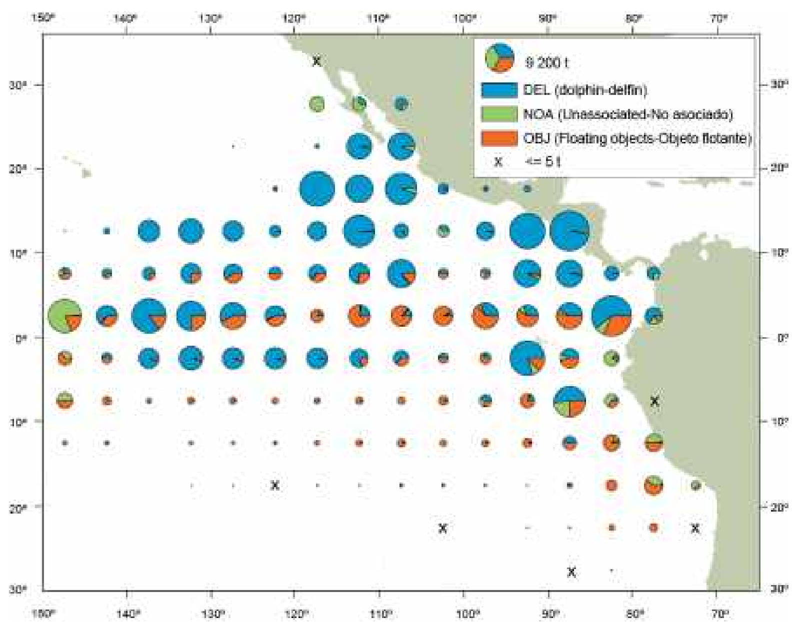


FIGURE A-1b. Annual distributions of the purse-seine catches of yellowfin, by set type, 2019. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.
FIGURA A-1b. Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2019. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

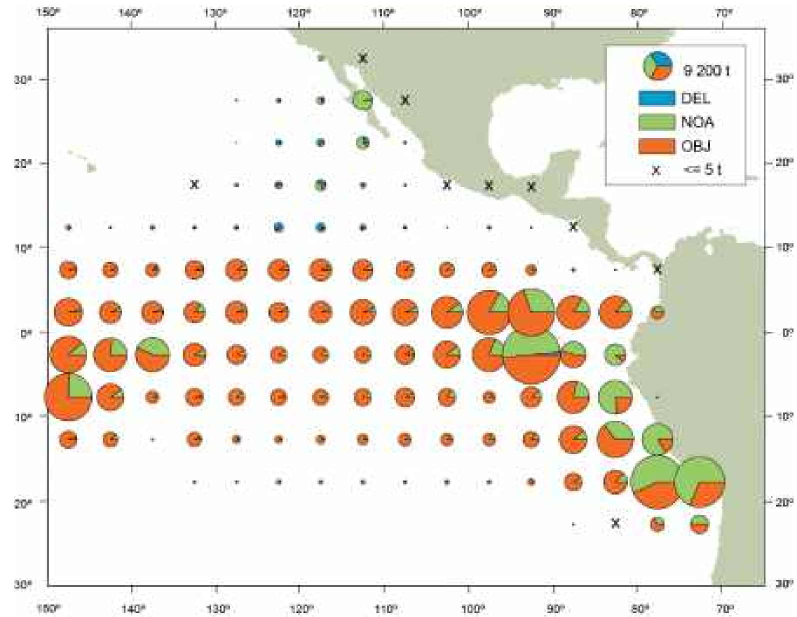


FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 2014-2018. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 2014-2018. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

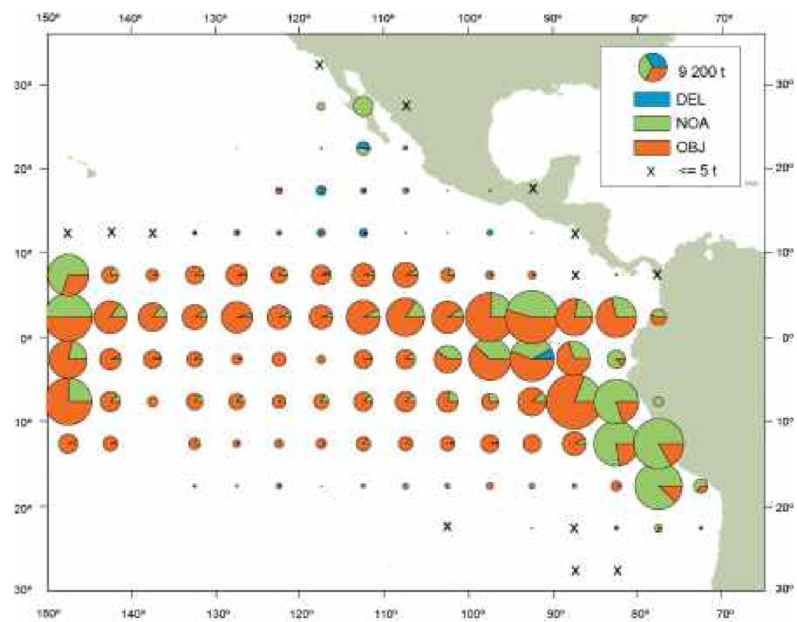


FIGURE A-2b. Annual distributions of the purse-seine catches of skipjack, by set type, 2019. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.
FIGURA A-2b. Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2019. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

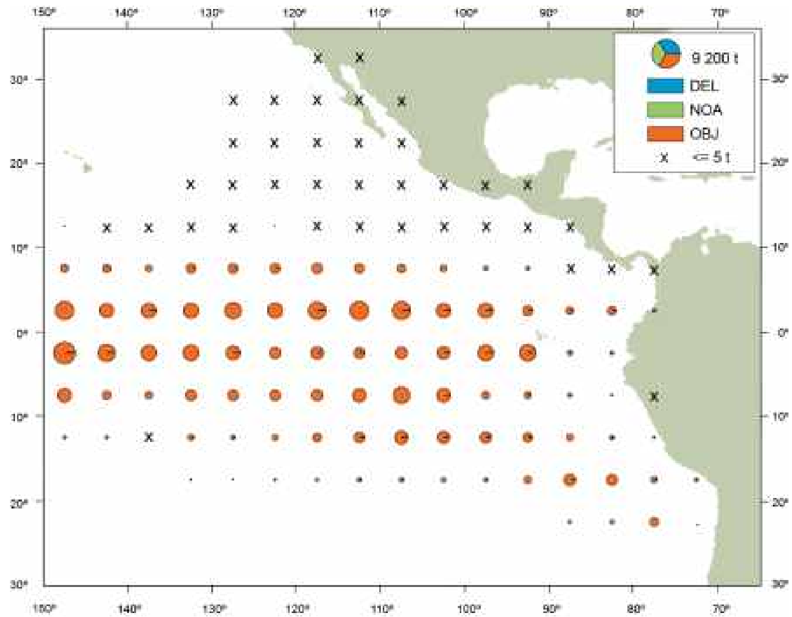


FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 2014-2018. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 2014-2018. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

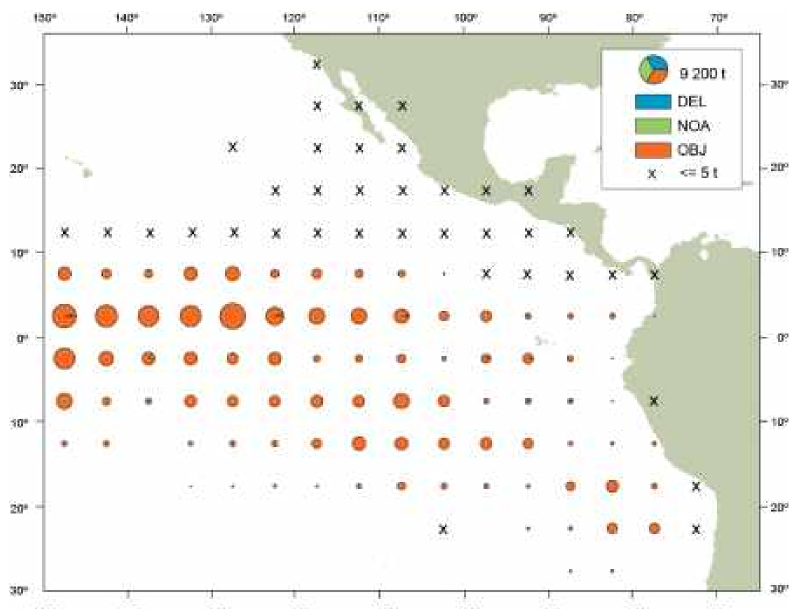


FIGURE A-3b. Annual distributions of the purse-seine catches of bigeye, by set type, 2019. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.
FIGURA A-3b. Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2019. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

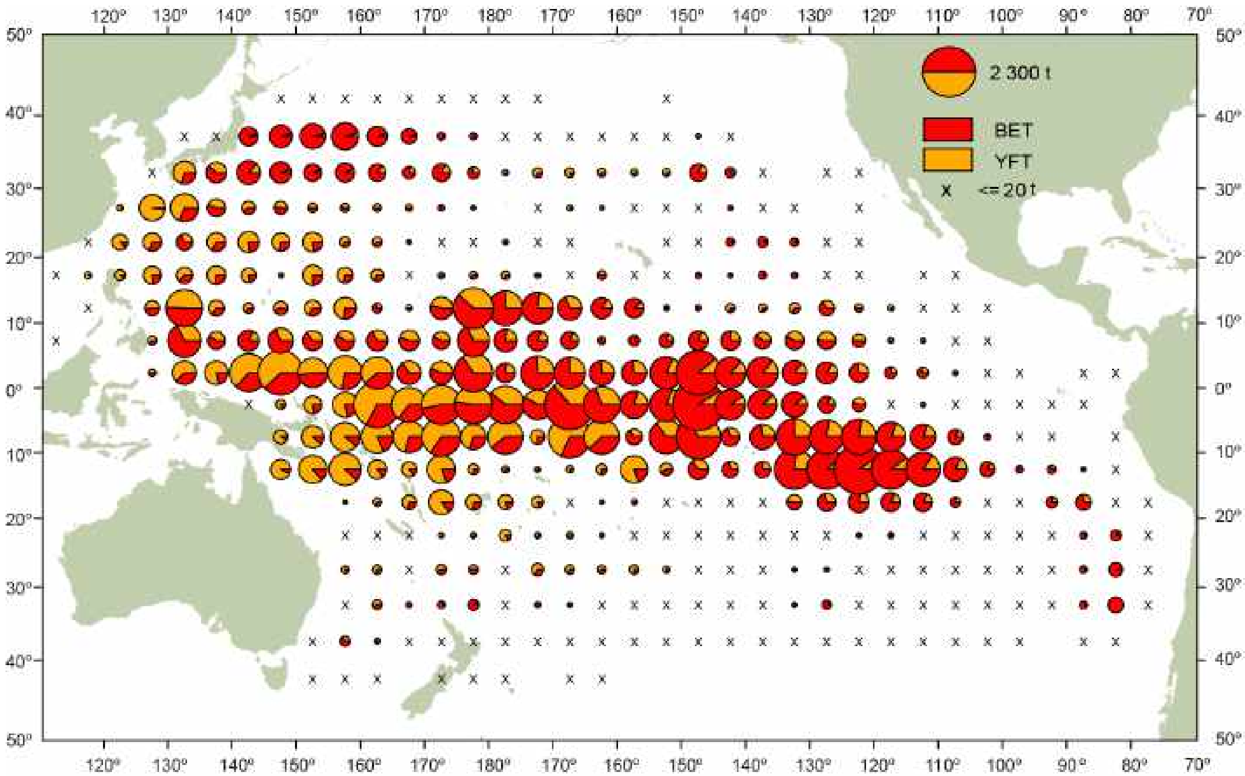


FIGURE A-4. Distributions of the average annual catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by Chinese, Japanese, Korean, and Chinese Taipei longline vessels, 2014-2018. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° 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, 2014-2018. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

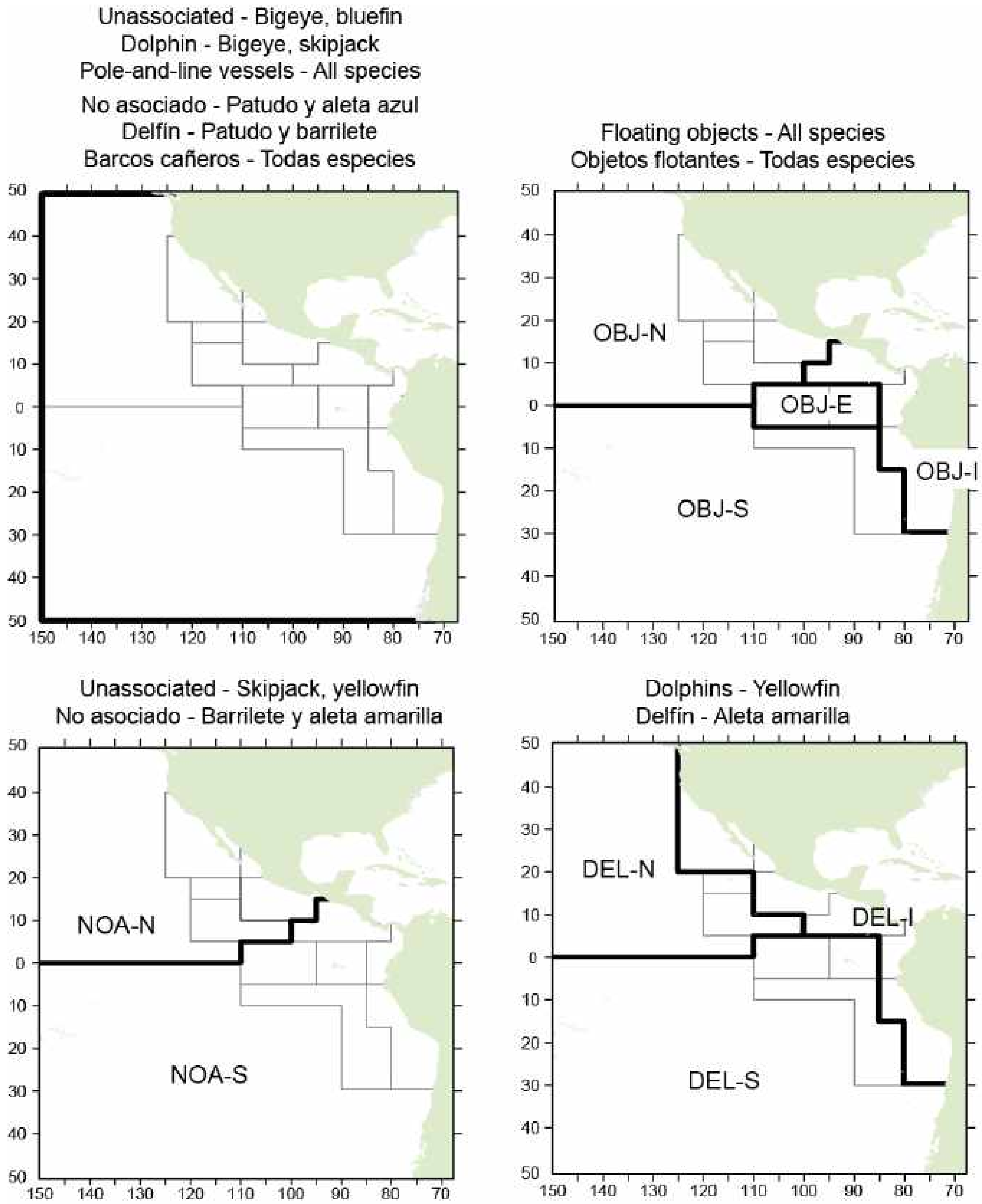


FIGURE A-5. The purse-seine fisheries defined by the IATTC staff for analyses of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

FIGURA A-5. Las pesquerías cerqueras definidas por el personal de la CIAT para los análisis de los atunes 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.

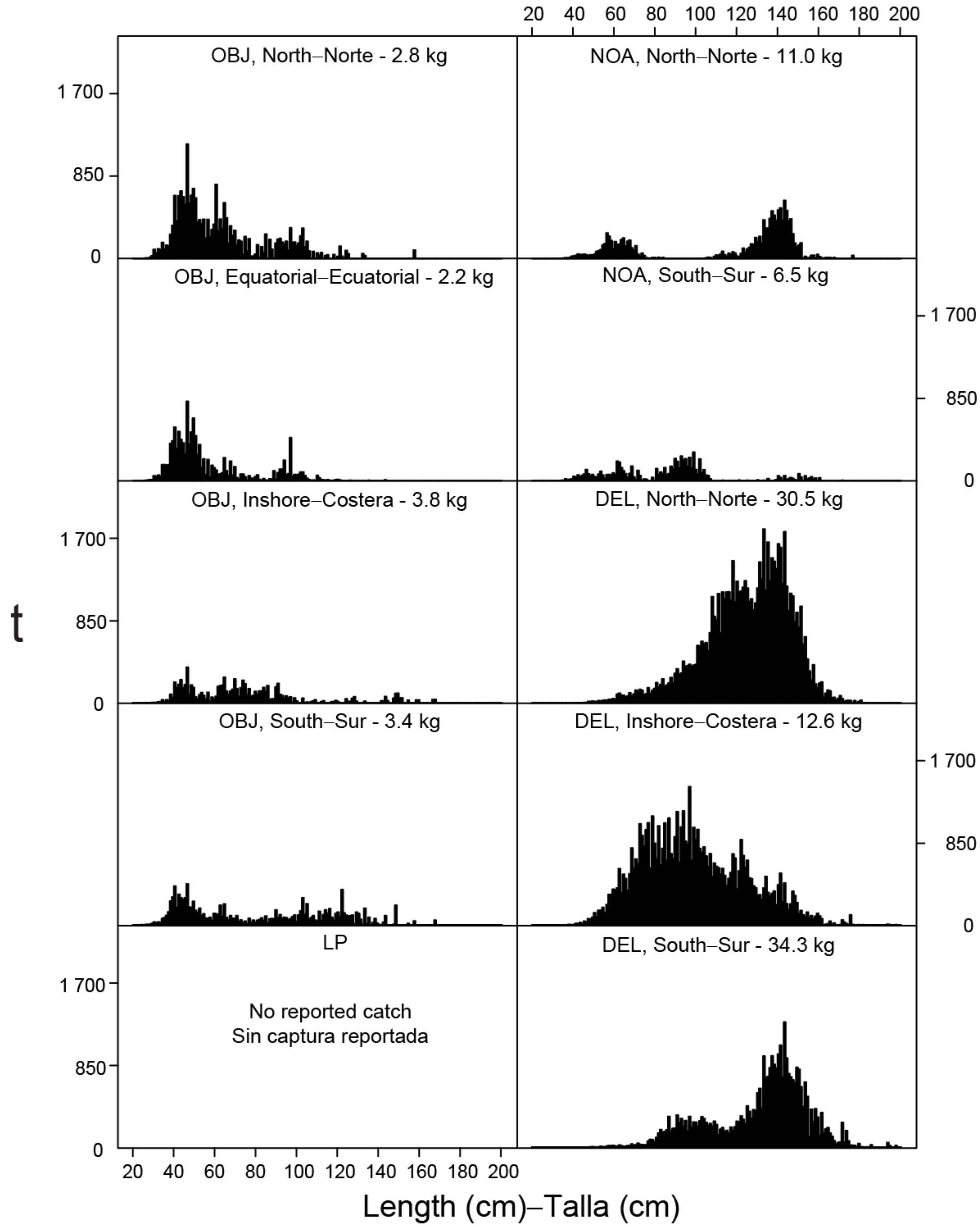


FIGURE A-6a. Estimated size compositions of the yellowfin caught in the EPO during 2019 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.
FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2019 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

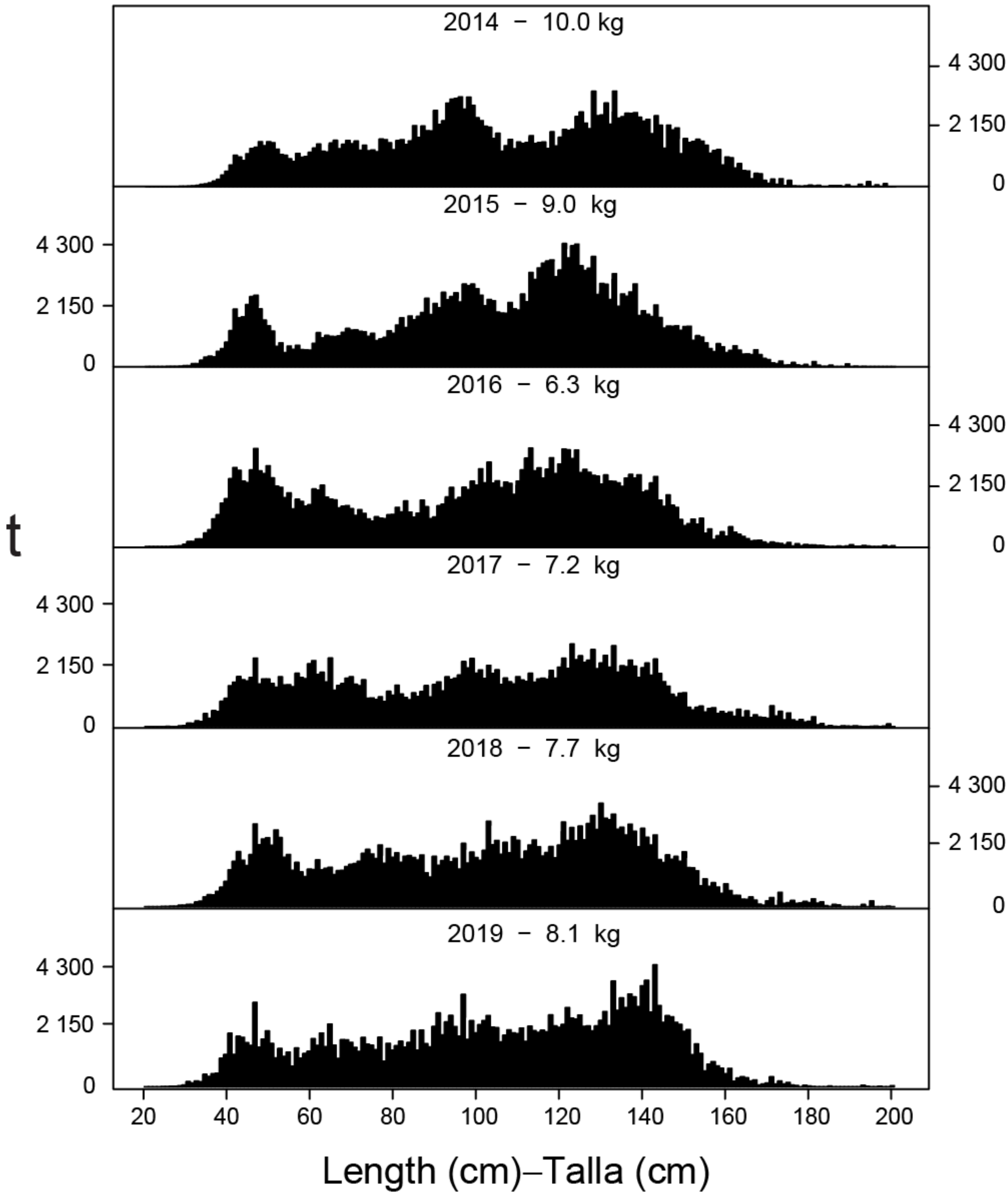


FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2014-2019. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2014-2019. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

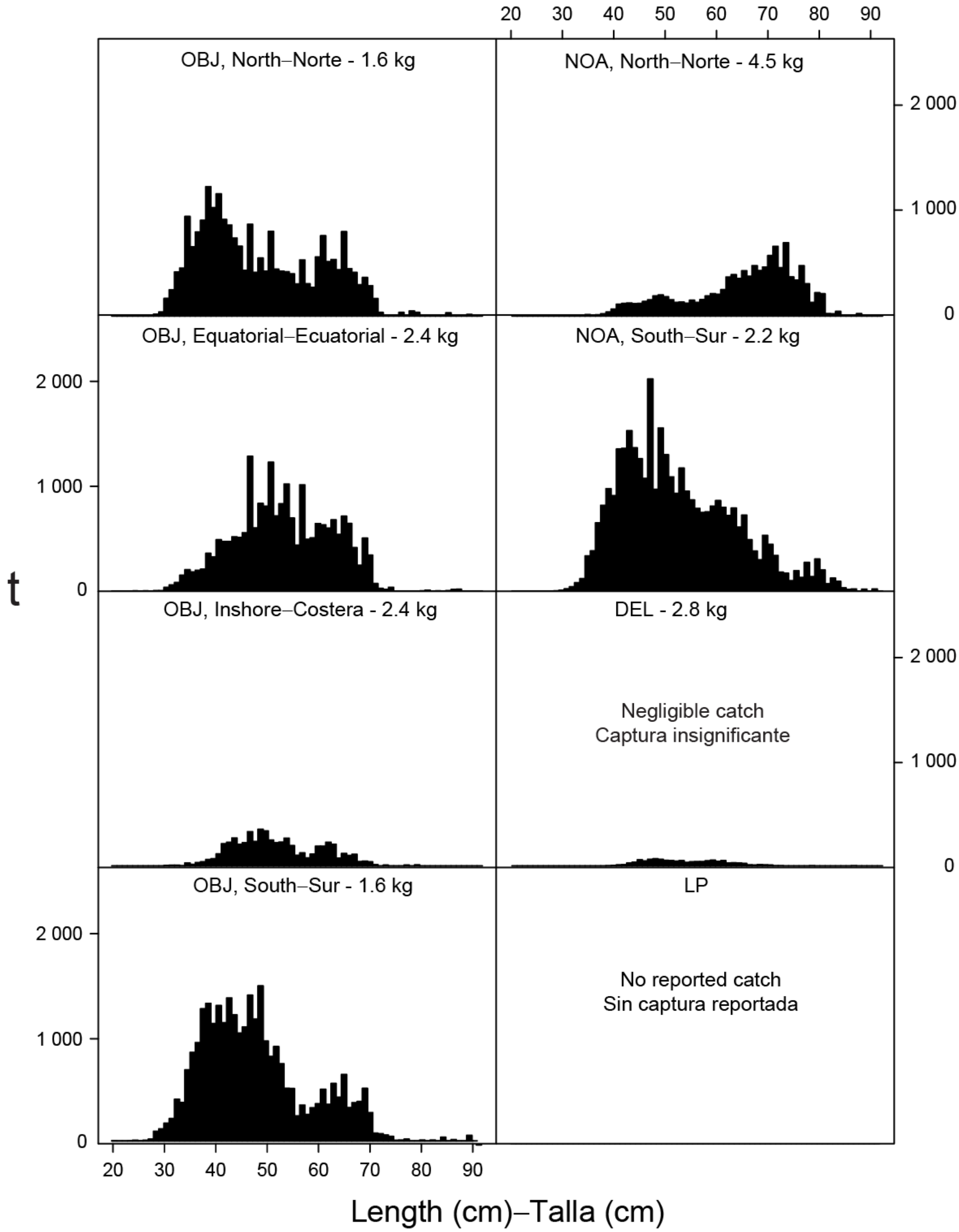


FIGURE A-7a. Estimated size compositions of the skipjack caught in the EPO during 2019 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.
FIGURA A-7a. Composición por tallas estimada del barrilete capturado en el OPO durante 2019 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

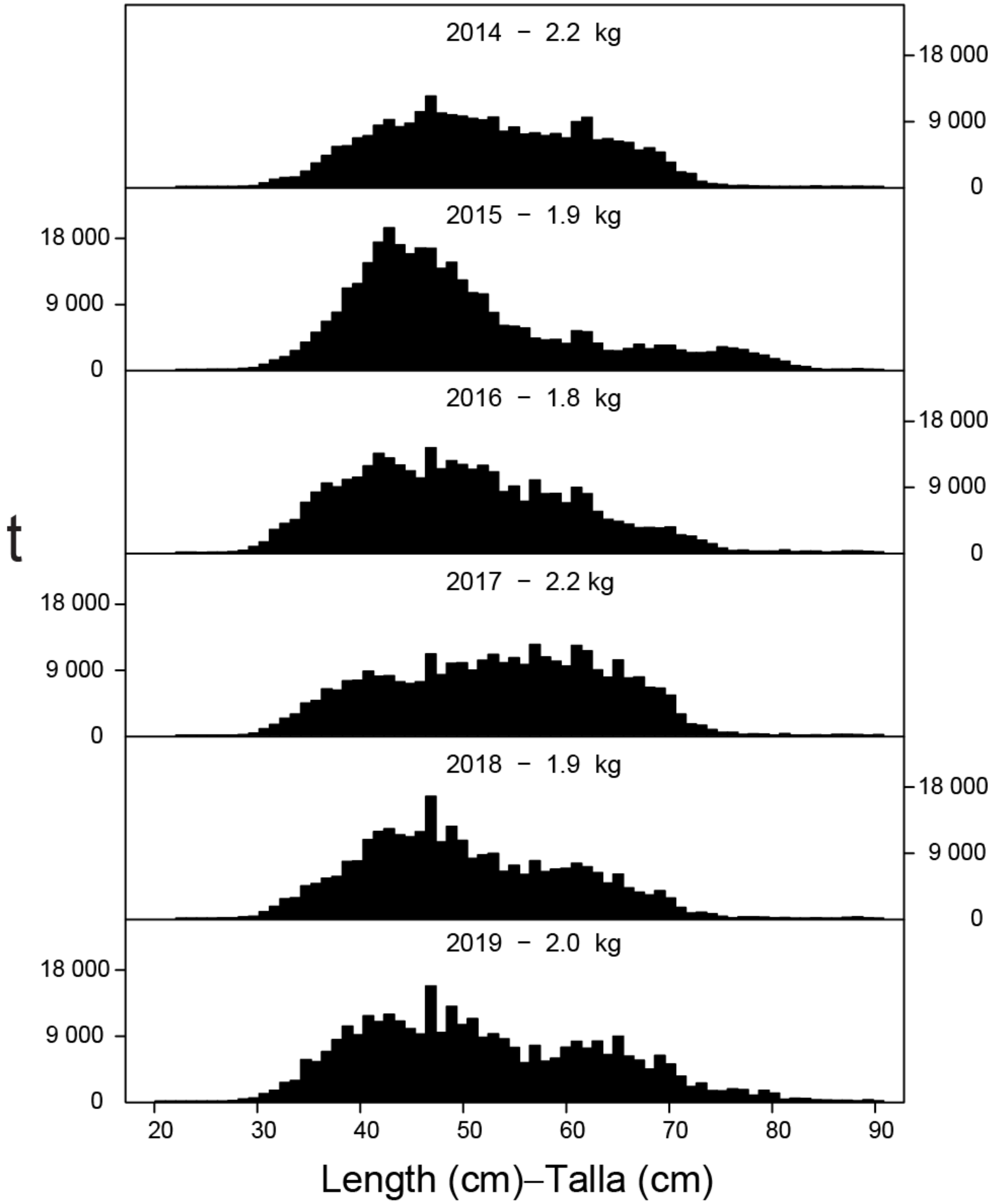


FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2014-2019. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2014-2019. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

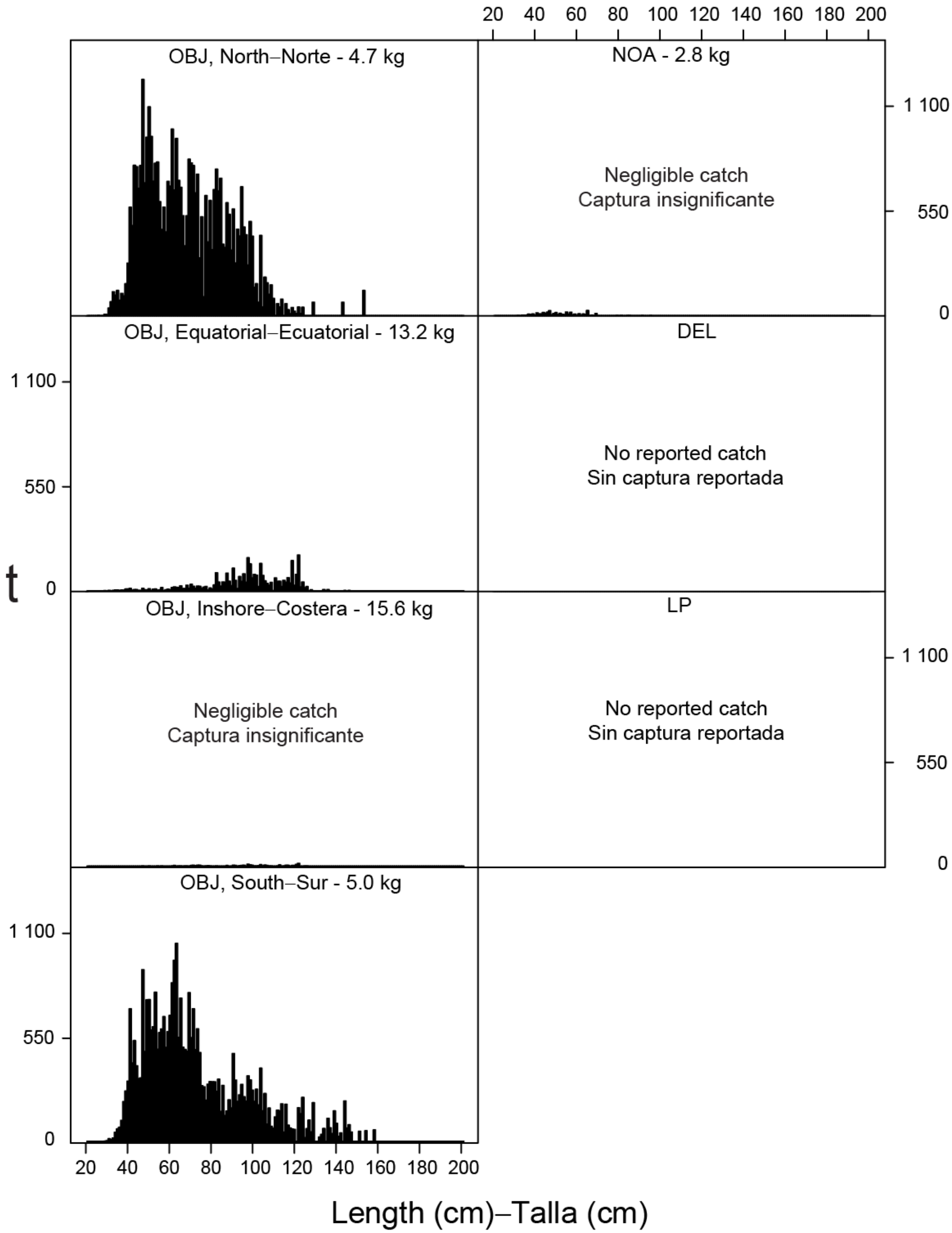


FIGURE A-8a. Estimated size compositions of the bigeye caught in the EPO during 2019 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight.

FIGURA A-8a. Composición por tallas estimada del patudo capturado en el OPO durante 2019 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

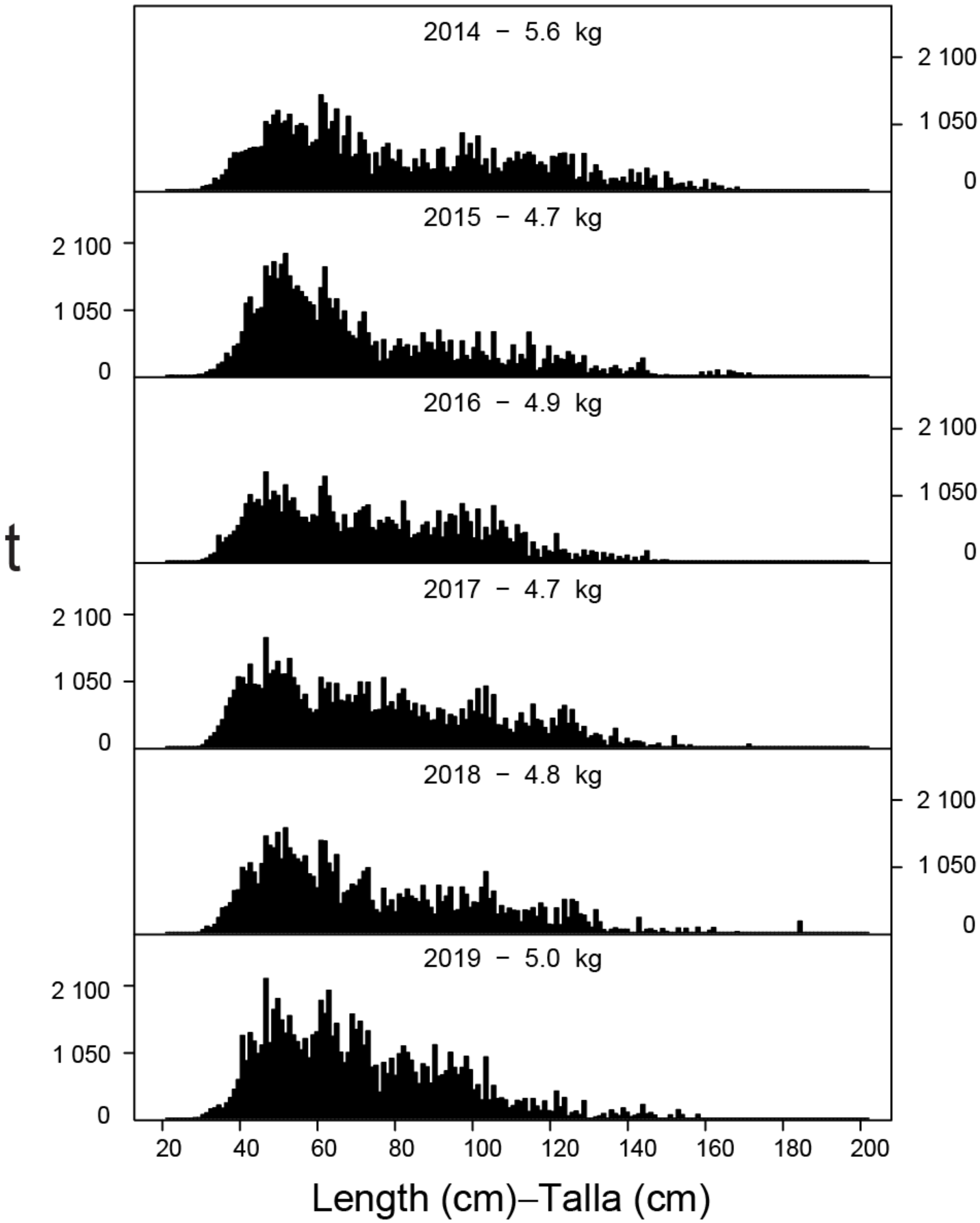


FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2014-2019. The value at the top of each panel is the average weight.

FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2014-2019. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

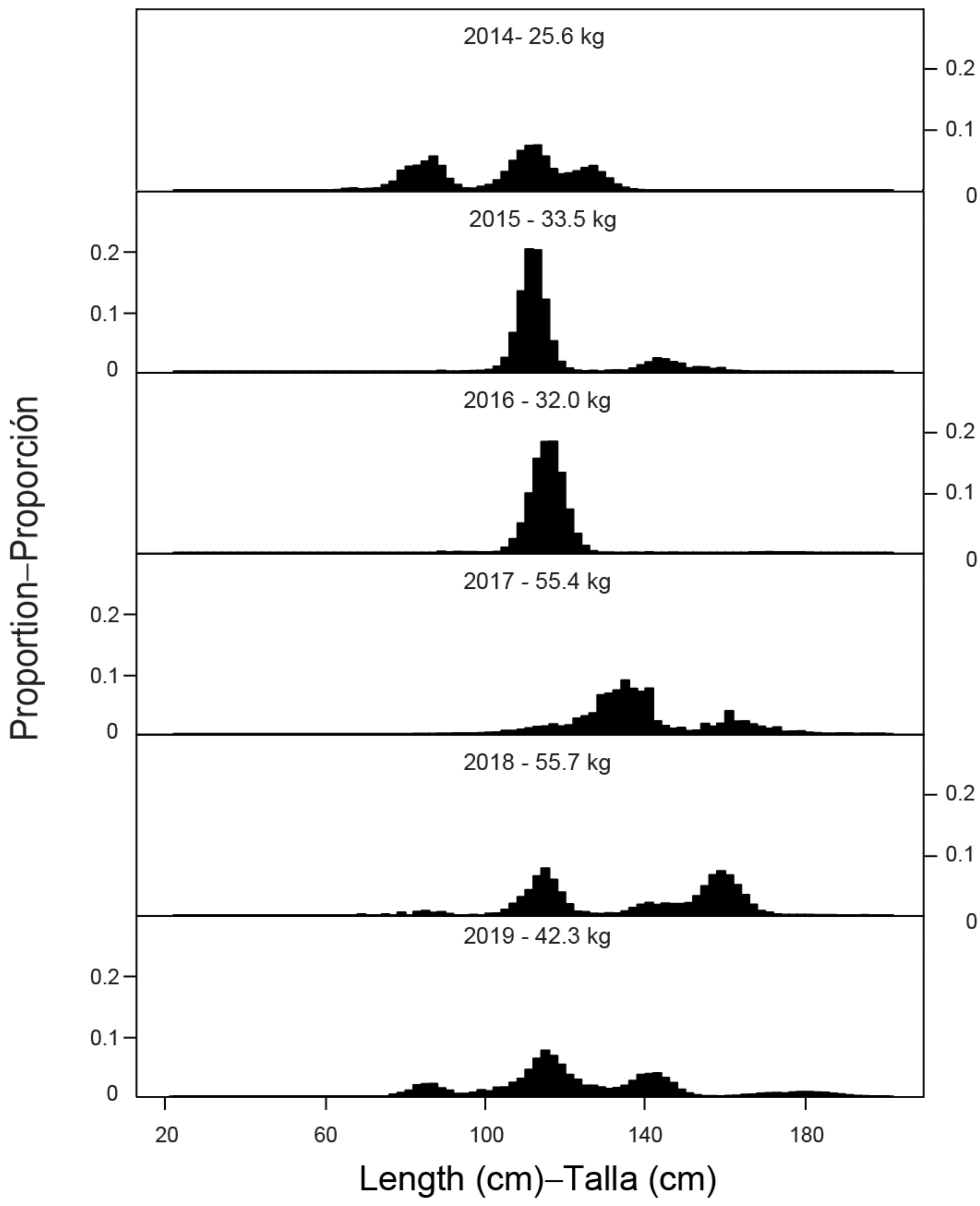


FIGURE A-9. Estimated length compositions of purse-seine catches of Pacific bluefin tuna, 2014-2019. The length distribution has been standardized as a proportion of the total number of measured tuna in each length interval. The value at the top of each panel is the average weight. Source: INAPESCA, Mexico.

FIGURA A-9. Composición por talla estimada de las capturas cerqueras de atún aleta azul del Pacífico, 2014-2019. La distribución de las tallas ha sido estandarizada como proporción del número total de atunes medidos en cada intervalo de talla. El valor en cada recuadro representa el peso promedio. Fuente: INAPESCA, México.

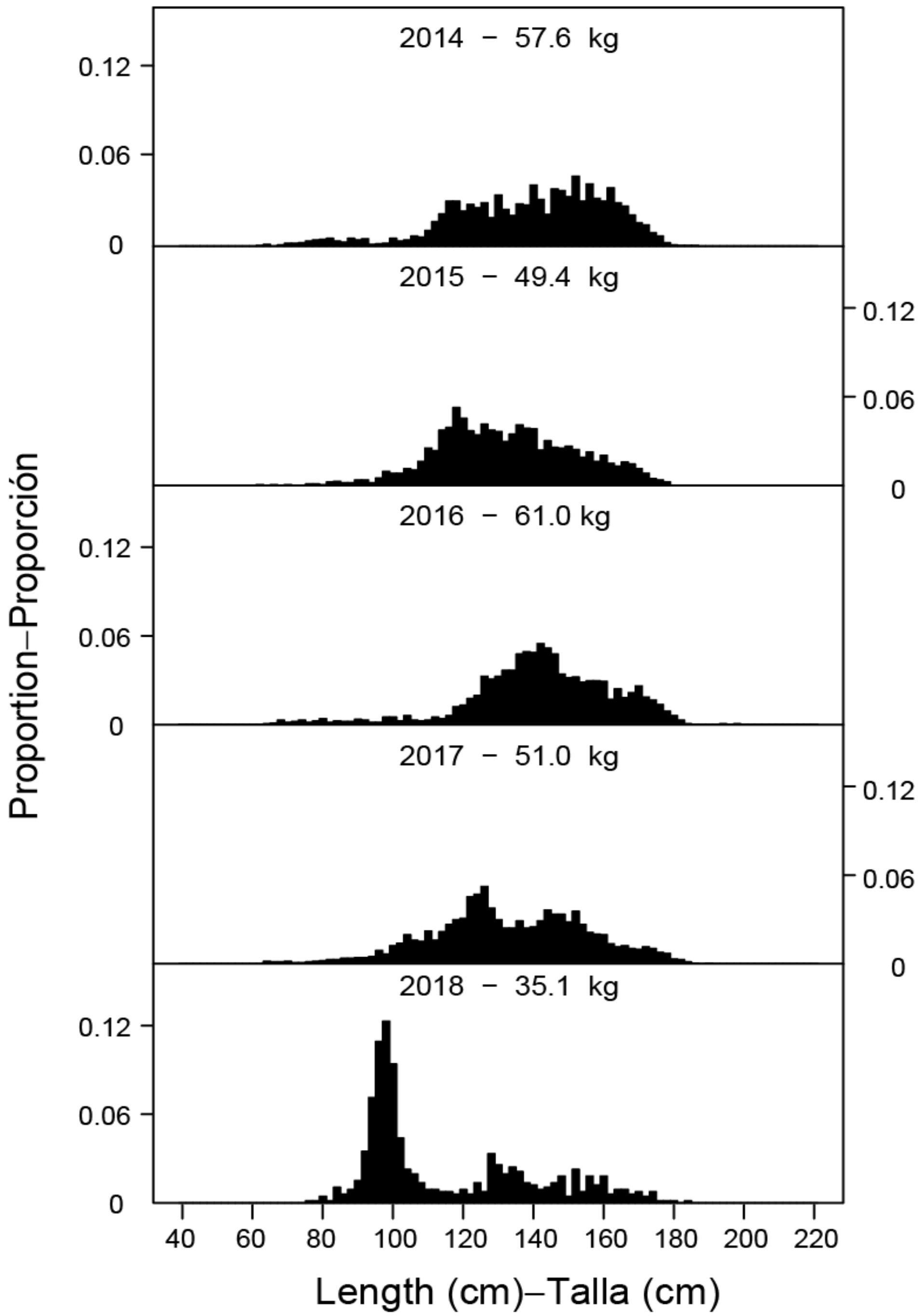


FIGURE A-10. Estimated size compositions of the catches of yellowfin by the Japanese longline fleet in the EPO, 2014-2018. The size distribution has been standardized as a proportion of the total number of measured tuna in each size range. The value at the top of each panel is the average weight. Source: Fisheries Agency of Japan.

FIGURA A-10. Composición por tallas estimada de las capturas de aleta amarilla por la flota palangrera japonesa en el OPO, 2014-2018. La distribución de las tallas ha sido estandarizada como proporción del número total de atunes medidos en cada gama de tallas. El valor en cada recuadro representa el peso promedio. Fuente: Agencia Pesquera de Japón.

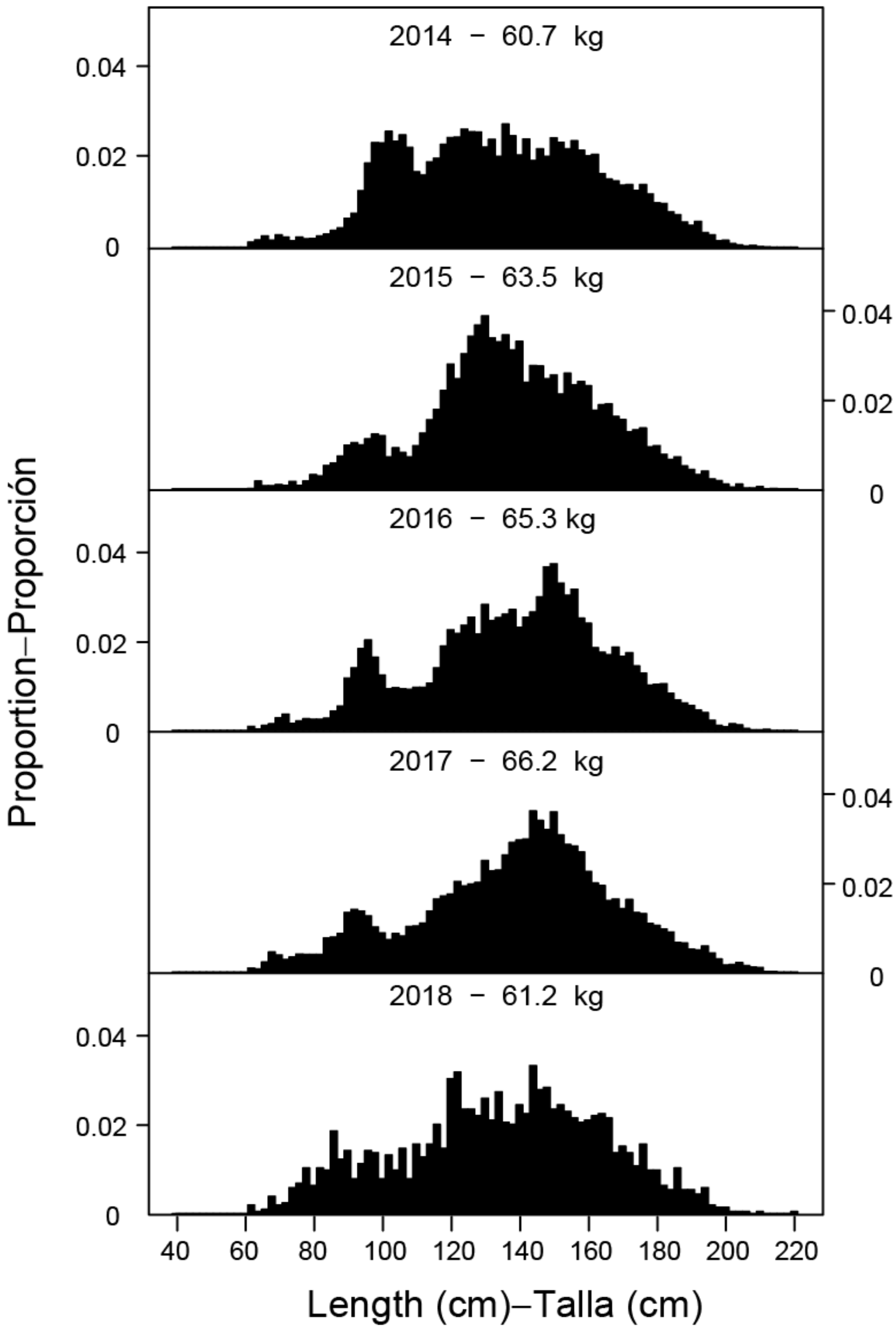


FIGURE A-11. Estimated size compositions of the catches of bigeye by the Japanese longline fleet in the EPO, 2014-2018. The size distribution has been standardized as a proportion of the total number of measured tuna in each size range. The value at the top of each panel is the average weight. Source: Fisheries Agency of Japan

FIGURA A-11. Composición por tallas estimada de las capturas de patudo por la flota palangrera japonesa en el OPO, 2014-2018. La distribución de las tallas ha sido estandarizada como proporción del número total de atunes medidos en cada gama de tallas. El valor en cada recuadro representa el peso promedio. Fuente: Agencia Pesquera de Japón.

TABLE A-1. Annual catches (t) of yellowfin, skipjack, and bigeye tunas, by all types of gear combined, in the Pacific Ocean. The EPO totals for 1993-2019 include discards from purse-seine vessels with carrying capacities greater than 363 t.

TABLA A-1. Capturas anuales (t) de atunes aleta amarilla, barrilete, y patudo, por todas las artes combinadas, en el Océano Pacífico. Los totales del OPO de 1993-2019 incluyen los descartes de buques cerqueros de más de 363 t de capacidad de acarreo.

	YFT			SKJ			BET			Total		
	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total	EPO	WCPO	Total
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	286,863	560,932	847,795	230,479	1,156,160	1,386,639	148,557	137,201	285,758	665,899	1,854,293	2,520,192
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	559,734	821,605	153,092	1,688,958	1,842,050	95,408	132,507	227,915	510,371	2,381,199	2,891,570
2011	216,720	520,937	737,657	283,509	1,534,944	1,818,453	89,460	154,391	243,851	589,689	2,210,272	2,799,961
2012	213,310	602,975	816,285	273,519	1,758,388	2,031,907	102,687	155,702	258,389	589,516	2,517,065	3,106,581
2013	231,170	548,776	779,946	284,043	1,835,068	2,119,111	86,029	143,156	229,185	601,242	2,527,000	3,128,242
2014	246,789	590,102	836,891	265,490	2,006,092	2,271,582	96,045	154,976	251,021	608,324	2,751,170	3,359,494
2015	260,293	573,947	834,240	334,051	1,793,193	2,127,244	104,737	136,280	241,017	699,081	2,503,420	3,202,501
2016	255,196	634,165	889,361	342,579	1,795,389	2,137,968	92,829	144,409	237,238	690,604	2,573,963	3,264,567
2017	224,556	691,839	916,395	327,571	1,626,818	1,954,389	102,577	123,309	225,886	654,704	2,441,966	3,096,670
2018	252,976	686,445	939,421	291,276	1,840,609	2,131,885	93,458	141,792	235,250	637,710	2,668,846	3,306,556
2019	228,288	*	228,288	349,965	*	349,965	95,192	*	95,192	673,445	*	673,445

TABLE A-2a. Estimated catches, in metric tons, of tunas and bonitos in the EPO, by fishing gear, 1990-2019. For purse-seine (PS) vessels, retained (Ret.) catches include all vessels; discard (Dis.) data are for Class-6 vessels only. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The purse-seine and pole-and-line (LP) data for yellowfin, skipjack, and bigeye tunas have been adjusted to the species composition estimate, and are preliminary. The data for 2018-2019 are preliminary.

TABLA A-2a. Capturas estimadas, en toneladas métricas, de atunes y bonitos en el OPO, por arte de pesca, 1990-2019. En el caso de los buques de cerco (PS), las capturas retenidas (Ret) incluyen todos los buques; los datos de descartes (Dis.) son de buques de Clase 6 únicamente. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos de los atunes aleta amarilla, barrilete, y patudo de las pesquerías de cerco y de caña (LP) fueron ajustados a la estimación de composición por especies, y son preliminares. Los datos de 2018-2019 son preliminares.

	Yellowfin—Aleta amarilla						**Skipjack—Barrilete**						**Bigeye—Patudo**					
	PS		**LP**	**LL**	**OTR + UNK**	**Total**	**PS**		**LP**	**LL**	**OTR + UNK**	**Total**	**PS**		**LP**	**LL**	**OTR + UNK**	**Total**
	Ret.	**Dis.[§]**					**Ret.**	**Dis.[§]**					**Ret.**	**Dis.[§]**				
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	-	36,170	99	86,029
2014	234,066	517	C	8,649	3,557	246,789	261,469	2,596	C	194	1,231	265,490	60,445	83	-	35,340	177	96,045
2015	245,727	334	C	10,649	3,583	260,293	328,907	3,699	C	189	1,256	334,051	62,913	177	-	41,626	21	104,737
2016	242,118	404	-	9,798	2,876	255,196	337,561	4,086	-	214	718	342,579	56,731	541	-	35,535	22	92,829
2017	210,980	412	-	10,476	2,688	224,556	324,759	1,765	-	168	879	327,571	66,973	201	-	35,361	42	102,577
2018	238,981	231	-	12,347	1,417	252,976	288,821	865	-	1,176	414	291,276	64,523	145	-	28,772	18	93,458
2019	227,709	579	-	*	*	228,288	347,114	2,851	-	*	*	349,965	70,544	117	-	24,531	*	95,192

[§] Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

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

	Pacific bluefin—Aleta azul del Pacífico						Albacore—Albacora						Black skipjack—Barrilete negro					
	PS		LP	LL	OTR + UNK	Total	PS		LP	LL	OTR + UNK	Total	PS		LP	LL	OTR + UNK	Total
	Ret.	Dis. §					Ret.	Dis. §					Ret.	Dis. §				
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	25,396	18,513	43,909	3,580	805	-	10	24	4,419
2014	5,263	66	-	-	427	5,756	-	-	C	29,231	19,463	48,694	4,153	486	-	11	81	4,731
2015	3,168	-	-	7	411	3,586	-	-	C	28,957	17,142	46,099	3,763	356	-	1	111	4,231
2016	3,025	-	-	-	408	3,433	2	-	-	26,778	14,586	41,366	6,606	792	-	-	178	7,576
2017	4,109	-	-	3	469	4,581	-	-	-	26,332	9,461	35,793	5,079	306	-	-	53	5,438
2018	2,852	-	-	-	539	3,391	8	-	-	24,494	10,940	35,442	3,002	732	-	-	118	3,852
2019	2,475	-	-	-	*	2,475	*	-	-	*	*	*	5,126	499	-	-	*	5,625

§ Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

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

	Bonitos						Unidentified tunas—Atunes no identificados						Total					
	PS		LP	LL	OTR + UNK	Total	PS		LP	LL	OTR + UNK	Total	PS		LP	LL	OTR + UNK	Total
	Ret.	Dis.[§]					Ret.	Dis.[§]					Ret.	Dis.[§]				
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	18,781	7,311	111,901	13,943	474,867
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	39,827	6,395	71,283	13,183	544,311
1997	1,097	4	8	-	34	1,143	71	3,383	-	7	1,437	4,898	466,483	48,157	7,747	84,588	9,962	616,936
1998	1,330	4	7	-	588	1,929	13	1,233	-	24	18,158	19,428	442,365	33,276	6,897	74,758	34,815	592,111
1999	1,719	-	-	24	369	2,112	27	3,092	-	2,113	4,279	9,511	599,160	44,076	4,059	62,254	24,310	733,859
2000	636	-	-	75	56	767	190	1,410	-	1,992	1,468	5,060	559,095	39,494	2,809	83,305	16,756	701,459
2001	17	-	-	34	19	70	191	679	-	2,448	55	3,373	591,243	22,799	4,523	121,616	14,755	754,935
2002	-	-	-	-	1	1	576	1,863	-	482	1,422	4,343	627,077	21,741	1,958	116,057	17,158	783,992
2003	-	-	1	-	25	26	80	1,238	-	215	750	2,283	714,079	33,416	1,177	110,799	25,600	885,071
2004	15	35	1	8	3	62	256	973	-	349	258	1,836	545,992	23,066	2,539	81,818	25,120	678,536
2005	313	18	-	-	11	342	190	1,922	-	363	427	2,902	605,945	25,664	3,187	62,585	19,865	717,246
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	12,540	1,298	51,488	22,179	552,452
2008	7,874	37	9	6	26	7,952	136	1,380	1	727	883	3,127	572,763	14,712	2,388	47,164	19,617	656,644
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	6,170	511	63,279	22,045	562,111
2011	7,969	45	18	10	11	8,053	108	784	-	3,178	-	4,070	552,631	7,813	318	61,136	18,311	640,208
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	74,397	22,286	656,703
2014	2,821	38	-	-	154	3,013	113	328	-	269	392	1,102	568,330	4,113	-	73,695	25,482	671,620
2015	789	28	-	1	-	818	90	242	-	-	1,232	1,564	645,357	4,836	-	81,430	23,756	755,379
2016	3,806	15	-	-	1	3,822	129	212	-	-	294	635	649,978	6,050	-	72,325	19,083	747,436
2017	3,438	54	-	-	-	3,492	234	303	-	-	366	903	615,572	3,041	-	72,340	13,958	704,911
2018	2,409	58	-	-	-	2,467	75	448	-	3	227	753	600,671	2479	-	66,792	13,673	683,615
2019	7,032	27	-	-	-	7,059	78	276	-	*	*	354	660,078	4,349	-	24,531	*	688,958

[§] Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

TABLE A-2b. Estimated catches, in metric tons, of billfishes in the EPO, by fishing gear, 1990-2019. For purse-seine (PS) vessels, retained (Ret.) catches include all vessels; discard (Dis.) data are for Class-6 vessels only. The data for 2018-2019 are preliminary.

TABLA A-2b. Capturas estimadas, en toneladas métricas, de peces picudos en el OPO, por arte de pesca, 1990-2019. En el caso de los buques de cerco (PS), las capturas retenidas (Ret.) incluyen todos los buques; los datos de descartes (Dis.) son de buques de Clase 6 únicamente. Los datos de 2018-2019 son preliminares.

	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. §			
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	-	22,342	5,560	27,904	172	15	4,202	168	4,557	99	4	138	-	241	21	1	2,439	19	2,480
2014	4	-	21,331	6,332	27,667	209	12	4,069	186	4,476	70	4	151	-	225	22	1	1,929	3	1,955
2015	5	1	25,805	6,079	31,890	306	11	4,121	182	4,620	117	14	240	-	371	26	-	1,269	474	1,769
2016	4	-	23,895	7,156	31,055	247	6	3,677	175	4,105	62	3	80	-	145	19	-	1,561	4	1,584
2017	1	2	21,327	6,301	27,631	151	4	3,832	191	4,178	39	1	211	-	251	10	-	1,736	4	1,750
2018	2	-	22,767	5,185	27,954	167	1	4,020	174	4,362	23	-	297	-	320	10	1	1,801	5	1,817
2019	3	-	*	*	3	202	3	*	*	205	45	-	45	-	45	16	*	*	*	16

§ Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

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.§			
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	8	1,616	285	31	17,721	4,310	22,347
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	33,391	5,757	39,499
2014	-	-	721	-	721	16	1	481	8	506	8	2	220	3	233	329	20	28,902	6,532	35,783
2015	1	-	497	-	498	18	8	1,402	22	1,450	19	1	704	4	728	492	35	34,038	6,761	41,326
2016	1	-	416	-	417	49	9	457	19	534	112	9	732	1	854	494	27	30,818	7,355	38,694
2017	-	-	244	-	244	22	2	525	15	564	164	12	258	15	449	387	21	28,133	6,526	35,067
2018	-	-	235	-	235	13	2	426	17	458	123	6	144	10	283	338	10	29,690	5,391	35,429
2019	-	-	*	-	*	18	*	*	*	18	121	4	*	*	125	405	7	45	*	457

§ Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

TABLE A-2c. Estimated catches, in metric tons, of carangids, dorado, elasmobranchs, and other fishes in the EPO, by fishing gear, 1990-2019. For purse-seine (PS) vessels, retained (Ret.) catches include all vessels; discard (Dis.) data are for Class-6 vessels only. The data for 2018-2019 are preliminary.
TABLA A-2c. Capturas estimadas, en toneladas métricas, de carángidos, dorado, elasmobranquios, y otros peces en el OPO, por arte de pesca, 1990-2019. En el caso de los buques de cerco (PS), las capturas retenidas (Ret.) incluyen todos los buques; los datos de descartes (Dis.) son de buques de Clase 6 únicamente. Los datos de 2018-2019 son preliminares.

	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. §			
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	-	3	77	266	476	17	724	1,483	253	1,153	1,028	916	3,350	145	554	186	2	887
1994	19	28	-	16	63	687	826	46	3,459	5,018	372	1,029	1,234	1,314	3,949	243	567	275	-	1,085
1995	27	32	-	9	68	465	729	39	2,127	3,360	278	1,093	922	1,075	3,368	177	760	246	-	1,183
1996	137	135	-	57	329	548	885	43	183	1,659	239	1,001	1,120	2,151	4,511	155	467	492	-	1,114
1997	38	111	-	39	188	569	703	6,866	3,109	11,247	413	1,232	956	2,328	4,929	261	654	894	-	1,809
1998	83	149	-	4	236	424	426	2,528	9,167	12,545	279	1,404	2,099	4,393	8,175	303	1,133	1,403	-	2,839
1999	108	136	-	1	244	568	751	6,284	1,160	8,763	260	843	5,997	2,088	9,188	245	748	1,047	-	2,040
2000	97	66	4	4	171	813	785	3,537	1,041	6,176	263	771	8,418	405	9,857	148	408	1,578	-	2,134
2001	16	145	18	26	205	1,028	1,275	15,942	2,825	21,070	183	641	12,540	107	13,471	391	1,130	1,803	-	3,324
2002	20	111	15	20	166	932	938	9,464	4,137	15,471	137	758	12,398	99	13,392	355	722	1,920	-	2,997
2003	13	141	54	-	208	583	346	5,301	288	6,518	118	833	14,498	372	15,821	280	406	4,682	-	5,368
2004	41	103	1	-	145	811	317	3,986	4,645	9,759	157	623	11,273	173	12,226	339	1,031	670	-	2,040
2005	82	79	-	-	161	863	295	3,854	8,667	13,679	199	498	12,117	220	13,034	439	276	636	-	1,351
2006	247	146	-	-	393	1,002	385	3,408	13,127	17,922	235	677	20,579	233	21,724	496	381	603	100	1,580
2007	175	183	6	17	381	1,266	350	6,907	7,827	16,350	343	401	25,002	237	25,983	830	675	2,481	120	4,106
2008	86	55	5	17	163	933	327	15,845	5,458	22,563	540	371	30,143	201	31,255	522	429	1,526	85	2,562
2009	65	42	10	16	133	1,923	476	17,136	51,328	70,863	279	347	31,001	143	31,770	1,036	374	2,435	378	4,223
2010	82	15	8	23	128	1,243	253	9,484	47,881	58,861	335	467	40,655	120	41,577	884	192	2,341	384	3,801
2011	72	24	8	-	104	1,291	386	12,438	20,935	35,050	280	318	45,450	94	46,142	511	219	1,972	507	3,209
2012	53	23	1	-	77	1,805	401	17,255	26,627	46,088	230	281	31,889	429	32,829	875	230	2,693	381	4,179
2013	17	17	1	3	38	1,447	489	11,249	22,673	35,858	217	325	33,090	205	33,837	1,393	369	2,795	273	4,830
2014	20	11	11	46	88	1,762	370	3,340	20,915	26,387	248	476	29,076	352	30,152	1,459	438	2,763	348	5,008
2015	28	15	11	218	272	1,045	169	1,201	17,361	19,776	307	623	39,823	514	41,267	697	208	3,303	235	4,443
2016	30	33	11	142	216	893	175	447	13,002	14,517	229	590	37,877	178	38,874	955	463	2,858	159	4,435
2017	33	26	-	103	162	1,374	264	1,804	16,051	19,493	44	861	42,174	946	44,025	305	147	3,122	148	3,722
2018	33	64	-	56	153	1,186	342	3,499	16,834	21,861	3	543	36,612	974	38,132	505	100	1,912	115	2,632
2019	30	17	-	*	47	1,072	165	*	*	1,237	227	363	*	*	590	466	84	*	*	550

§ Class-6 (carrying capacity >363 t) purse-seine vessels only-Buques cerqueros de Clase 6 (capacidad de acarreo >363 t) solamente

TABLE A-3a. Catches (t) of yellowfin tuna by purse-seine vessels in the EPO, by vessel flag. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The data have been adjusted to the species composition estimate and are preliminary.

TABLA A-3a. Capturas (t) de atún aleta amarilla por buques de cerco en el OPO, por bandera del buque. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos están ajustados a la estimación de composición por especie, y son preliminares.

	COL	CRI	ECU	EU (ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C + OTR[1]	Total
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	19,280	-	59,280	C	93,928	11,047	23,249	1,647	C	4,578	23,812	-	5,298	242,118
2017	15,106	-	55,705	C	80,870	9,347	19,921	3,349	C	6,500	16,809	-	3,373	210,980
2018	21,855	-	57,164	C	101,651	7,552	22,625	1,458	C	3,808	19,527	-	3,341	238,981
2019	17,172		45,519	C	105,570	7,111	17,793	1,778	C	6,465	22,500	-	3,801	227,709

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

TABLE A-3b. Annual catches (t) of yellowfin tuna by longline vessels, and totals for all gears, in the EPO, by vessel flag. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The data for 2018-2019 are preliminary.

TABLA A-3b. Capturas anuales (t) de atún aleta amarilla por buques de palangre en el OPO, y totales de todas las artes, por bandera del buque. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos de 2018-2019 son preliminares.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS+LL	OTR[2]
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	8	325	572	43	101	1,981	10,783	228,970	1,993
2014	2,120	1,072	567	2,633	704	4	249	896	61	323	20	8,649	242,715	3,557
2015	2,642	1,415	929	2,177	957	20	419	1,287	134	530	139	10,649	256,376	3,582
2016	2,398	1,010	825	1,839	1,124	29	688	1,222	244	166	253	9,798	251,916	2,876
2017	2,907	837	1,252	1,463	1,176	10	612	1,263	531	406	18	10,475	221,456	2,688
2018	5,386	1,190	1,101	1,401	1,189	-	130	1,212	419	293	26	12,347	251,328	1,417
2019	*	*	*	*	*	*	*	*	*	*	*	*	227,709	*

[1] Includes—Incluye: BLZ, CHL, ECU, EU(ESP), EU(PRT), 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 (t) of skipjack tuna by purse-seine and longline vessels in the EPO, by vessel flag, adjusted to the species composition estimate. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The 2018-2019 data are preliminary.
TABLA A-3c. Capturas (t) de atún barrilete por buques de cerco y de palangre en el OPO, por bandera del buque, ajustadas a la estimación de composición por especie. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos de 2018-2019 son preliminares.

	PS														LL+ OTR[2]
	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C+OTR[1]	Total	
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	2,347
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	-	9,770	261,469	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	1,445
2016	20,665	-	190,577	C	13,286	1,971	32,844	6,449	C	40,036	9,067	-	22,666	337,561	932
2017	19,284	-	190,139	C	21,238	6,959	37,419	6,257	C	24,989	7,288	-	11,186	324,759	1,047
2018	15,365	-	177,456	C	17,014	7,759	36,504	4,119	C	11,869	6,679	-	12,056	288,821	1,590
2019	23,216	-	211,521	C	19,683	8,091	33,641	8,948	C	19,700	5,847	-	16,467	347,114	*

[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 (t) of bigeye tuna by purse-seine vessels in the EPO, by vessel flag. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The data have been adjusted to the species composition estimate and are preliminary for 2018 and 2019.

TABLA A-3d. Capturas (t) de atún patudo por buques de cerco en el OPO, por bandera del buque. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos están ajustados a la estimación de composición por especie, y los de 2018 y 2019 son preliminares.

	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C + OTR[1]	Total
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	2,743	-	33,139	C	255	667	8,440	312	C	2,801	345	-	8,029	56,731
2017	3,656	-	38,299	C	358	1,610	10,544	0	C	6,210	1,256	-	5,040	66,973
2018	1,449	-	40,427	C	766	1,519	11,753	104	C	3,354	1,157	-	3,994	64,523
2019	4,169	-	39,943	C	1,001	2,629	10,918	-	C	3,398	983	-	7,503	70,544

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

TABLE A-3e. Annual catches (t) of bigeye tuna by longline vessels, and totals for all gears, in the EPO, by vessel flag. 'C' indicates that the catch has been combined with the total in the 'OTR' column. The data for 2018-2019 are preliminary.

TABLA A-3e. Capturas anuales (t) de atún patudo por buques de palangre en el OPO, y totales de todas las artes, por bandera del buque. 'C' indica que la captura se ha combinado con el total en la columna 'OTR'. Los datos de 2018-2019 son preliminares.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS + LL	OTR[2]
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	544	36,170	85,657	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	13,079	8,635	-	364	5,181	3,050	1,888	328	41,626	104,539	21
2016	7,052	3	477	10,467	7,692	-	313	6,006	2,084	762	679	35,535	92,266	22
2017	7,093	16	700	8,054	8,749	-	357	6,186	2,700	1,359	147	35,361	102,334	42
2018	6,060	14	897	6,098	6,675	-	175	5,125	2,389	1,194	145	28,772	93,295	18
2019	5,338	*	797	5,861	5,267	*	191	6,035	*	1,042	*	24,531	95,075	*

[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 2018 and 2019, 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 2018 y 2019, 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	%
2018	**Retained catches–Capturas retenidas**									
COL	21,855	15,365	1,449	-	-	9	11	4	38,693	6.4
ECU	57,164	177,456	40,427	-	-	506	201	23	275,777	45.9
MEX	101,651	17,014	766	2,840	-	2,482	94	42	124,889	20.8
NIC	7,552	7,759	1,519	-	8	-	-	-	16,838	2.8
PAN	22,625	36,504	11,753	-	-	-	-	1	70,883	11.8
PER	1,458	4,119	104	-	-	-	1,936	-	7,617	1.3
USA	3,808	11,869	3,354	12	-	5	167	-	19,215	3.2
VEN	19,527	6,679	1,157	-	-	-	-	-	27,363	4.6
OTR[1]	3,341	12,055	3,994	-	-	-	-	5	19,395	3.2
Total	238,981	288,820	64,523	2,852	8	3,002	2,409	75	600,670	
2019	**Retained catches–Capturas retenidas**									
COL	17,172	23,216	4,169	-	-	12	-	1	44,570	6.8
ECU	45,519	211,521	39,943	-	-	777	928	53	298,741	45.3
MEX	105,570	19,683	1,001	2,249	-	4,290	6,068	15	138,876	21.0
NIC	7,111	8,091	2,629	-	-	17	-	-	17,848	2.7
PAN	17,793	33,641	10,918	-	-	9	-	1	62,362	9.4
PER	1,778	8,948	-	-	-	-	36	3	10,765	1.6
USA	6,465	19,700	3,398	226	-	1	-	-	29,790	4.5
VEN	22,500	5,847	983	-	-	20	-	5	29,355	4.4
OTR[2]	3,801	16,467	7,503	-	-	-	-	-	27,771	4.3
Total	227,709	347,114	70,544	2,475	-	5,126	7,032	78	660,078	

[1] Includes El Salvador and European Union (Spain) - This category is used to avoid revealing the operations of individual vessels or companies.

[1] Incluye El Salvador 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 landings, in metric tons, of tunas and bonitos caught by purse-seine vessels in the EPO in 2018 and 2019, by year, 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 2018 y 2019, por año, 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	%
2018	**Landings-Descargas**									
COL	19,388	10,868	1,132	-	-	3	-	4	31,395	5.3
ECU	90,534	228,771	44,116	-	8	369	480	20	364,298	61.0
MEX	102,194	16,515	774	2,840	-	2,533	94	45	124,995	20.9
PER	4,675	18,934	1,652	-	-	11	2,145	1	27,418	4.6
USA	2,576	7,996	1,983	12	-	-	167	-	12,734	2.1
OTR[1]	19,476	12,983	3,872	-	-	-	-	5	36,336	6.1
Total	238,843	296,067	53,529	2,852	8	2,916	2,886	75	597,176	
2019	**Landings-Descargas**									
COL	7,696	10,740	1,157	-	-	1	-	-	19,594	3.1
ECU	85,028	268,476	39,988	-	-	690	930	5,020	400,132	63.8
MEX	99,850	20,577	903	2,249	-	4,287	4,733	15	132,614	21.1
PER	3,330	18,721	748	-	-	30	36	12	22,877	3.6
USA	3,195	6,158	330	269	-	-	-	-	9,952	1.6
OTR[2]	19,628	16,088	6,589	-	-	3	-	-	42,308	6.8
Total	218,727	340,760	49,715	2,518	-	5,011	5,699	5,047	627,477	

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

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

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

[2] Incluye Costa Rica, Desconocida, El Salvador 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, 1990-2018. The data for 2017 and 2018 are preliminary; 2019 data are not available.

TABLA A-5a. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas, 1990-2018. Los datos de 2017 y 2018 son preliminares; no se dispone de datos de 2019.

PBF	Western Pacific flags—Banderas del Pacífico occidental[1]										EPO flags—Banderas del OPO					Total
	JPN				KOR		TWN			Sub-total	MEX		USA		Sub-total	
	PS	LP	LL	OTR	PS	OTR	PS	LL	OTR		PS	OTR	PS	OTR		
1990	2,989	536	309	2,421	132	-	149	189	315	7,040	50	-	1,380	157	1,587	8,627
1991	9,808	286	218	4,204	265	-	-	342	119	15,242	9	-	410	98	517	15,759
1992	7,162	166	513	3,204	288	-	73	464	8	11,878	0	-	1,928	171	2,099	13,977
1993	6,600	129	812	1,759	40	-	1	471	3	9,815	-	-	580	386	966	10,781
1994	8,131	162	1,206	5,667	50	-	-	559	-	15,775	63	2	906	145	1,116	16,891
1995	18,909	270	678	7,223	821	-	-	335	2	28,238	11	-	657	294	962	29,200
1996	7,644	94	901	5,359	102	-	-	956	-	15,056	3,700	-	4,639	110	8,449	23,505
1997	13,152	34	1,300	4,354	1,054	-	-	1,814	-	21,708	367	-	2,240	264	2,871	24,579
1998	5,391	85	1,255	4,450	188	-	-	1,910	-	13,279	1	0	1,771	703	2,475	15,754
1999	16,173	35	1,157	5,246	256	-	-	3,089	-	25,956	2,369	35	184	592	3,180	29,136
2000	16,486	102	953	7,031	2,401	-	-	2,780	2	29,755	3,019	99	693	380	4,191	33,946
2001	7,620	180	791	5,614	1,176	10	-	1,839	4	17,234	863	-	292	392	1,547	18,781
2002	8,903	99	841	4,338	932	1	-	1,523	4	16,641	1,708	2	50	625	2,385	19,026
2003	5,768	44	1,237	3,345	2,601	-	-	1,863	21	14,879	3,211	43	22	373	3,649	18,528
2004	8,257	132	1,847	3,855	773	-	-	1,714	3	16,581	8,880	14	-	61	8,955	25,536
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	9,806	-	-	96	9,902	26,234
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	4,407	15	-	64	4,486	24,523
2009	8,077	50	1,080	4,814	936	4	-	877	11	15,849	3,019	-	410	162	3,591	19,440
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	2,731	1	-	343	3,075	17,069
2012	2,462	113	673	2,846	1,421	2	-	210	4	7,731	6,668	1	-	442	7,111	14,842
2013	2,771	8	784	2,848	604	1	-	331	3	7,350	3,154	-	-	820	3,974	11,324
2014	5,456	5	683	3,429	1,305	6	-	483	42	11,409	4,862	-	401	427	5,690	17,099
2015	3,645	8	619	2,086	676	1	-	552	26	7,613	3,082	-	86	412	3,580	11,193
2016	5,095	44	657	2,514	1,024	6	-	454	0	9,794	2,709	-	316	408	3,433	13,227
2017	4,540	86	901	3,522	734	9	-	415	0	10,207	3,643	-	466	471	4,580	14,787
2018	4,050	8	698	1,448	523	12	-	381	-	7,120	2,482	-	12	534	3,028	10,148

[1] Source: International Scientific Committee, 19th Plenary Meeting, PBFWG workshop report on Pacific Bluefin Tuna, July 2019—Fuente: Comité Científico Internacional, 19ª Reunión Plenaria, Taller PBFWG sobre Atún Aleta Azul del Pacífico, julio de 2019

TABLE A-5b. Reported catches of Pacific bluefin tuna in the EPO by recreational gear, in number of fish, 1990-2019.

TABLA A-5b. Capturas reportadas de atún aleta azul del Pacifico en el OPO por artes deportivas, en número de peces, 1990-2019.

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**	27,889
2000	20,669	**2015**	28,661
2001	21,913	**2016**	12,312
2002	33,399	**2017**	16,493
2003	22,291	**2018**	10,414
2004	3,391	**2019**	16,620

TABLE A-6. Annual retained catches of albacore in the EPO, by gear and area (north and south of the equator), in metric tons, 1990-2018. The data for 2017 and 2018 are preliminary; 2019 data are not available.

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, 1990-2018. Los datos de 2017 y 2018 son preliminares; no se dispone de datos de 2019.

ALB	North—Norte				South—Sur				Total
	LL	LTL[1]	OTR	Subtotal	LL	LTL	OTR	Subtotal	
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	119	10,328	32,922
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	4,583	16,633	1,222	22,438	19,613	35	210	19,858	42,296
2013	6,193	17,398	844	24,435	19,204	0	271	19,475	43,910
2014	3,546	18,178	1,042	22,766	25,685	0	243	25,928	48,694
2015	2,083	15,986	935	19,004	26,873	0	221	27,094	46,098
2016	1,641	13,619	677	15,937	25,136	0	290	25,426	41,363
2017	2,512	8,870	386	11,768	23,820	0	206	24,026	35,794
2018	2,429	10,449	173	13,051	22,062	0	329	22,391	35,442

[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 2018 and 2019 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 2018 y 2019 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 associated with dolphins Lances asociados a delfines**					
2004	0	11,783	11,783	177,513	10,706	2
2005	0	12,173	12,173	167,224	12,321	1
2006	0	8,923	8,923	91,800	4,801	0
2007	0	8,871	8,871	97,075	3,272	7
2008	0	9,246	9,246	122,107	8,388	4
2009	0	10,910	10,910	178,291	2,683	1
2010	0	11,646	11,646	170,028	1,365	0
2011	0	9,604	9,604	134,926	4,387	2
2012	0	9,220	9,220	133,825	2,122	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	146,526	3,179	4
2017	0	8,863	8,863	112,533	1,656	1
2018	0	9,774	9,774	147,859	2,456	1
2019	0	9,680	9,680	153,252	3,698	28
OBJ	**Sets associated with floating objects Lances asociados a objetos flotantes**					
2004	723	4,986	5,709	28,312	117,212	64,001
2005	796	4,992	5,788	25,752	132,937	66,256
2006	1,313	6,862	8,175	34,111	191,006	82,176
2007	1,605	5,857	7,462	29,412	122,119	62,187
2008	1,958	6,655	8,613	34,763	157,324	73,851
2009	2,142	7,077	9,219	36,147	157,023	75,889
2010	2,432	6,399	8,831	37,850	114,659	57,059
2011	2,538	6,921	9,459	42,176	171,193	55,587
2012	3,067	7,610	10,677	37,487	177,055	65,035
2013	3,081	8,038	11,119	35,112	194,372	48,337
2014	3,860	8,777	12,637	46,049	199,696	59,797
2015	3,457	9,385	12,842	43,603	206,515	60,975
2016	4,214	10,377	14,591	58,673	248,190	55,269
2017	4,544	11,148	15,692	67,167	224,422	65,443
2018	4,954	11,871	16,825	66,122	213,626	63,815
2019	4,852	10,591	15,443	52,706	226,173	69,861

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**					
2004	5,637	5,696	11,333	66,732	69,906	1,468
2005	6,922	7,816	14,738	75,125	117,971	1,638
2006	7,180	8,443	15,623	40,720	100,461	1,662
2007	5,480	7,211	12,691	43,529	82,904	1,256
2008	5,204	6,210	11,414	28,187	130,891	1,173
2009	3,822	4,109	7,931	22,319	70,817	909
2010	2,744	3,885	6,629	43,131	31,168	693
2011	2,840	5,182	8,022	29,749	100,455	923
2012	2,996	5,369	8,365	26,705	87,038	985
2013	3,064	4,156	7,220	25,643	79,916	1,150
2014	2,428	3,369	5,797	20,237	57,360	645
2015	3,116	6,201	9,317	41,529	116,784	1,936
2016	2,300	5,101	7,401	36,919	86,192	1,458
2017	2,016	4,960	6,976	31,280	98,681	1,529
2018	1,925	4,163	6,088	25,000	72,739	707
2019	2,054	5,948	8,002	21,751	117,243	655
ALL	**Sets on all types of schools / Lances sobre todos tipos de cardumen**					
2004	6,360	22,465	28,825	272,557	197,824	65,471
2005	7,718	24,981	32,699	268,101	263,229	67,895
2006	8,493	24,228	32,721	166,631	296,268	83,838
2007	7,085	21,939	29,024	170,016	208,295	63,450
2008	7,162	22,111	29,273	185,057	296,603	75,028
2009	5,964	22,096	28,060	236,757	230,523	76,799
2010	5,176	21,930	27,106	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	6,288	23,528	29,816	234,066	261,469	60,445
2015	6,573	26,606	33,179	245,727	328,907	62,913
2016	6,514	26,697	33,211	242,118	337,561	56,731
2017	6,560	24,971	31,531	210,980	324,759	66,973
2018	6,879	25,808	32,687	238,981	288,821	64,523
2019	6,906	26,219	33,125	227,709	347,114	70,544

TABLE A-8. Types of floating objects involved in sets by vessels of >363 t carrying capacity, 2004-2019. The 2019 data are preliminary.
TABLA A-8. Tipos de objetos flotantes sobre los que realizaron lances buques de >363 t de capacidad de acarreo, 2004-2019. Los datos de 2019 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
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	271	2.4	10,877	97.6	0	0	11,148
2018	322	2.7	11,549	97.3	0	0	11,871
2019	184	1.7	10,404	98.2	3	< 0.1	10,591

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
1990	-	-	178,414	117,923	47,167	17,415	-	-	12,543	4,755	-	-	-
1991	-	-	200,365	112,337	65,024	24,644	-	-	17,969	5,862	42	12	173
1992	-	-	191,284	93,011	45,634	13,104	199	89	33,025	14,142	325	106	128
1993	-	-	159,955	87,977	46,375	12,843	153	79	18,064	6,566	415	81	227
1994	-	-	163,968	92,606	44,788	13,250	1,373	574	12,588	4,883	303	25	523
1995	-	-	129,598	69,435	54,979	12,778	1,776	559	2,910	1,639	828	180	562
1996	-	-	103,654	52,298	40,290	14,121	2,087	931	5,830	3,553	510	182	185
1997	-	-	96,383	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	-	-	80,958	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	103,920	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	9,754
2014	78,851	24,282	40,735	17,235	22,695	9,132	10,572	3,291	17,047	10,435	11,276	2,168	6,874
2015	99,131	25,559	35,290	16,046	22,394	9,879	13,661	4,509	15,334	11,274	13,868	3,234	10,924
2016	66,405	25,756	30,910	13,242	23,235	9,457	13,677	3,954	20,941	11,432	11,312	2,362	6,121
2017	82,461	27,341	27,930	10,612	27,540	10,604	11,641	3,425	24,164	11,811	15,266	3,266	5,357
2018	83,023	27,024	24,538	8,642	19,443	8,474	13,258	4,300	21,143	9,985	13,549	2,853	5,510

[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 2018 and 2019 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 2018 y 2019 son preliminares.

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
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
2018	261	263,666	0	0	261	263,666
2019	261	265,085	0	0	261	265,085

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 2018, 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 2018 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	38	31	22	10	12	113	91,658
EU(ESP)	PS	-	-	-	-	2	2	4,120
MEX	PS	5	4	21	23	-	53	62,659
NIC	PS	-	-	3	2	1	6	9,066
PAN	PS	-	2	5	5	4	16	22,361
PER	PS	5	4	-	-	-	9	4,175
SLV	PS	-	-	-	1	2	3	6,202
USA	PS	14	-	3	8	6	31	28,201
VEN	PS	-	-	6	6	2	14	20,364
Grand total—Total general	PS	64	43	67	58	29	261	
Well volume—Volumen de bodega (m^3)								
Grand total—Total general	PS	15,930	26,297	73,246	88,505	59,688		263,666

- : 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 2019, 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 2019, 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 (m³)					Total	
		<401	401-800	801-1300	1301-1800	>1800	No.	Vol. (m³)
		Number—Número						
COL	PS	2	2	7	3	-	14	14,860
ECU	PS	38	33	22	9	12	114	91,057
EU(ESP)	PS	-	-	-	-	2	2	4,120
MEX	PS	5	2	21	23	-	51	61,146
NIC	PS	-	-	3	2	1	6	9,066
PAN	PS	-	2	5	6	4	17	23,719
PER	PS	6	5	-	-	-	11	4,767
SLV	PS	-	-	-	1	2	3	6,202
USA	PS	11	-	3	9	6	29	30,367
VEN	PS	-	-	7	6	1	14	19,781
Grand total—Total general	PS	62	44	68	59	28	261	
Well volume—Volumen de bodega (m³)								
Grand total—Total general	PS	16,015	26,070	75,928	88,886	58,186		265,085

- : 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 2009-2018 and in 2019, 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 2009-2018 y en 2019, por mes.

Month Mes	2009-2018			2019
	Min	Max	Ave.-Prom.	
1	86.9	129.6	101.4	105.5
2	150.7	192.3	168.2	189.9
3	135.4	189.7	159.9	184.2
4	145.9	200.8	166.2	174.0
5	139.8	196.9	163.4	189.3
6	154.9	198.6	170.2	174.7
7	154.1	200.4	169.7	172.4
8	108.0	148.7	121.5	116.9
9	105.5	142.2	119.8	108.9
10	150.7	188.9	172.3	170.2
11	102.9	140.8	124.7	102.8
12	45.9	66.4	56.8	68.2
Ave.-Prom.	123.4	166.3	141.2	146.4

B. YELLOWFIN TUNA

For the full version of this analysis, see documents SAC-11-05, SAC-11-07, SAC-11-INF-J and SAC-11-08.

Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made in the eastern and western regions. Purse-seine catches in the vicinity of the western boundary of the EPO at 150°W are relatively low, but have been increasing, mainly in sets on floating objects (Figure A-1a and A-1b, Tables A-1, A-2). The majority of the catch in the eastern Pacific Ocean (EPO) is taken in purse-seine sets associated with dolphins and floating objects (Figure B-1). Tagging studies of yellowfin throughout the Pacific indicate that they tend to stay within 1,800 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. However, movement rates between these putative stocks, as well as across the 150°W meridian, cannot be estimated with currently-available tagging data.

In 2020, stock status indicators (SSIs) were developed for yellowfin using the data collected in the EPO as a whole (SAC-11-05). Most floating-object fishery SSIs suggest that the yellowfin stock has potentially been subject to increased fishing mortality, mainly due to the increase in the number of sets in the floating-object fishery since 2005 (Figure B-2) and corresponding increase in catch for yellowfin (Figure B-3), associated with decline in catch-per-set (Figure B-3) and reduction in the average length of the fish in the catch (Figure B-3) for the floating-object fishery. This coincided with a declining trend in the yellowfin longline CPUE index based on spatio-temporal modelling which remained at low historic levels since 2005 (Figure B-4). Trends in some of the other SSIs do not support the interpretation that increased fishing mortality is occurring as a result of an increase in the numbers of floating-object sets, such as trends in catch-per-set for other set types (Figure B-3), mean length of yellowfin in the other set types (Figure B-3), and the longline SSIs (Figure B-3). The SSI based on spatio-temporal modelling of CPDF for the purse-seine fishery associated with dolphins shows a period of low values starting in 2015 (Figure B-4) which coincides with a period of increased yellowfin catches in floating-objects set (Figure B-3). The SSI based on spatio-temporal modelling of CPUE for the longline fishery do not coincide with the purse-seine one (Figure B-4). Identifying the causes of differences in the SSIs is difficult, even when SSIs are considered in aggregate. The inconsistencies among SSIs for yellowfin may be due to an interaction between potential stock structure and differences in the spatial distribution of effort in the different set types. In addition, catch-per-set may not be a reliable indicator of abundance, particularly for the target species (i.e. yellowfin in the dolphin-associated fishery). Nonetheless, the fact that most SSIs based on the floating-object fishery are consistent with an increase in fishing mortality in that fishery means that precautionary management measures should be considered to prevent further increases.

A workplan to improve the stock assessments for tropical tunas was completed taking into consideration the results of the external review of yellowfin. The yellowfin review panel did not single out a particular model configuration as a replacement for the current base case model, but suggested a variety of alternatives for the staff to consider. To encompass as many scenarios as possible, the staff developed a pragmatic risk assessment framework to apply for both species, which included the development of hypothesis, the implementation and weighting of models, and the construction of risk tables based on the combined result (SAC-11-08, SAC-11-INF-F,SAC-11-INF-J).

The degree of spatial mixing of the yellowfin tuna population in the EPO was considered the main uncertainty within the risk analysis (SAC-11-INF-J). This conclusion came from the detailed inspection of the contradictory indices of abundance. Previous assessments used five indices of abundance, one from the longline fishery and four from the purse-seine fisheries, and the length composition data from longline and purse-seine fisheries. The model was unable to reconcile indices from different fisheries and length-frequency data that apparently carried contradictory signals about the status of the stock (SAC-10 INF-F). To solve the inconsistencies, spatiotemporal models were used to produce new purse-seine and longline indices and associated length frequencies, but the inconsistencies were not resolved (Figure B-4). The mismatch was most apparent in 2001-2003, when a peak occurred earlier in the longline index and later in the purse-seine index (opposite to what was expected given the growth and selectivity assumptions of the model). By incorporating length classes in the standardization, it became clear that the differences were due mainly to the 1998 cohort (of an important El Niño year) being prominent in the longline index, while not showing in in purse-seine index, and the opposite occurring with the 1999 cohort (an equally important La Niña year). Spatial heterogeneity was considered as the most plausible explanation for the unresolved inconsistencies.

Three overarching hypotheses related to the degree of spatial mixing of the yellowfin tuna stock in the EPO where developed (SAC-11-INF-J). Of those, the high-mixing hypothesis was assumed for the benchmark assessment, with the purse-seine index assumed the most representative of the core of the exploited population (SAC-11-07). A series of lower hierarchical level hypotheses were developed regarding other major uncertainties in the previous assessment. From those, 12 reference models were developed, which combine components that address changes in selectivity and catchability, growth, asymptotic selectivity, and density-dependence in the index catchability (Table B-1). Each reference model was run with four steepness of the stock-recruitment relationship assumptions (0.7, 0.8, 0.9, and 1.0). A total of 48 models composed the benchmark assessment for yellowfin tuna (SAC-11-07). In addition, new fishery definitions were implemented, and spline selectivity functions were adopted for most fisheries. All EPO catches were added to the models, which were fit to a standardized purse-seine index of abundance for the EPO north of 5°N and to the length-composition data from the purse-seine fisheries that operate north of 5°N, in order to avoid contamination of the signal with that of a possible southern population. The models were diagnosed for model misspecification, lack of fit, retrospective bias, among others (SAC-11-07). Rather than choosing a base-case model, all models where used to produce management advice by combining them using relative weights determined based on several criteria, including performance on model diagnostics (SAC-11-INF-J).

The 48 models of the benchmark assessment estimate similar relative recruitment trends, regardless of the steepness assumed (Figure B-5). All biomass trajectories have declining trends, but they vary in the magnitude of the declines (Figure B-6). All models indicate the highest F for fish aged 21+ quarters (5.25+ years), followed by fish aged 11-20 quarters (2.75-5 years) (Figure B-7). All models estimate similar impacts of the different types of fisheries (Figure B-8). The longline and the sorted discard fisheries have the smallest impact, while the purse-seine fisheries associated with dolphins have the greatest impact during most of the assessment period (1984-2019). In 1990s the impact of the floating-object fisheries started to be noteworthy, and surpassed that of the unassociated fisheries around 2008 and that of the purse-seine fisheries associated with dolphins in 2018. At the beginning of 2020, the spawning biomass (S) of yellowfin ranged from 49% to 219% of the level at dynamic MSY (S_{MSY_d}); 12 models suggested that it was below that level (Figure B-9, Table B-2). At the beginning of 2020, the spawning biomass (S) of yellowfin ranged from 145% to 345% of the limit reference level (S_{LIMIT}); no models suggest that it was below that limit. During 2017-2019 the fishing mortality (F) of yellowfin ranged from 40% to 168% of the level at MSY (F_{MSY}); 14 models suggested that it was above that level. During 2017-2019, the fishing mortality of yellowfin ranged from 22% to 65% of the limit reference level (F_{LIMIT}); no models suggest that it was above that limit. Every reference model suggests that lower steepness values correspond to more pessimistic estimates of stock status: lower S and higher F relative to the reference points.

The results from the reference models are combined in a risk analysis to provide management advice (SAC-11-08). The probabilities of exceeding the reference points where computed using each model result and its associated weight, the final estimates are in Table B-3 and Figures B-9 and B-10. All probability distributions are unimodal (Figure B-10). There is a low probability of F_{cur} being above F_{MSY} (9%). The probability of F_{cur} being above F_{LIMIT} is zero. The probability of the spawning biomass being below S_{MSY_d} is low (12%). The probability of the spawning biomass exceeding S_{LIMIT} is zero. The combined expected risk of F exceeding F_{MSY} is below 50% for six closure durations (Table B-3; Figure B-11), varying from 26% (no closure) to 5% (100 days), with a low risk (9%) for the current closure (72 days). One model (Base-A) produced a pessimistic result (a risk above 50% of exceeding F_{MSY} for all scenarios (Table B-3), but this model has a very low relative weight (0.01).

A key uncertainty not addressed in this assessment is the spatial structure of the stock of yellowfin tuna in the EPO. Future work to further improve the assessment will focus on it.

TABLE B-1. Model configurations (hypotheses) used for yellowfin tuna in the EPO (from SAC-11-08 Table A)
TABLA B-1. Configuraciones de los modelos (hipótesis) usadas para el atún aleta amarilla en el OPO (de SAC-11-08 Tabla A)

TABLE A. Model configurations (hypotheses) used for yellowfin tuna in the EPO.	
Model	**Description**
A. Prop: Proportional	
Base-A	Index of abundance proportional to abundance. Growth fixed; selectivity of all fleets and survey time-invariant; F19 selectivity asymptotic; index catchability (q, the proportionality constant between the index and biomass) time-invariant.
EstGro-A	As Base-A, but fitted to otolith data, growth estimated.
EstSel-A	As Base-A, but assumes dome-shaped F19 selectivity, with parameters estimated.
B. DDQ: Density dependence	
Base-B	As Base-A, but assumes non-linear relationship between index of abundance and biomass, with parameters estimated.
EstGro-B	As Base-B, but growth estimated.
EstSel-B	As Base-B, but assumes dome-shaped F19 selectivity, with parameters estimated.
C. TBM: Time block middle	
Base-C	As Base-A, but assumes a time block during 2001-2003 for the index catchability (q) (to accommodate a large increase in the index) and a time block for selectivity during 2002-2007 for the index, and F18 and F19 fisheries. F19 selectivity assumed dome-shaped during 2002-2007, otherwise asymptotic.
EstGro-C	As Base-C, but growth estimated.
EstSel-C	As Base-C, but assumes dome-shaped F19 selectivity, with parameters estimated.
D. TBE: Time block end	
Base-D	As Base-A, but assumes a time block beginning in 2015 for the index (both catchability and selectivity) and for F19 selectivity (to accommodate increase in size in the index and fishery with asymptotic selectivity).
EstGro-D	As Base-D, but growth estimated.
EstSel-D	As Base-D, but assumes dome-shaped F19 selectivity, with parameters estimated.

TABLE B-2. Management quantities for yellowfin tuna in the EPO for each reference model summarized over the four steepness values. See explantion of code in Table B-1 (from SAC-11-08 Table 1)
TABLA B-2. Cantidades de ordenación para el atún aleta amarilla en el OPO para cada modelo de referencia resumidas sobre los cuatro valores de inclinación. Ver explicación de los códigos en la Tabla B-1 (de SAC-11-08 Tabla 1)

TABLE 1. Management quantities for yellowfin tuna in the EPO. See explanation of codes in Table A.
E(x) is the expected value. P=0.5: median of the distributions of P(S_{cur}/S_{MSY}) and P(F_{cur}/F_{MSY}).

	A. Proportional			B. Density dependence			C. Time block middle			D. Time block end			Combined	
	Base-A	EstGro-A	EstSel-A	Base-B	EstGro-B	EstSel-B	Base-C	EstGro-C	EstSel-C	Base-D	EstGro-D	EstSel-D	E(x)	P=0.5
P (Model)	0.01	0.05	0.06	0.03	0.13	0.09	0.05	0.10	0.24	0.03	0.06	0.14	1.00	
Fishing mortality (F)														
F_{cur}/F_{MSY}	1.24	0.95	0.69	1.01	0.65	0.55	0.93	0.72	0.47	0.79	0.72	0.73	0.67	0.65
$P(F_{cur}>F_{MSY})$	0.88	0.37	0.05	0.46	0.03	0.01	0.32	0.07	0.00	0.13	0.08	0.09	0.09	
F_{cur}/F_{LIMIT}	0.46	0.45	0.31	0.38	0.32	0.25	0.38	0.35	0.22	0.33	0.33	0.31	0.30	
$P(F_{cur}>F_{LIMIT})$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Spawning biomass (S)														
S_{cur}/S_{MSY_d}	0.78	1.07	1.48	1.01	1.60	1.74	1.09	1.48	2.02	1.31	1.48	1.40	1.57	1.58
$P(S_{cur}<S_{MSY})$	0.93	0.41	0.07	0.48	0.04	0.08	0.34	0.06	0.03	0.15	0.09	0.11	0.12	
S_{cur}/S_{LIMIT}	1.87	1.96	2.60	2.62	3.24	3.70	2.33	2.53	3.25	2.99	2.94	3.08	2.98	
$P(S_{cur}<S_{LIMIT})$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

TABLE B-3. Decision table for yellowfin tuna in the EPO for each reference model summarized over the four steepness values. See explantion of code in Table B-1 (FROM SAC-11-08 Table 3). **TABLA B-3.** Tabla de decisión para el atún aleta amarilla en el OPO para cada modelo de referencia resumidas sobre los cuatro valores de inclinación. Ver explicación de los códigos en la Tabla B-1 (de SAC-11-08 Tabla 3).

TABLA 3. Tabla de decisión para el atún aleta amarilla en el OPO. Ver explicación de códigos en Tabla A.													
Días de veda	A. Prop			B. DDQ			C. TBM			D. TBE			Comb
	Base-A	EstGro-A	EstSel-A	Base-B	EstGro-B	EstSel-B	Base-C	EstGro-C	EstSel-C	Base-D	EstGro-D	EstSel-D	
***P*(*F*>*F*RMS)**											Probabilidad	≤50%	>50%
0	0.99	0.74	0.23	0.88	0.17	0.09	0.74	0.29	0.02	0.43	0.30	0.32	0.26
36	0.97	0.56	0.12	0.70	0.08	0.04	0.53	0.17	0.01	0.27	0.17	0.19	0.17
70	0.88	0.37	0.05	0.46	0.03	0.01	0.32	0.07	0.00	0.13	0.08	0.09	0.09
72	0.87	0.36	0.05	0.44	0.03	0.01	0.31	0.07	0.00	0.13	0.08	0.08	0.09
88	0.77	0.28	0.03	0.33	0.01	0.01	0.22	0.04	0.00	0.08	0.05	0.05	0.06
100	0.68	0.22	0.01	0.26	0.01	0.00	0.16	0.02	0.00	0.06	0.03	0.03	0.05
$P(F>F_{LÍMITE})$											Probabilidad	≤10%	>10%
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

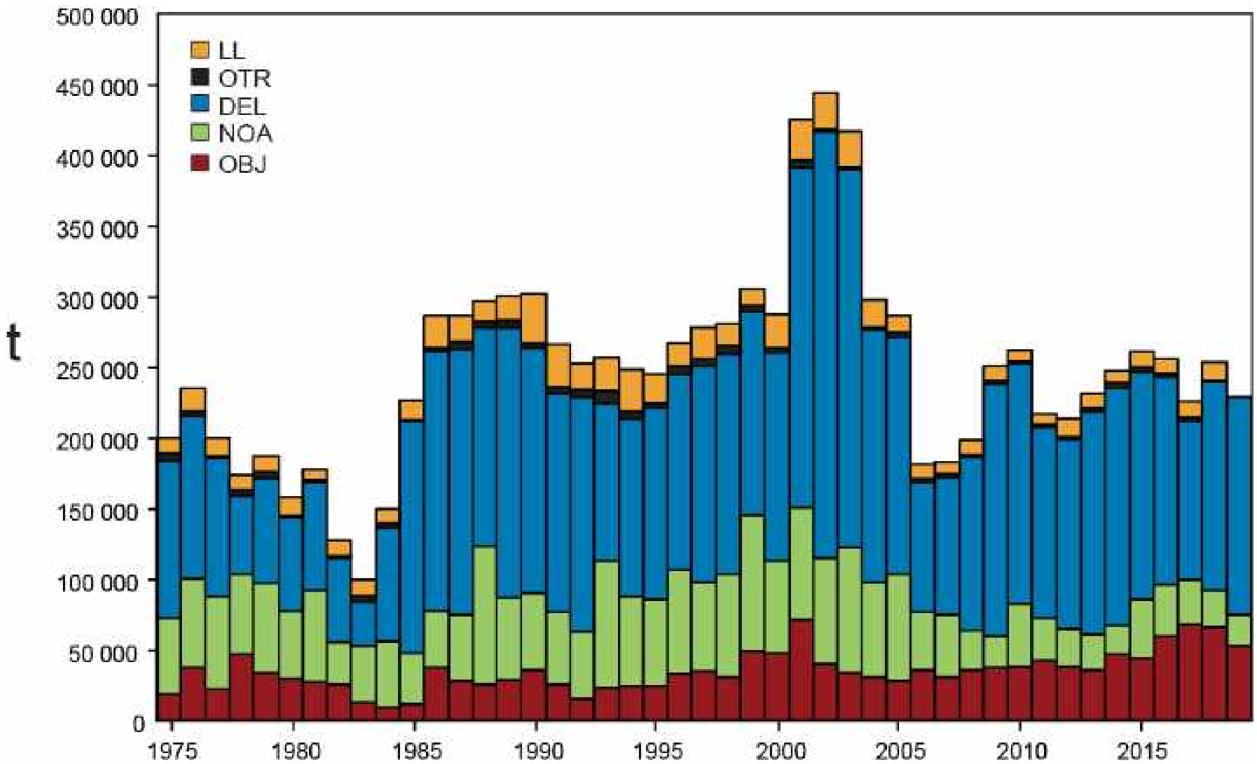


FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, by set type (DEL, NOA, OBJ), and retained catches for the longline (LL) and other (OTR) fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2019. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2019 data are preliminary.

FIGURA B-1. Capturas totales (capturas retenidas más descartes) en las pesquerías de cerco, por tipo de lance (DEL, NOA, OBJ), y capturas retenidas de las pesquerías de palangre (LL) y otras (OTR), de atún aleta amarilla en el Océano Pacífico oriental, 1975-2019. Se ajustan las capturas de cerco a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de 2019 son preliminares.

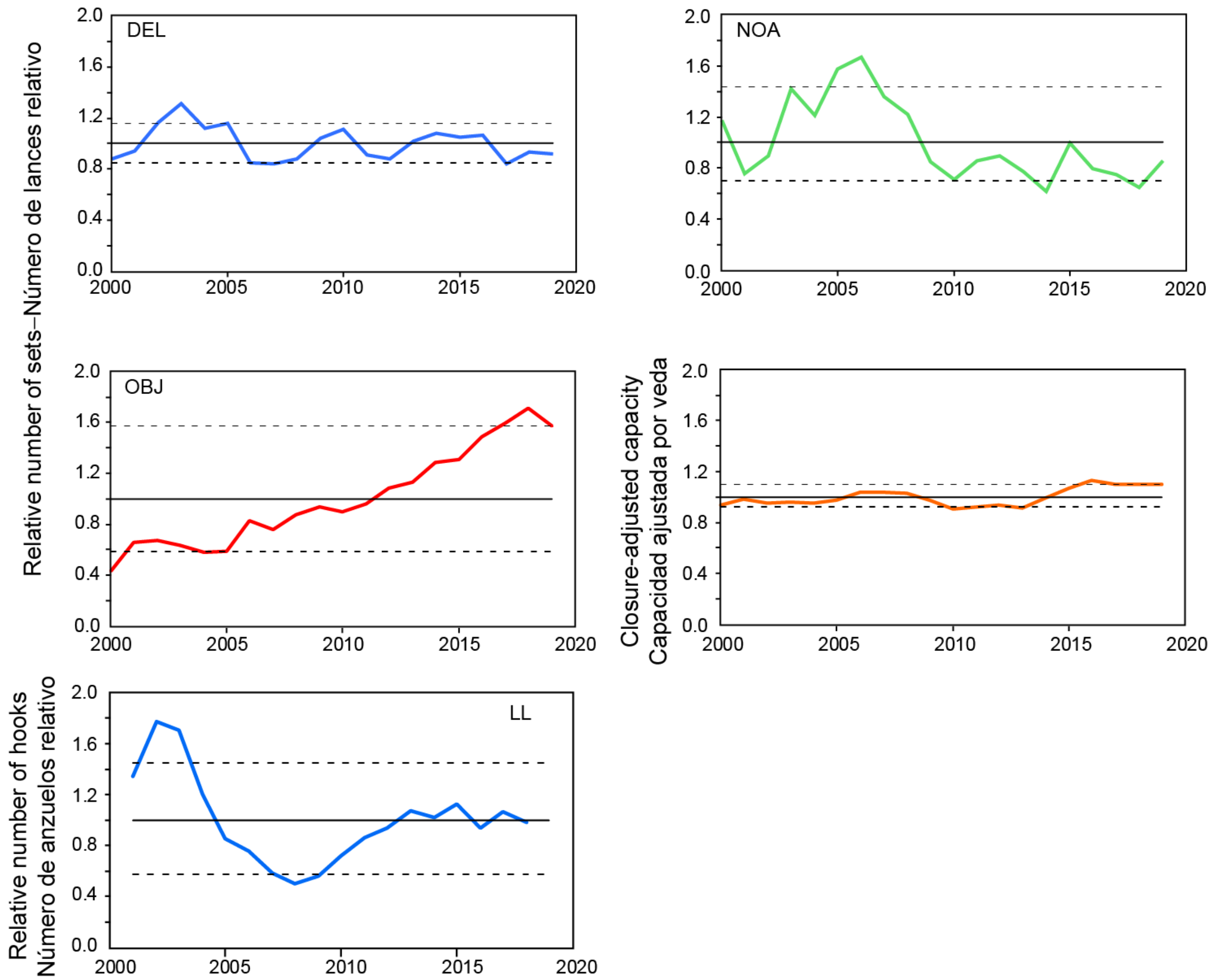


FIGURE B-2. Indicators of total effort in the EPO, based on purse-seine data closure-adjusted capacity, 2000-2019; annual total number of sets, by type, 1987-2019) and based on longline data for 2000-2018 (effort reported by all fleets, in total numbers of hooks; proportion of the effort corresponding to Japan). The dashed horizontal lines are the 5th and 95th percentiles, the solid horizontal line is the median.

FIGURA B-2. Indicadores del esfuerzo total en el OPO, basados en datos de cerco (capacidad ajustada por veda, 2000-2019; número total anual de lances, por tipo, 1987-2019) y en datos de palangre de 2000-2018 (esfuerzo notificado por todas las flotas, en número total de anzuelos; proporción del esfuerzo correspondiente a Japón). Las líneas horizontales de trazos representan los percentiles de 5 y 95%, y la línea horizontal sólida la mediana.

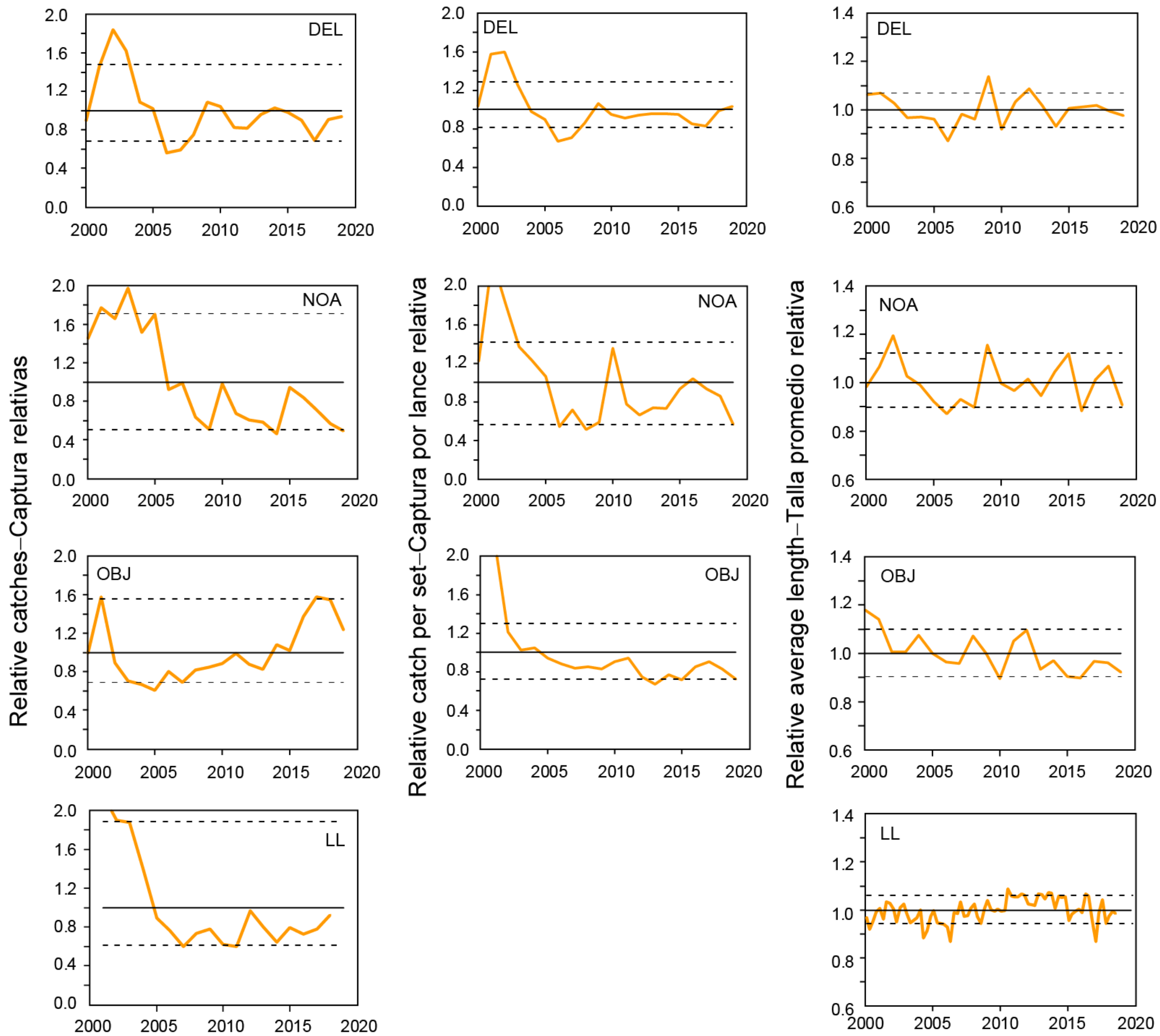


FIGURE B-3. Indicators (catch (t and numbers); CPUE (t/day fished); average length (cm)) for the yellowfin tuna stock in the eastern Pacific Ocean, from purse-seine fisheries; relative catch and relative average length, obtained from standardized length composition using spatiotemporal model, from longline fisheries.

FIGURA B-3. Indicadores (captura (t); esfuerzo (días de pesca); CPUE (t/día de pesca); talla promedio (cm)) para la población de atún aleta amarilla en el Océano Pacífico oriental, de las pesquerías de cerco Captura relativa y talla promedio relativa de las pesquerías de palangre, obtenidas de la composición por talla estandarizada usando el modelo espaciotemporal, de las pesquerías de palangre.

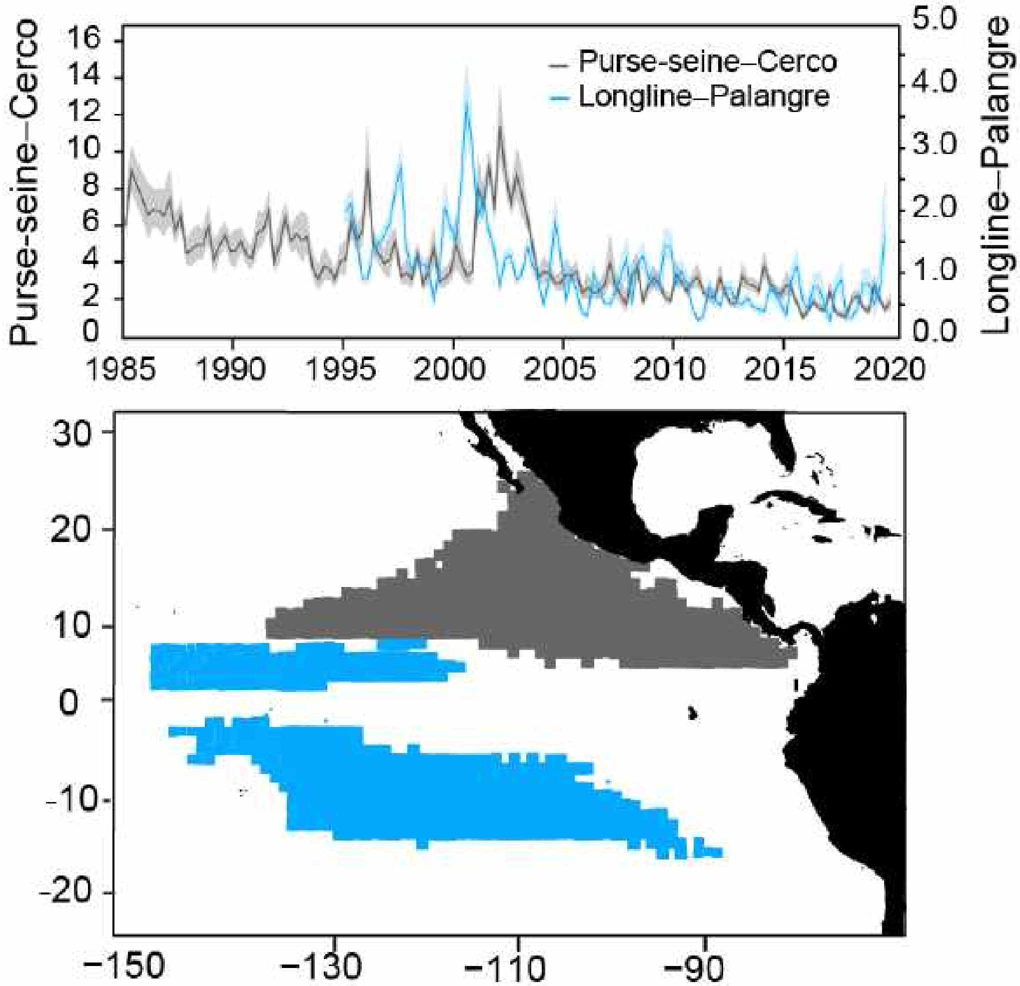


FIGURE B-4. Top: Relative abundance indices derived from catch per unit of effort of purse-seine and longline fisheries standardized using spatiotemporal models. Bottom – Spatial domain of the purse-seine and longline derived indices.

FIGURA B-4. Arriba: Índices de abundancia relativa derivados de la captura por unidad de esfuerzo de las pesquerías de cerco y de palangre estandarizados mediante modelos espaciotemporales. Abajo: Dominio espacial de los índices derivados de cerco y palangre.

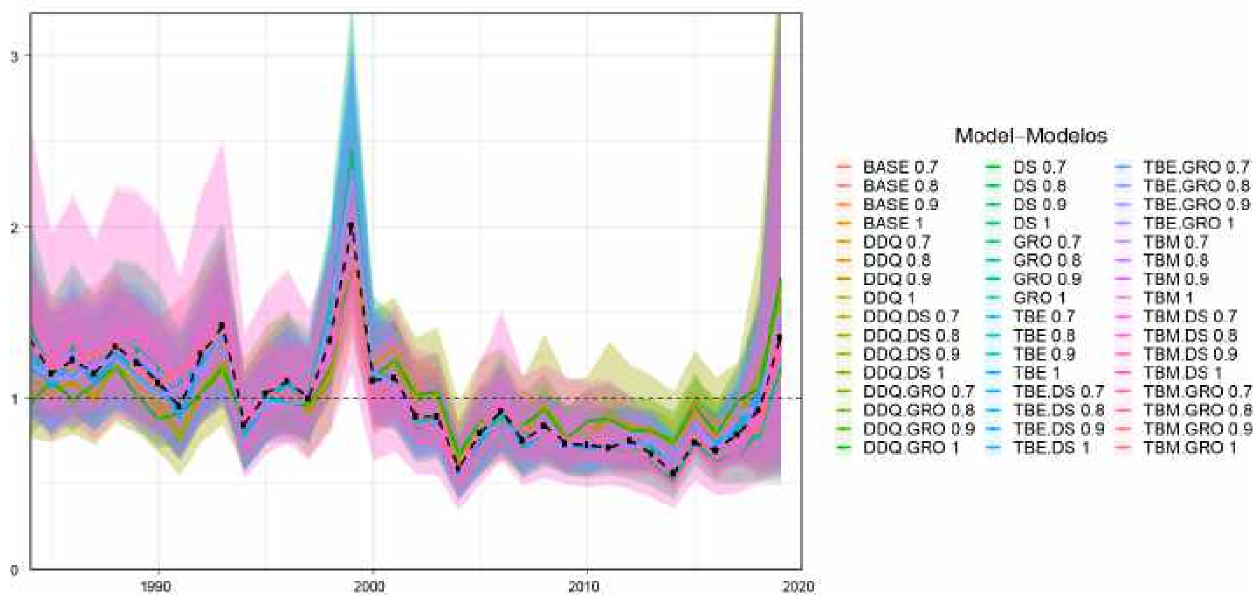


FIGURE B-5 Annual relative recruitment of yellowfin tuna to the fisheries of the EPO estimated by the 48 models and weighted average (black dashed line). The lines and dots indicate the maximum likelihood estimates of recruitment, and the shaded areas the approximate 95% confidence intervals around the estimates. The estimates are scaled so that the average recruitment is equal to 1.0 (dashed horizontal line). See model descriptions in Table B-1. The weighted average is computed using the weights assigned to each model in SAC-11-INF-J.

FIGURA B-5. Reclutamiento anual relativo del aleta amarilla en las pesquerías del OPO estimado por los 48 modelos y media ponderada (línea negra de trazos). Las líneas y puntos indican las estimaciones de máxima verosimilitud (EMV) del reclutamiento, y las áreas sombreadas los intervalos de confianza de 95% aproximados alrededor de las estimaciones. Se ajusta la escala de las estimaciones para que el reclutamiento promedio sea igual a 1.0 (línea de trazos horizontal). Ver descripciones de los modelos en la Tabla B-1. . La media ponderada fue calculada usando los pesos asignados a cada modelo en SAC-11-INF-J.

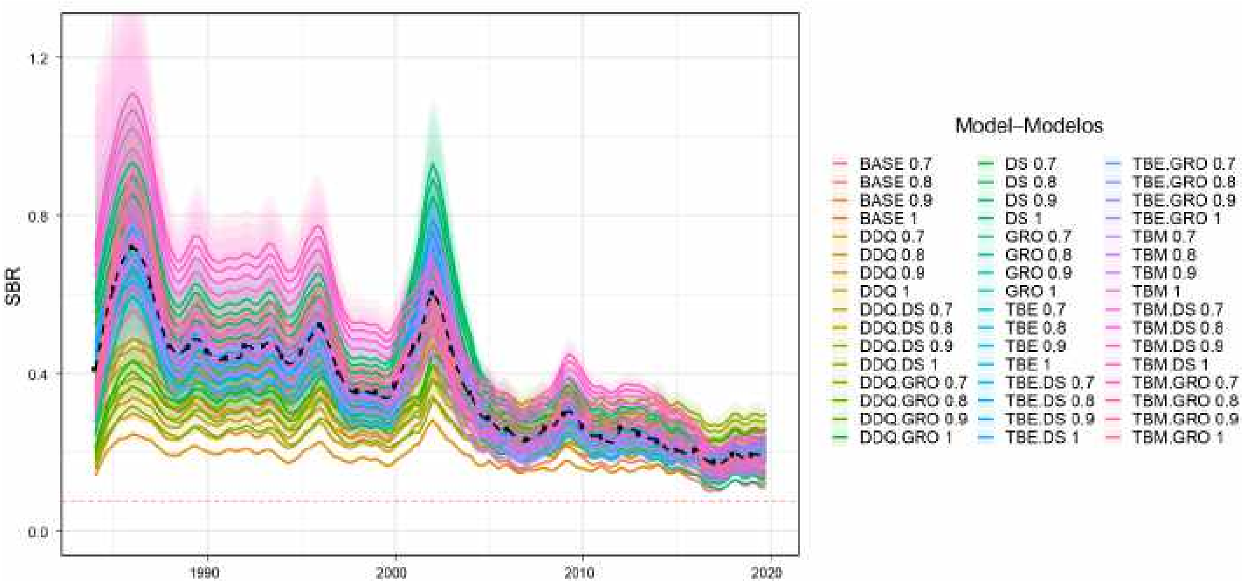


FIGURE B-6. Spawning biomass ratios (SBRs) for yellowfin tuna in the EPO, 1985-2019. The solid lines represent the maximum likelihood estimates and the shaded areas the approximate 95% confidence intervals around those estimates estimated by the 48 models and weighted average (black dashed line). The red dashed horizontal line (at 0.077) identifies the SBR at S_{LIMIT}. See model descriptions in Table B-1 The weighted average was computed using the weights assigned to each model in SAC-11-INF-J.

FIGURA B-6. Cocientes de biomasa reproductora (SBR) del aleta amarilla en el OPO, 1985-2019. Las líneas sólidas representan las estimaciones de máxima verosimilitud, las áreas sombreadas son los intervalos de confianza de 95% aproximados alrededor de esas estimaciones para los 48 modelos y media ponderada (línea negra de trazos). La línea de trazos horizontal roja (en 0.077) identifica el SBR en $S_{LÍMITE}$. Ver descripciones de los modelos en la Tabla B-1. La media ponderada fue calculada usando los pesos asignados a cada modelo en SAC-11-INF-J.

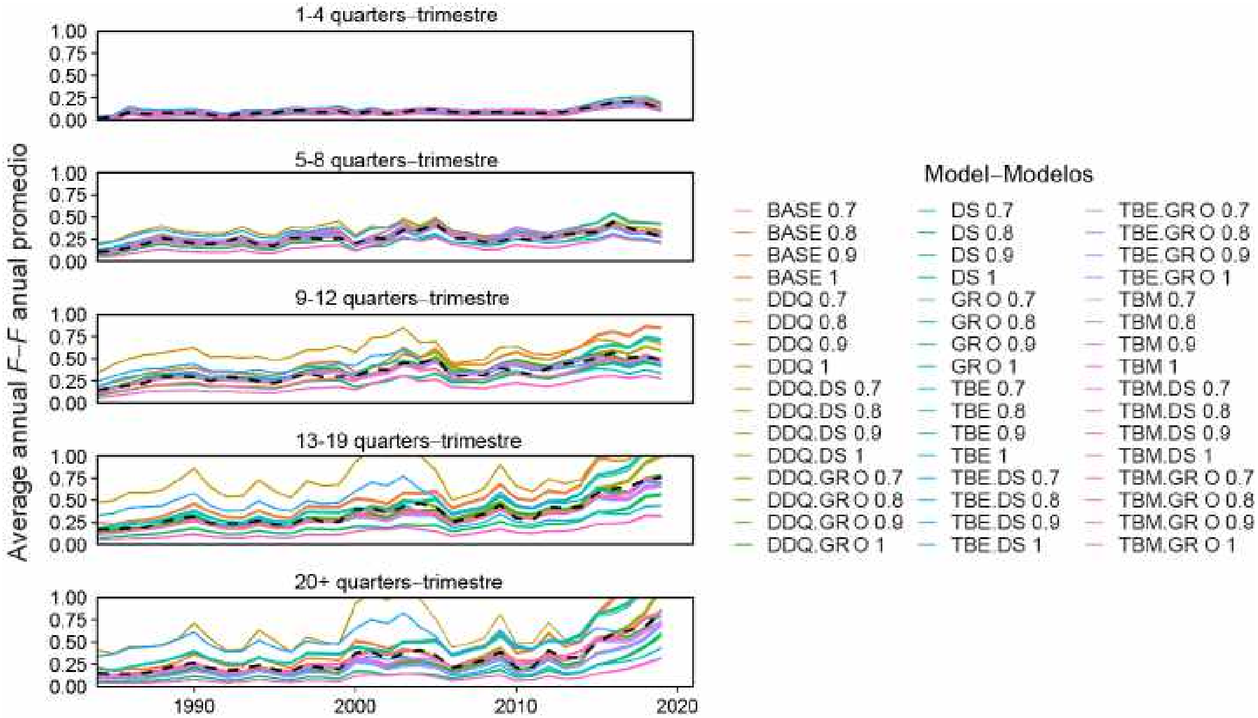


FIGURE B-7. Average annual fishing mortality (F) of yellowfin tuna in the EPO, by age group (in quarters), for all gears, estimated by the 48 models and weighted average. See model descriptions in Table B-1. The weighted average was computed using the weights assigned to each model in SAC-11-INF-J.

FIGURA B-7.Mortalidad por pesca (F) anual promedio del atún aleta amarilla en el OPO, por grupo de edad (en trimestres), por todas las artes, estimada por los 48 modelos y media ponderada. Ver descripciones de los modelos en la Tabla B-1. La media ponderada fue calculada usando los pesos asignados a cada modelo en SAC-11-INF-J.

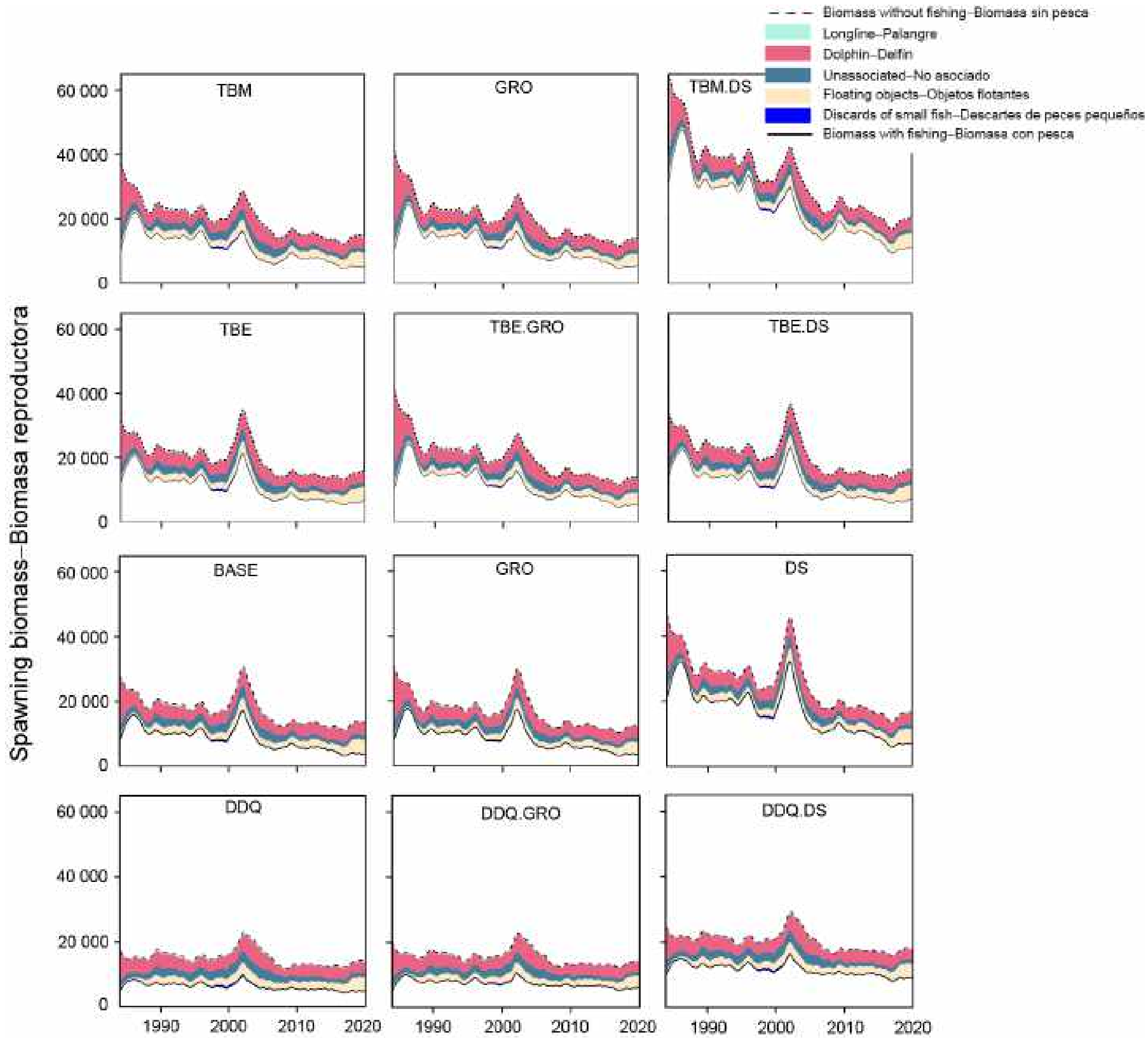


FIGURE B-8 Impact of fishing, 1985-2019: trajectory of the spawning biomass (a fecundity index, see text for details) of a simulated population of yellowfin tuna that was never exploited (dashed line) and that predicted by each model, with a steepness of 1.0 (solid line). The shaded areas between the two lines show the portions of the impact attributed to each fishing method. See model descriptions in Table B-1.

FIGURA B-8. Impacto de la pesca, 1985-2019: trayectoria de la biomasa reproductora (un índice de fecundidad, ver detalles en el texto) de una población simulada de aleta amarilla que nunca fue explotada (línea de trazos) y la trayectoria predicha por cada modelo, con una inclinación de 1.0 (línea sólida). Las áreas sombreadas entre las dos líneas muestran las porciones del impacto atribuido a cada método de pesca. Ver descripciones de los modelos en la Tabla B-1.

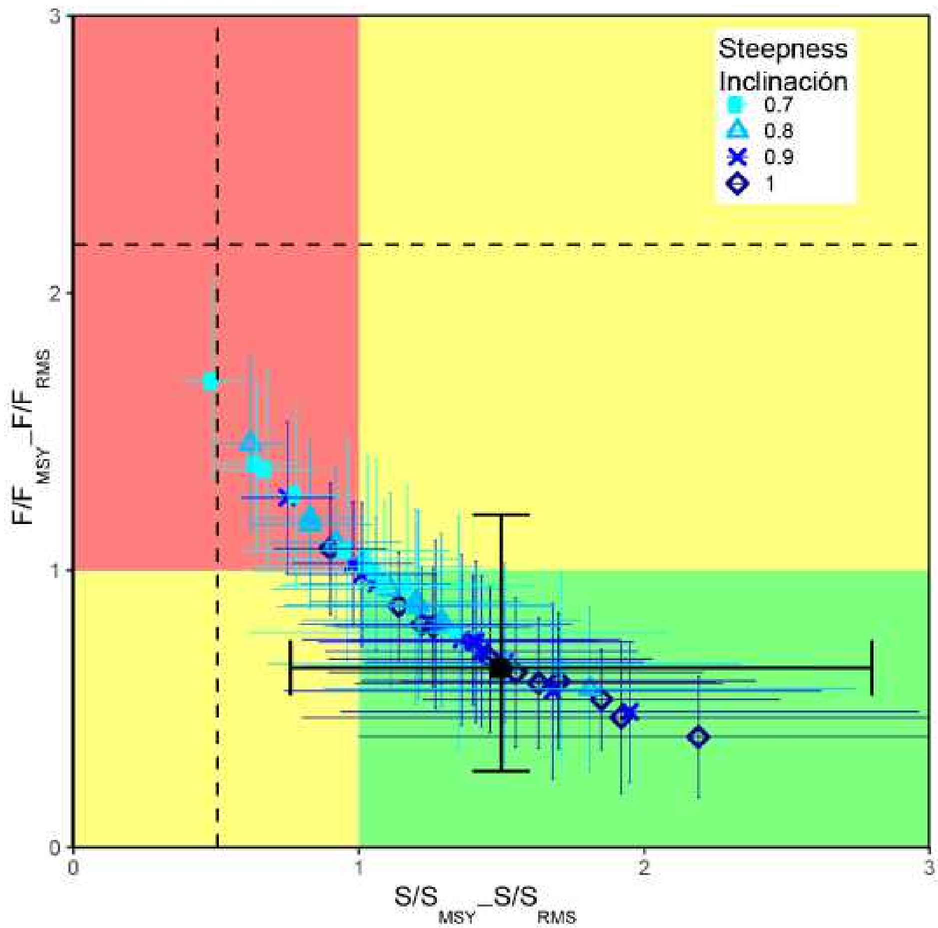


FIGURE B-9 Kobe (phase) plot of the time series of estimates of spawning stock size (*S*) and fishing mortality (*F*) of yellowfin tuna relative to their MSY reference points. The colored panels are separated by the target reference points (S_{MSY} and F_{MSY}). Limit reference points (dashed lines), which correspond to a 50% reduction in recruitment from its average unexploited level, based on a conservative steepness (*h*) of 0.75 for the Beverton-Holt stock-recruitment relationship, are merely indicative, since they vary by model and are based on all models combined. The center point for each model indicates the current stock status, based on the average fishing mortality (*F*) over the last three years; The solid black circle represents all models combined; to be consistent with the probabilistic nature of the risk analysis and the HCR, it is based on P(S_{cur}/S_{LIMIT}<x) = 0.5 and P(F_{cur}/F_{MSY}>x) = 0.5. The lines around each estimate represent its approximate 95% confidence interval.

FIGURA B-9 Diagrama de Kobe (fase) de la serie de tiempo de las estimaciones del tamaño de la población reproductora (*S*) y de la mortalidad por pesca (*F*) del atún aleta amarilla relativas a sus puntos de referencia de RMS. Los paneles de colores están separados por los puntos de referencia objetivo (S_{RMS} y F_{RMS}). Los puntos de referencia límite (líneas de trazos), que corresponden a una reducción del 50% del reclutamiento de su nivel promedio sin explotación, basados en una inclinación (*h*) cautelosa de 0.75 para la relación población-reclutamiento de Beverton-Holt, son meramente indicativos, ya que varían por modelo y se basan en todos los modelos combinados. El punto central para cada modelo indica la condición actual de la población, con base en la mortalidad por pesca media durante los tres últimos años. El círculo negro sólido representa todos los modelos combinados; para ser consistente con la naturaleza probabilista del análisis de riesgos y la RCE, se basa en *P*(S_{act}/$S_{LÍMITE}$<x) = 0.5 y *P*(F_{act}/F_{RMS}>x) = 0.5. Las líneas alrededor de cada estimación representan su intervalo de confianza aproximado de 95%.

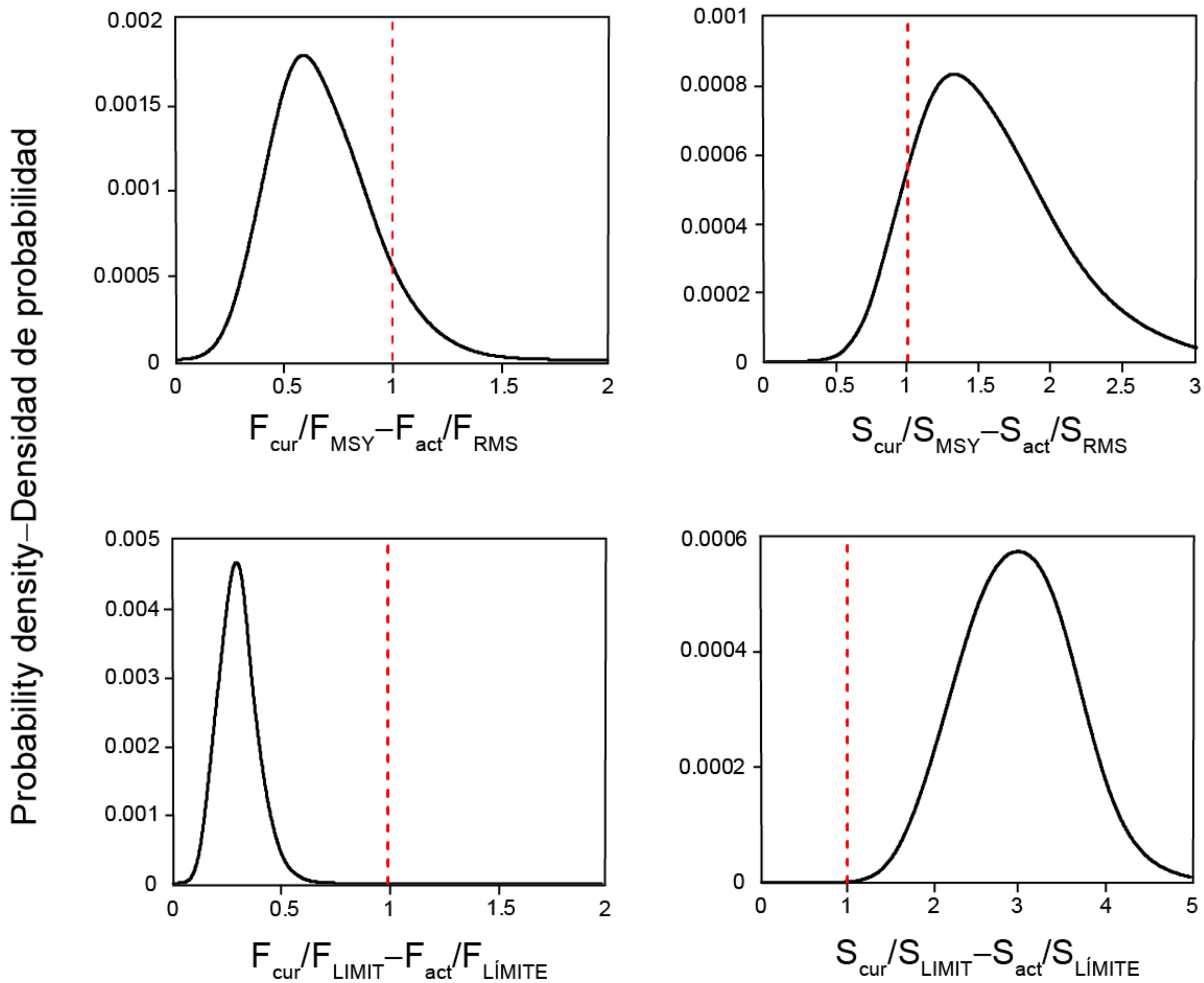


FIGURE B-10 Yellowfin probability density functions for F_{cur}/F_{MSY}, F_{cur}/F_{LIMIT} and S_{cur}/S_{LIMIT} broken down into different components for models developed to address: a) combined; b) issues with the index of abundance; c) misfit to the composition data for the fishery with asymptotic selectivity; and d) different assumptions on steepness (*h*).

FIGURA B-10 Funciones de densidad de probabilidad para F_{act}/F_{RMS}, $F_{act}/F_{LÍMITE}$ y $S_{act}/S_{LÍMITE}$ de aleta amarilla divididas en diferentes componentes para modelos implementados para resolver: a) combinada; b) problemas con el índice de abundancia; c) problemas en los ajustes a los datos de composiciones de talla de la pesquería con selectividad asintótica; y d) distintos supuestos sobre la inclinación (*h*).

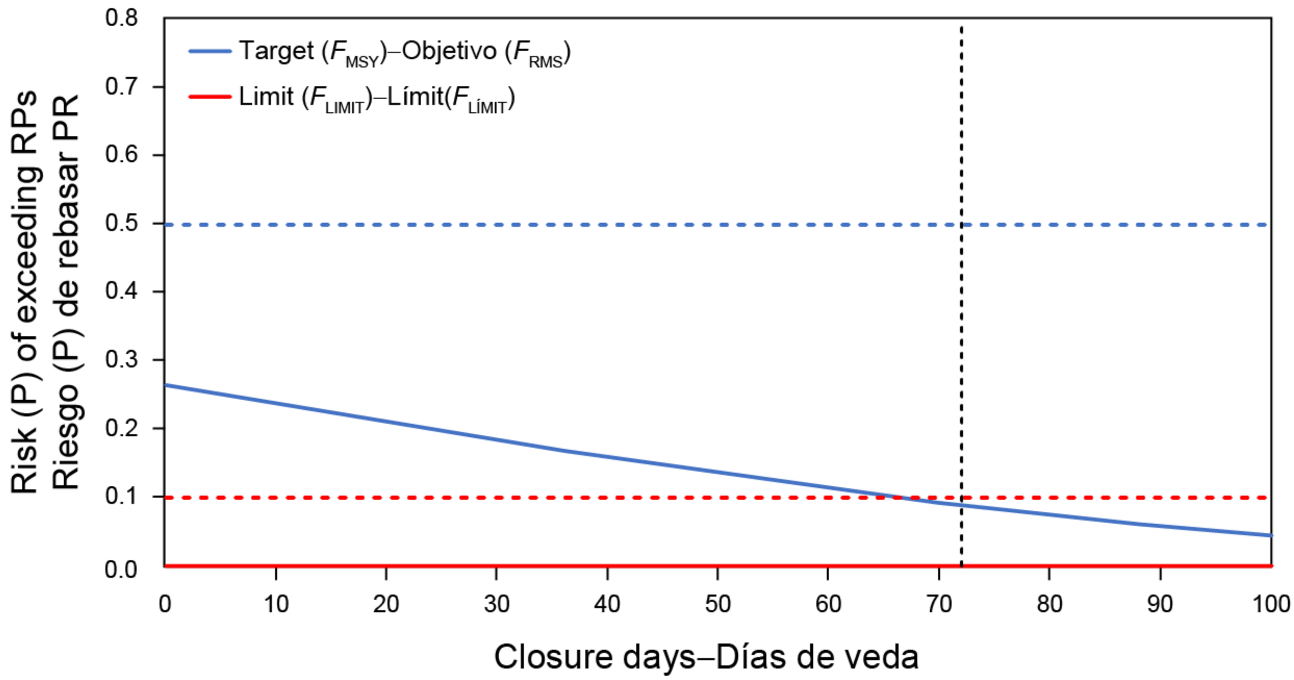


FIGURE B-11. Risk curves showing the probability of exceeding the target and limit reference points (RPs) for different durations of the temporal closure for yellowfin in the EPO.

FIGURA B-11. Curvas de riesgo que señalan la probabilidad de rebasar los puntos de referencia (PR) objetivo y límite con diferentes duraciones de la veda temporal para aleta amarilla en el OPO.

C. SKIPJACK TUNA

This analysis was originally presented in document SAC-10-09.

A major management objective for tunas in the eastern Pacific Ocean (EPO) is to keep stocks at levels capable of producing maximum sustainable yields (MSYs). Management objectives based on MSY or related reference points (*e.g.* fishing mortality that produces MSY (F_{MSY}); spawner-per-recruit proxies) are in use for many species and stocks worldwide. However, these objectives require that reference points and quantities to which they are compared be available. The various reference points require different amounts and types of information, ranging from biological information (*e.g.* natural mortality, growth, and stock-recruitment relationship) and fisheries characteristics (*e.g.* age-specific selectivity), to absolute estimates of biomass and exploitation rates. These absolute estimates generally require a formal stock assessment model. For many species, the information required to estimate these quantities is not available, and alternative approaches are needed.

Skipjack tuna is a notoriously difficult species to assess. Due to its high and variable productivity (*i.e.* annual recruitment is a large proportion of total biomass), it is difficult to detect the effect of fishing on the population with standard fisheries data and stock assessment methods. This is particularly true for the stock of the EPO, due to the lack of age-composition data, and especially tagging data, without which a conventional stock assessment of skipjack is not possible. The continuous recruitment and rapid growth of skipjack mean that the temporal stratification needed to observe modes in length-frequency data make the current sample sizes inadequate. Previous assessments have had difficulty in estimating the absolute levels of biomass and exploitation rates, due to the possibility of a dome-shaped selectivity curve, which would mean that there is a cryptic biomass of large skipjack that cannot be estimated. The most recent assessment of skipjack in the EPO is considered preliminary because it is not known whether the catch per day fished for purse-seine fisheries is proportional to abundance. Further analysis of currently available tagging data is unlikely to improve the skipjack stock assessment and a fully length-structured model produced unrealistic estimates. In addition to the problems listed above, the levels of age-specific natural mortality are uncertain, if not unknown, and current yield-per-recruit (YPR) calculations indicate that the YPR would be maximized by catching the youngest skipjack in the model. Therefore, neither the biomass- nor fishing mortality-based reference points, nor the indicators to which they are compared, are available for skipjack in the EPO.

One of the major problems mentioned above is the uncertainty as to whether the catch per unit of effort (CPUE) of the purse-seine fisheries is an appropriate index of abundance for skipjack, particularly when the fish are associated with fish-aggregating devices (FADs). Purse-seine CPUE data are particularly problematic, because it is difficult to identify the appropriate unit of effort. In previous analyses, effort was defined as the amount of searching time required to find a school of fish on which to set the purse seine, and this is approximated by number of days fished. Few skipjack are caught in the longline fisheries or dolphin-associated purse-seine fisheries (Figure C-1), so these fisheries cannot be used to develop reliable indices of abundance for skipjack. Within a single trip, purse-seine sets on unassociated schools are generally intermingled with floating-object or dolphin-associated sets, complicating the CPUE calculations. Maunder and Hoyle (2007) developed a novel method to generate an index of abundance, using data from the floating-object fisheries. This method used the ratio of skipjack to bigeye in the catch and the "known" abundance of bigeye based on stock assessment results. Unfortunately, the method was of limited usefulness, and more research is needed to improve it. Currently, there is no reliable index of relative abundance for skipjack in the EPO. Therefore, other indicators of stock status, such as the average weight of the fish in the catch, should be investigated.

Since the stock assessments and reference points for skipjack in the EPO are so uncertain, developing alternative methods to assess and manage the species that are robust to these uncertainties would be beneficial. Full management strategy evaluation (MSE) for skipjack would be the most comprehensive method to develop and test alternative assessment methods and management strategies; however, developing MSE is time-consuming, and has not yet been conducted for skipjack. In addition, higher priority for MSE is given to yellowfin and bigeye tuna, as available data indicate that these species are more susceptible to overfishing than skipjack. Therefore, Maunder and Deriso (2007) investigated some simple indicators of stock status based on relative quantities. Rather than using reference points based on MSY, they compared current values of indicators to the distribution of indicators observed historically. They also developed a simple stock assessment model to generate indicators for biomass, recruitment, and exploitation rate. However, this year catch-per-set by set type replaces the catch-per-day-fished Stock Status Indicators (SSIs) used previously, which are considered unreliable due to possible biases in the method used to assign days fished to set types; also, the model-based indicators used for skipjack are no longer reported because they were based on the same CPDF data. The current SSIs begin in 2000 because the IATTC port-sampling program began the species composition sampling in that year, and it is after the major offshore expansion of the floating-object fishery which started in the mid-1990s. All SSIs are scaled (relative indicators) so that their average equals 1 during the 2000-2019 period. The reference levels were changed from the 5% and 95% percentiles to the 10% and 90% percentiles because extreme percentiles are less reliable with fewer years of data.

Many of the indicator values for recent years are near their reference levels (Figures B-2 and C-2). Exceeding a reference level can have multiple interpretations, and these will depend on the particular SSI being considered and whether the upper or the lower reference level has been exceeded. To interpret trends in SSIs, it may be helpful to take multiple SSIs into consideration simultaneously.

Most floating-object fishery SSIs suggest that the skipjack has potentially been subject to increased fishing mortality, mainly due to the increase in the number of sets in the floating-object fishery. Of particular concern is the constantly increasing trend in the number of floating object sets observed since 2005 (Figure B-2). This is reflected as an increase in catch for skipjack in floating-object sets and a decline in catch-per-set and in average length of the fish in the catch for the floating-object fishery (Figure C-2). The interpretation of increased fishing mortality is supported by trends in average length of skipjack caught in the other set types. On the other hand, trends in catch-per-set for unassociated sets, are not consistent with this interpretation (Figure C-2).

The fact that most SSIs based on the floating-object fishery are consistent with an increase in fishing mortality in that fishery means that precautionary management measures should be considered to prevent further increases.

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 an assessment of bigeye is available, inferences can be made about the status of skipjack. Productivity and Susceptibility Analysis (PSA; Duffy et al. 2019) for the tropical tuna fishery in the EPO indicated that skipjack and bigeye have about the same susceptibility to purse-seine fishing gear, and that skipjack is much more productive than bigeye. Taking the risk analysis results for bigeye as reference (SAC-11-08), the staff infers the following about the skipjack stock status in the EPO (Table A):

1. There is less than 50% probability that F_{MSY} has been exceeded ($P(F>F_{MSY})<50\%$), and a less than 53% probability that S_{cur} is below S_{MSY} ($P(S<S_{MSY})<53\%$),

2. There is less than 5% probability that F_{LIMIT} has been exceeded ($P(F>F_{LIMIT})<5\%$), and less than 6% probability that S_{LIMIT} has been breached ($P(S>S_{LIMIT})<6\%$).

These inferences about skipjack stock status from the PSA analysis are interim: direct advice from a skipjack assessment is still needed. The staff is currently conducting a multi-year tagging study of tropical tunas in the EPO aimed at obtaining data that will contribute to, and reduce uncertainty in, tuna stock assessments, particularly for skipjack (Project E.4.a). In addition, an MSE process for tropical tunas, which includes skipjack, is ongoing at IATTC.

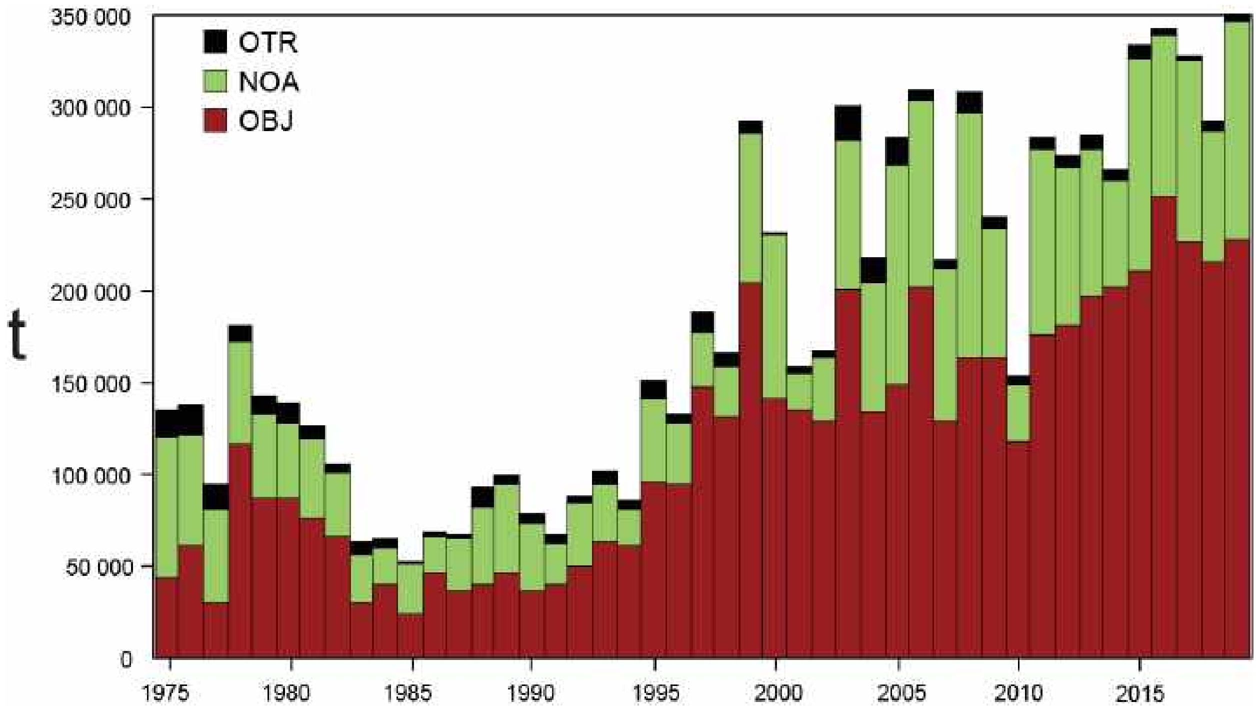


FIGURE C-1. Total catches (retained catches plus discards) for the purse-seine fisheries, by set type (NOA, OBJ) and retained catches for the other (OTR) fisheries, of skipjack tuna in the eastern Pacific Ocean, 1975-2019. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2019 catch data are preliminary.

FIGURA C-1. Capturas totales (capturas retenidas más descartes) en las pesquerías de cerco, por tipo de lance (NOA, OBJ), y capturas retenidas de las otras pesquerías (OTR), de atún barrilete en el Océano Pacífico oriental, 1975-2019. 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 2019 son preliminares.

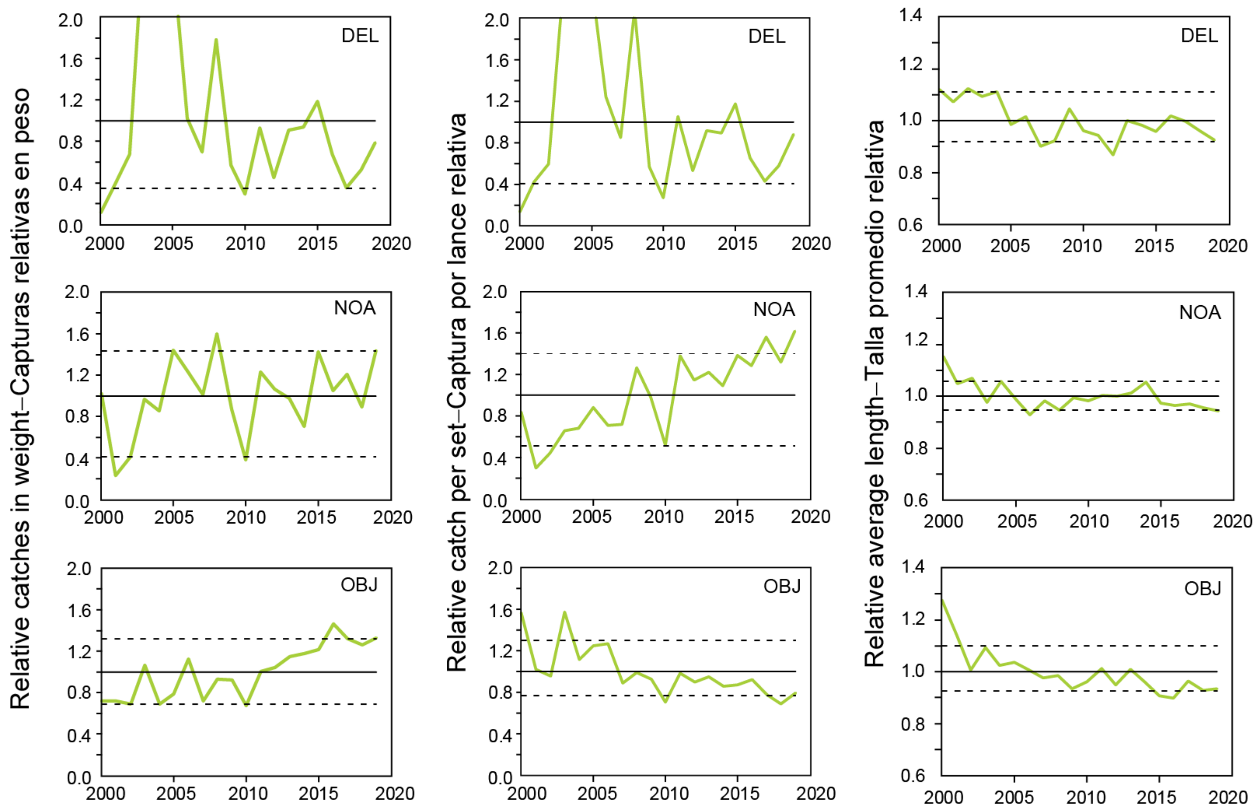


FIGURE C-2. Indicators of stock status for skipjack tuna in the eastern Pacific Ocean. OBJ: floating-object fishery; NOA: unassociated fishery; DEL: dolphin associated fishery. All indicators are scaled so that their average equals one.

FIGURA C-2. Indicadores de condición 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

For the full version of this analysis, see documents SAC-11-05, SAC-11-06, SAC-11-INF-F, and SAC-11-08.

Bigeye tuna are distributed in tropical and temperate waters across the Pacific Ocean. In the eastern Pacific Ocean (EPO), the majority of catch before 1993 was taken by longline fisheries that target large bigeye (Figure D-1). Due to the expansion of purse-seine fisheries associated with floating objects, purse-seine fisheries that target small bigeye have replaced longline fisheries as the dominant fishery type for EPO bigeye since 1996.

In 2020, stock status indicators (SSIs) were developed for bigeye using the data collected in the EPO as a whole (SAC-11-05). For the floating-object fishery, the main fishery for bigeye since 1993, fishing effort has been continuously increasing (Figure B-2). This increase in fishing effort corresponds to increased catch, decreased catch per set, and decreased average length for the floating-object fishery during the same time (Figure D-2). The fishing effort associated with the longline fishery, in comparison, does not show a noticeable long-term trend and remained around the median level since 2013 (Figure B-2). The longline index of abundance represents adult population trend and is one of the key inputs to the stock assessment model for bigeye. It suggests a long-term decreasing trend in adult population abundance since 2000 (Figure D-3). However, the average length for the longline fishery remained relatively stable since 2000 (Figure D-3).

A workplan to improve the stock assessments for tropical tunas was executed and an external review for bigeye was completed. The external review panel did not single out a particular model configuration as a replacement for the base case model but suggested a variety of alternatives for the staff to consider. To encompass as many hypotheses as possible, the staff developed a pragmatic risk assessment framework to apply for both species, which included the development of hypotheses, the implementation and weighting of models, and the construction of risk tables based on the combined result across all reference models (SAC-11-08, SAC-11-INF-F, SAC-11-INF-J).

The reference models for the benchmark assessment of bigeye were built based on three overarching hypotheses (SAC-11-INF-J). The first overarching hypothesis is about the cause of the apparent recruitment shift which coincides with the expansion of the floating-object fishery, assuming that shift is either real or an artifact of model misspecification. The second overarching hypothesis consists of two levels. The first level represents the cause of the apparent recruitment shift given it is an artifact of model misspecification. It is assumed that mis-specified process is either known (movement, mortality, selectivity, or growth) or unknown (other than those four processes). The second level represents the cause of the misfit to the length composition data from the longline fishery that has asymptotic selectivity. It is assumed that the misfit is due to random observation error or an artifact of model misspecification (in growth, selectivity, or natural mortality). The third overarching hypothesis is about the steepness of the Beverton-Holt stock-recruitment relationship, which was assumed in the reference models to be 0.7, 0.8, 0.9, or 1.0. In total, 44 reference models were retained in the benchmark assessment for bigeye tuna (SAC-11-06). These reference models on which the management advice is based were combined using relative weights determined by several criteria, including performance on model diagnostics (SAC-11-INF-J).

The results from the 44 reference models for bigeye show that (1) the recruitment shift is apparent in some but not all models (Figure D-4); (2) all models show a decreasing trend in spawning biomass while the scale of the spawning biomass varies dramatically among models (Figure D-5); (3) since 2000, the fishing mortality on juvenile bigeye (age 1-8 quarters) has increased while that on adult bigeye (age 13-39 quarters) has decreased (Figure D-6). The fishery impact plot shows clearly that the floating-object fishery has the dominant impact on the current spawning biomass of bigeye, regardless of the model (Figure D-7).

Regarding management quantities (Figure D-8), the 44 reference models estimate that (1) at the beginning of 2020, the spawning biomass of bigeye ranged from 14% to 212% of the level at dynamic MSY; 26 models suggest that it was below that level; (2) at the beginning of 2020, the spawning biomass of bigeye ranged from 51% to 532% of the limit reference level; five models suggest that it was below that limit; (3) during 2017-2019, the fishing mortality of bigeye ranged from 51% to 223% of the level at MSY; 26 runs suggest that it was above that level; (4) during 2017-2019, the fishing mortality of bigeye ranged from 32% to 114% of the limit reference level; three models suggest that it was above that limit.

The results from the 44 reference models are combined in a risk analysis framework to provide management advice (SAC-11-08). The combined risk curves (Figure D-9) show that (1) the probabilities of fishing mortality during 2017-2019 (F_{cur}) being higher than the target and limit reference levels are 50% and 5%, respectively; (2) the probabilities of spawning biomass at the beginning of 2020 (S_{cur}) being lower than the target and limit reference levels are 53% and 6%, respectively. Although the combined distribution suggests that the probability of F_{cur} being higher than the limit reference level is much lower than 10%, the combined probability distribution is bimodal (Figure D-10). This bimodal pattern for bigeye is due to the substantial differences in estimates between two groups of models, one more pessimistic and one more optimistic (Figures D-5 and D-11; Table D-2). It should be noted that the combined risk curve based only on pessimistic models shows that the probability of F_{cur} being higher than the limit reference level reaches 10% (Figure D-11 and Table D-3), the level beyond which additional management measures shall be established (Resolution C-16-02). The bimodality complicates the evaluation of the status of the bigeye stock and of the potential outcomes of management actions. This issue needs to be addressed in the future to improve management advice.

TABLE D-1. Model configurations (hypotheses) used for bigeye tuna in the EPO.	
Model	**Description**
A. Environment	
Env	*R* shift is real, caused by a change in the environment. Asymptotic selectivity for one longline fishery (F2). Similar to 'base case' model used in previous assessments, except (1) uses Francis method to weight composition data and (2) estimates a parameter representing change in recruitment.
Env-Fix	Environment, fixed (growth, *M* not estimated; asymptotic selectivity)
Env-Gro	Environment, growth estimated
Env-Sel	Environment, dome-shape selectivity
Env-Mrt	Environment, adult *M* estimated
B. Short-term	
Srt	Evaluated using 2000-2019 data only (1975-2019 for other models). *R* shift due to some unknown model misspecification prior to 2000 that cannot be identified/resolved with available data; thus, is not addressed by the other models.
Srt-Fix	Short-term, fixed (growth, *M* not estimated; asymptotic selectivity)
Srt-Gro	Short-term, growth estimated
Srt-Sel	Short-term, dome-shape selectivity
Srt-Mrt	Short-term, adult *M* estimated
C. Pre-adult movement	
Mov	Approximates movement of fish to and from the CPO, by applying *M* starting between ages selected by the PS-OBJ fishery and the longline fishery. Higher/lower *M* represents fish leaving/entering EPO, respectively. This modified mortality schedule also could capture actual differences in age-specific *M* driven by a variety of processes.
D. Estimate growth	
Gro	Estimating growth: (1) allows a larger biomass, thus reducing *R* shift (length-composition data for the fishery with asymptotic selectivity contain few fish around the asymptotic length, so model estimates high *F*, and corresponding low *S*, to reduce the number of large fish and fit those data); (2) produces low asymptotic length (reducing predicted number of large fish, and fits the length-composition data without increasing *F*, allowing a larger *S*). All four parameters of the Richards growth curve and the two parameters representing the variation of length at age are estimated. The model is fitted to the otolith age data conditioned on length. Can also address the misfit to the length-composition data.
E. Dome-shaped selectivity	
Sel	Dome-shape selectivity for longline fishery F2: (1) allows a larger biomass, thus reducing *R* shift (length-composition data for the fishery with asymptotic selectivity contain few fish around the asymptotic length, so model estimates high *F*, and corresponding low *S*, to reduce the number of large fish and fit those data); (2) reduces the predicted number of large fish caught, allowing the model to fit the observed length-composition data, but also produces a 'cryptic biomass', increasing the biomass estimate. A double normal selectivity curve is used. This model can also address the misfit to the length composition data.
F. Adult mortality	
Mrt	Estimating adult *M* allows a larger biomass, thus reducing *R* shift. An increased value of *M* reduces the *F* required to fit the length-composition data, thus increasing the biomass for a given level of catch. Can also address the misfit to the length-composition data.

TABLE D-2. Management quantities for bigeye tuna in the EPO. See explanation of codes in Table D-1. E(x) is the expected value. *P*=0.5: median of the distributions of $P(S_{cur}/S_{MSY})$ and $P(F_{cur}/F_{MSY})$.													
	Env-Fix	Env-Gro	Env-Sel	Env-Mrt	Srt-Fix	Srt-Gro	Srt-Sel	Srt-Mrt	Mov	Gro	Sel	Mrt	Combined	
P(Model)	0.01	0.13	0.05	0.02	0.04	0.22	0.11	0.07	0.01	0.24	0.09	0.02	*E*(x)	*P*=0.5
Fishing mortality (*F*)														
F_{cur}/F_{MSY}	1.82	0.82	0.99	1.25	1.84	1.42	1.36	1.57	0.81	0.59	0.73	0.89	1.07	1.00
$P(F_{cur}>F_{MSY})$	1.00	0.18	0.44	0.84	1.00	0.97	0.92	0.99	0.15	0.01	0.07	0.25	0.50	
F_{cur}/F_{LIMIT}	0.96	0.47	0.58	0.69	0.97	0.78	0.77	0.84	0.47	0.34	0.43	0.50	0.60	
$P(F_{cur}>F_{LIMIT})$	0.33	0.00	0.00	0.01	0.38	0.07	0.06	0.14	0.00	0.00	0.00	0.00	0.05	
Spawning biomass (*S*)														
S_{cur}/S_{MSY_d}	0.34	1.32	1.02	0.69	0.32	0.56	0.59	0.45	1.31	1.85	1.53	1.16	1.09	0.92
$P(S_{cur}<S_{MSY})$	1.00	0.19	0.49	0.96	1.00	1.00	1.00	1.00	0.16	0.03	0.07	0.27	0.53	
S_{cur}/S_{LIMIT}	0.97	3.61	2.67	2.04	0.97	1.65	1.65	1.38	3.84	5.24	4.21	3.63	3.07	
$P(S_{cur}<S_{LIMIT})$	0.59	0.00	0.00	0.02	0.50	0.06	0.09	0.19	0.00	0.00	0.00	0.00	0.06	

TABLE D-3. Decision table for bigeye tuna in the EPO. See explanation of codes in Table D-1.													
Closure days	Env-Fix	Env-Gro	Env-Sel	Env-Mrt	Srt-Fix	Srt-Gro	Srt-Sel	Srt-Mrt	Mov	Gro	Sel	Mrt	Comb
P(model)	0.01	0.13	0.05	0.02	0.04	0.22	0.11	0.07	0.01	0.24	0.09	0.02	
$\boldsymbol{P(F>F_{MSY})}$											Probability	≤50%	>50%
0	1.00	0.48	0.78	0.98	1.00	1.00	0.99	1.00	0.47	0.09	0.31	0.65	0.62
36	1.00	0.32	0.63	0.93	1.00	0.99	0.97	1.00	0.30	0.03	0.17	0.45	0.56
70	1.00	0.19	0.44	0.84	1.00	0.97	0.92	0.99	0.15	0.01	0.07	0.25	0.50
72	1.00	0.18	0.43	0.83	1.00	0.96	0.91	0.98	0.14	0.01	0.06	0.24	0.49
88	1.00	0.13	0.35	0.75	1.00	0.93	0.87	0.97	0.09	0.00	0.04	0.17	0.46
100	1.00	0.09	0.28	0.67	1.00	0.88	0.81	0.95	0.06	0.00	0.02	0.11	0.43
											Probability	≤10%	>10%
0	0.97	0.00	0.04	0.17	0.89	0.39	0.37	0.57	0.00	0.00	0.00	0.00	0.21
36	0.79	0.00	0.01	0.06	0.67	0.19	0.18	0.33	0.00	0.00	0.00	0.00	0.12
70	0.33	0.00	0.00	0.01	0.38	0.07	0.06	0.14	0.00	0.00	0.00	0.00	0.05
72	0.30	0.00	0.00	0.01	0.36	0.06	0.06	0.13	0.00	0.00	0.00	0.00	0.05
88	0.11	0.00	0.00	0.00	0.25	0.03	0.03	0.08	0.00	0.00	0.00	0.00	0.03
100	0.04	0.00	0.00	0.00	0.17	0.02	0.02	0.04	0.00	0.00	0.00	0.00	0.02

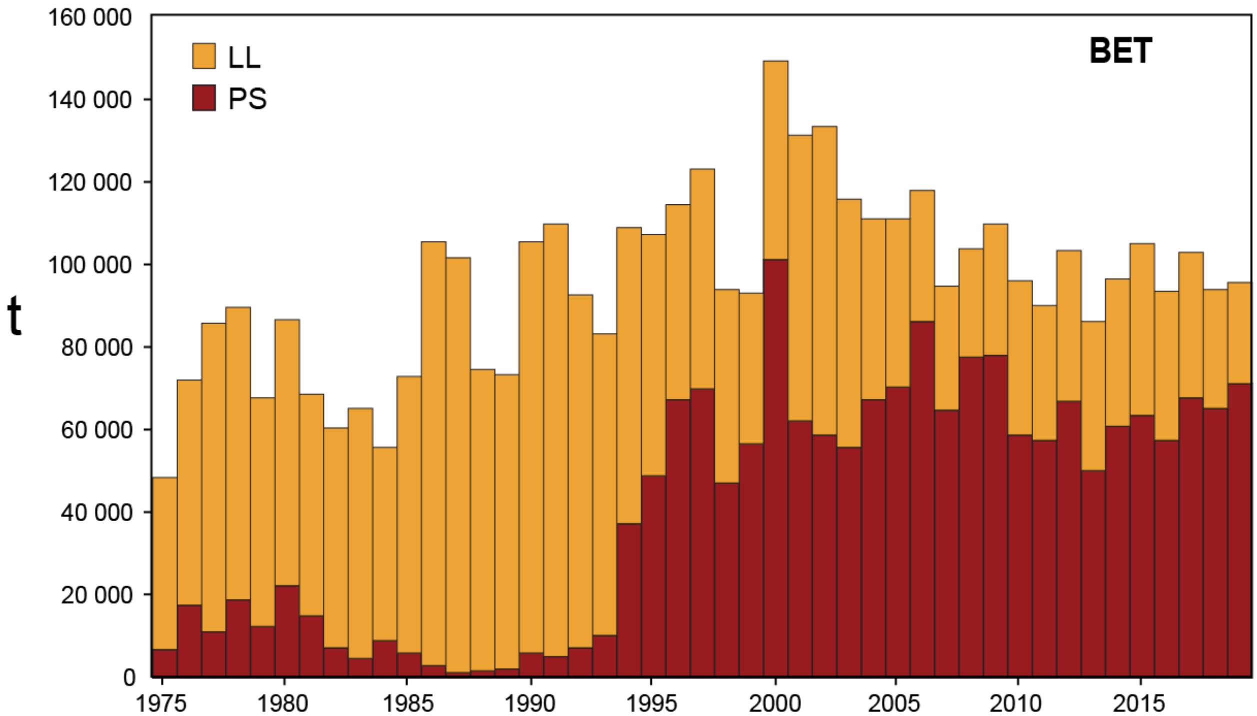


FIGURE D-1. Total catches (retained catches plus discards) by the purse-seine (PS) fisheries, and retained catches by the longline (LL) fisheries, of bigeye tuna in the eastern Pacific Ocean, 1975-2019. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. 2019 data are preliminary.

FIGURA D-1. Capturas totales (capturas retenidas más descartes) de las pesquerías de cerco (PS), y capturas retenidas de las pesquerías de palangre (LL), de atún patudo en el Océano Pacífico oriental, 1975-2019. Se ajustan las capturas de cerco a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de 2019 son preliminares.

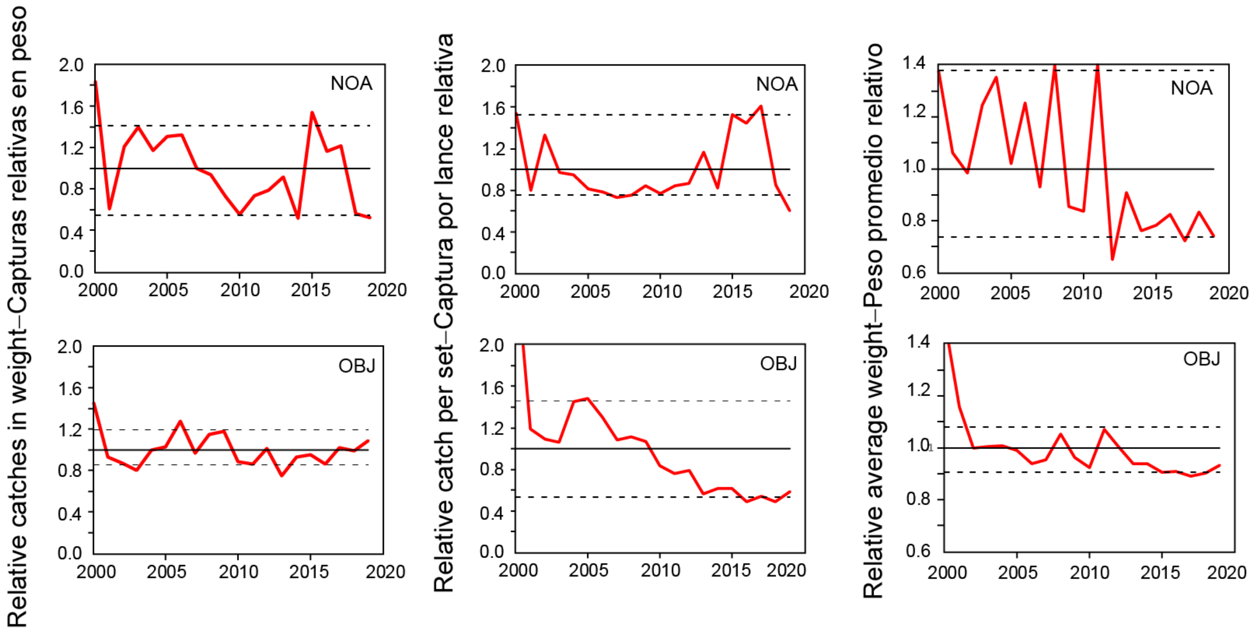
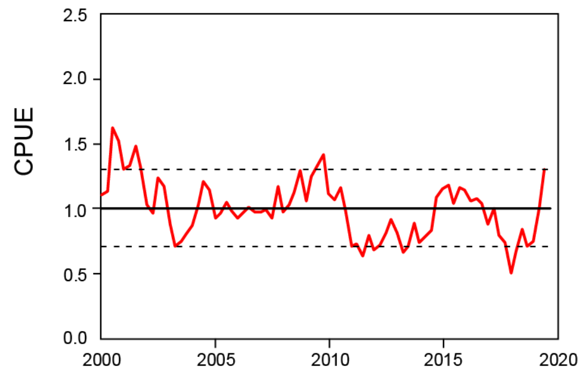


FIGURE D-2. Indicators of catch, catch per set, and average length for bigeye tuna in the EPO based on purse-seine data.
FIGURA D-2. Indicadores de captura, captura por lance, y talla promedio para el atún patudo en el OPO basados en datos de cerco.



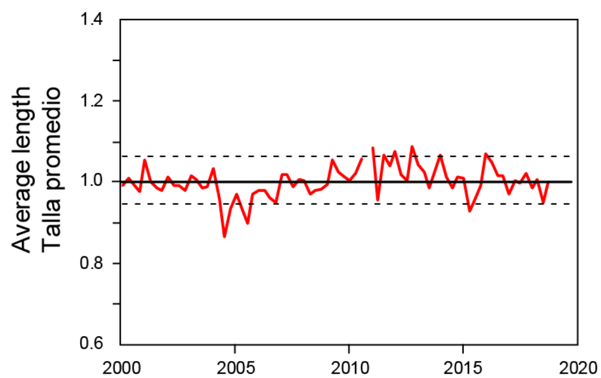


Figure D-3. Index of abundance and average length of bigeye in the EPO, based on Japanese longline data for 1975-2019. The dashed horizontal lines are the 5th and 95th percentiles, the solid horizontal line is the median.
Figura D-3. Índice de abundancia y talla promedio del patudo en el OPO, basados en datos de palangre japoneses para 1975-2019. Las líneas horizontales de trazos representan los percentiles de 5 y 95%, y la línea horizontal sólida la mediana.

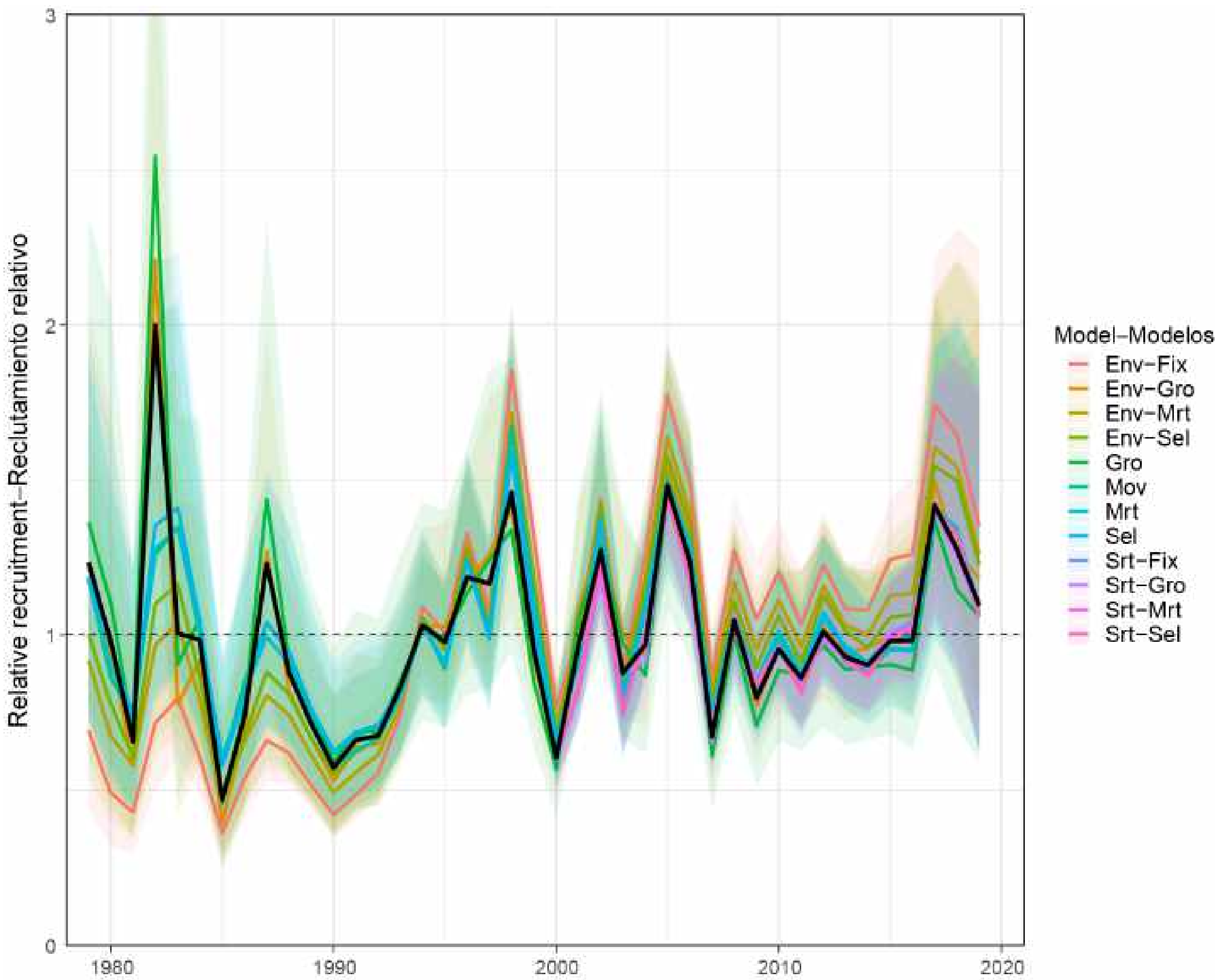


FIGURE D-4. Comparison of annual relative recruitment estimates for bigeye tuna in the eastern Pacific Ocean from the twelve reference models (only the estimates that correspond to steepness = 1.0 are shown). The shaded areas represent the 95% confidence intervals and the black line represents the combined estimates across the twelve models.

FIGURA D-4. Comparación de las estimaciones de reclutamiento relativo anual de atún patudo en el Océano Pacífico oriental de los doce modelos de referencia (se muestran solamente las estimaciones que corresponden a la inclinación = 1.0). Las áreas sombreadas representan los intervalos de confianza de 95% y la línea negra representa las estimaciones combinadas de los doce modelos.

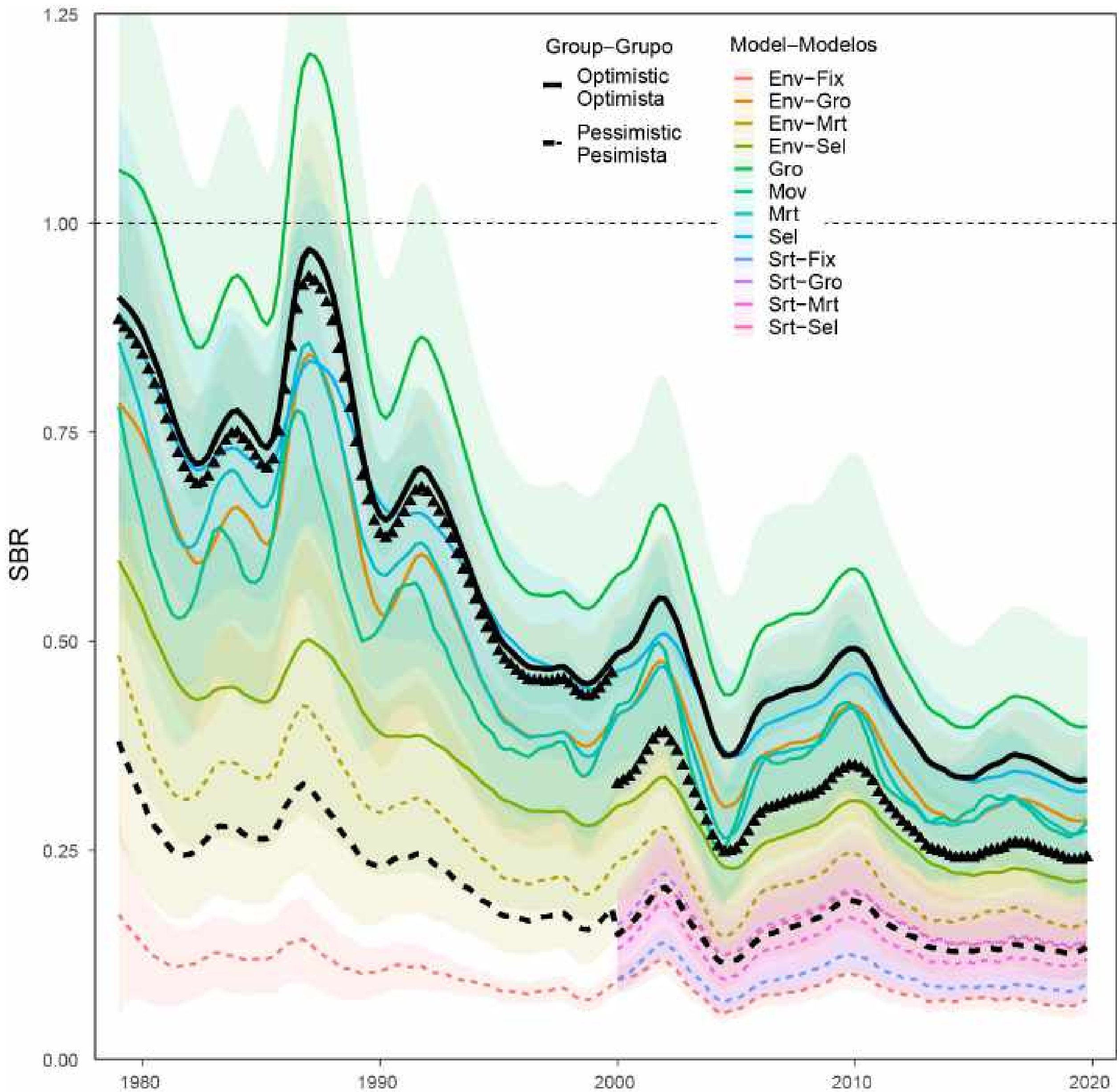


FIGURE D-5. Comparison of spawning biomass estimates for bigeye tuna in the eastern Pacific Ocean from the twelve reference models (only the estimates that correspond to steepness = 1.0 are shown). The shaded areas represent the 95% confidence intervals and the two black lines represent the combined estimates across the two groups of reference models. Black triangles mark the combined estimates across all reference models.

FIGURA D-5. Comparación de las estimaciones de biomasa reproductora del atún patudo en el Océano Pacífico oriental de los doce modelos de referencia (se muestran solamente las estimaciones que corresponden a la inclinación = 1.0). Las áreas sombreadas representan los intervalos de confianza de 95% y las dos líneas negras representan las estimaciones combinadas de los dos grupos de modelos de referencia. Los triángulos negros marcan las estimaciones combinadas de todos los modelos de referencia.

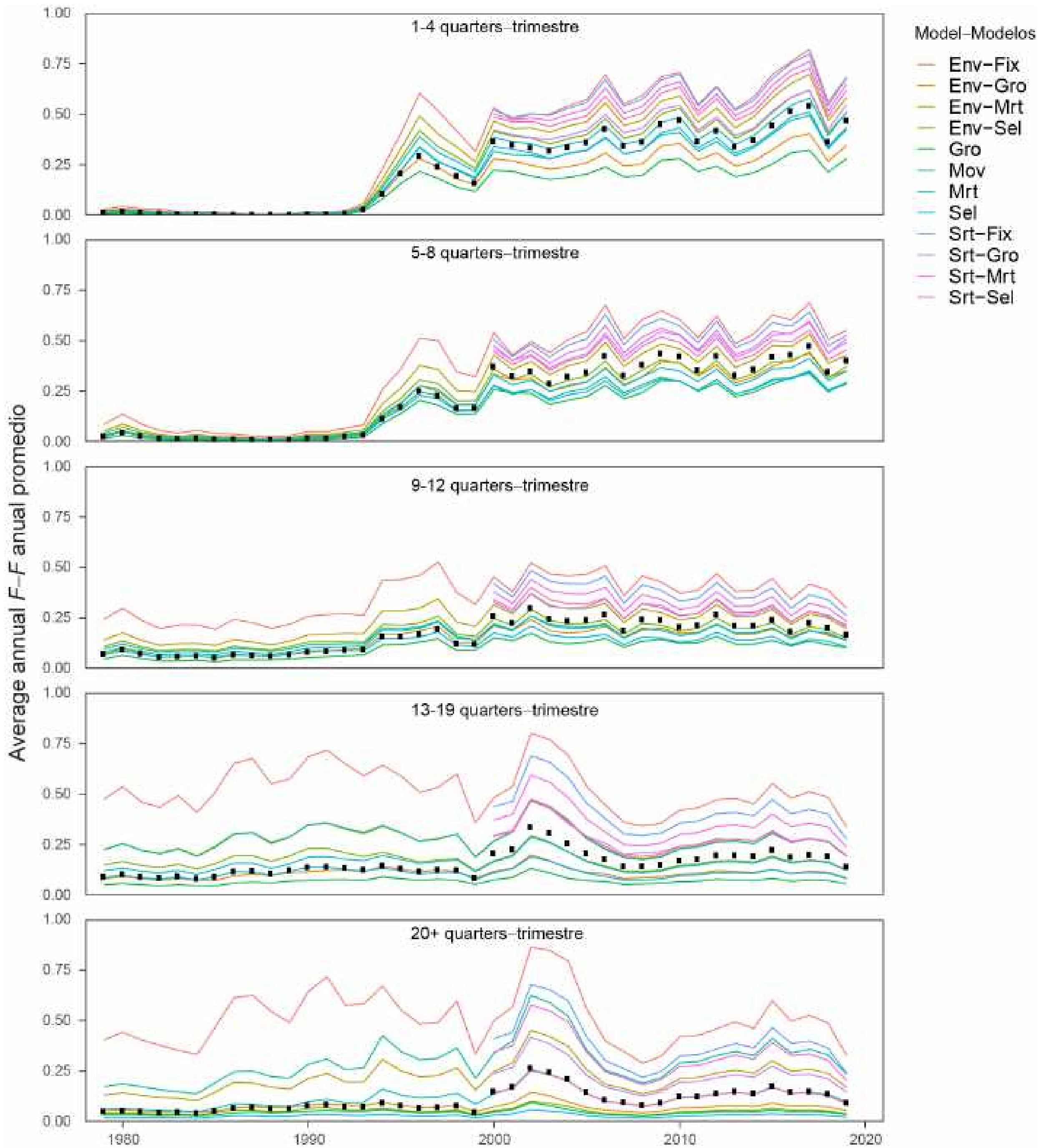


FIGURE D-6. Comparison of average annual fishing mortality, by age groups, of bigeye tuna in the eastern Pacific Ocean (only the estimates that correspond to steepness = 1.0 are shown). The black dots show the combined values across all models with a steepness of 1.0.

FIGURA D-6. Comparación de la mortalidad por pesca anual promedio, por grupos de edad, del atún patudo en el Océano Pacífico oriental (se muestran solamente las estimaciones que corresponden a la inclinación = 1.0). Los puntos negros muestran los valores combinados de todos los modelos con una inclinación de 1.0.

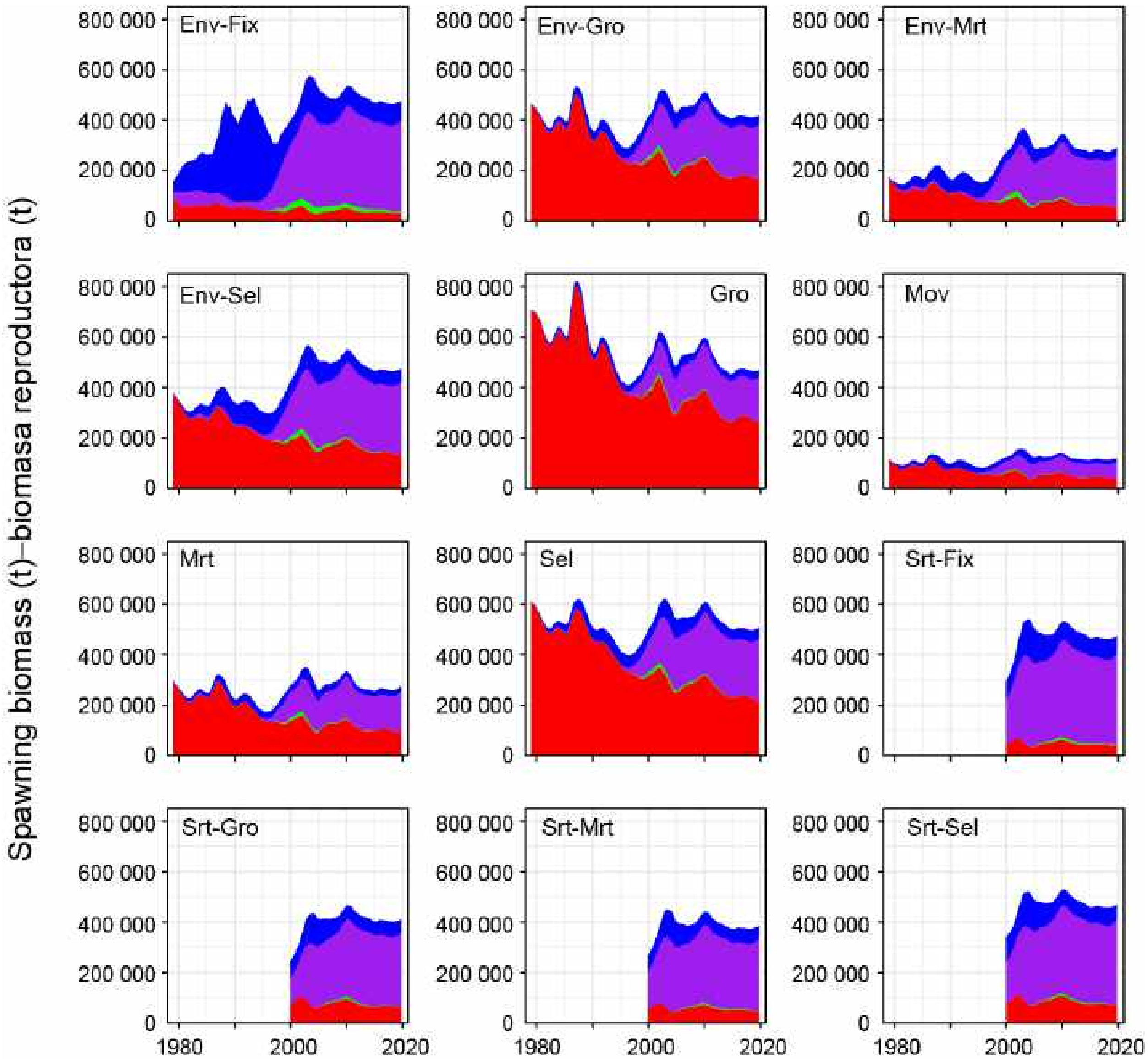


Figure D-7. Comparison of spawning biomass trajectory of a simulated population of bigeye tuna in the eastern Pacific Ocean that was never exploited (top line) and that predicted by the stock assessment model (bottom line). The shaded green, purple, and blue areas between the two lines show the portions of the impact attributed to the discard fishery, purse-seine fisheries, and longline fisheries, respectively. Only the simulation trajectories that correspond to steepness = 1.0 are shown.

Figura D-7. Comparación de la trayectoria de la biomasa reproductora de una población simulada de atún patudo en el Océano Pacífico oriental que nunca fue explotada (línea superior) y la trayectoria predicha por el modelo de evaluación (línea inferior). Las áreas sombreadas en verde, morado y azul entre las dos líneas muestran las porciones del impacto atribuido a la pesquería de descarte, las pesquerías cerqueras, y las pesquerías palangreras, respectivamente. Se muestran solamente las trayectorias de simulación que corresponden a la inclinación = 1.0.

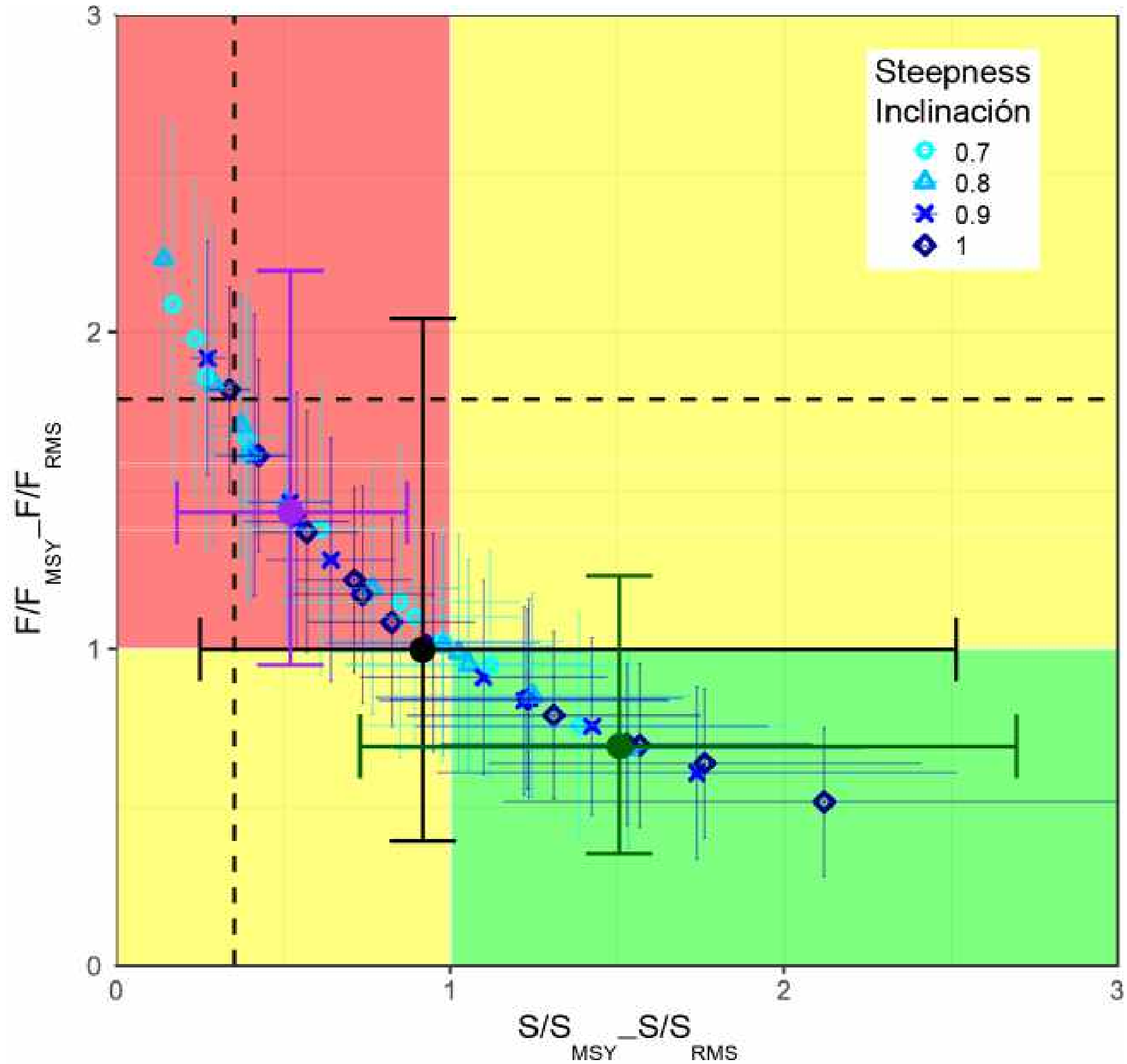


FIGURE D-8. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their MSY reference points (S_{MSY_d} and F_{MSY}) estimated by the 44 converged reference model runs (see Table 4). Each dot is based on the average *F* over the most recent three years. The dashed lines represent the limit reference points averaged for the 44 converged reference model runs. The error bars represent the 95% confidence interval of the estimates. The black, purple, and green dots are the combined estimates across all models, all pessimistic models, and all optimistic models, respectively.
Figura D-8. Gráfica de Kobe de las estimaciones más recientes de biomasa reproductora (*S*) y mortalidad por pesca (*F*) con respecto a sus puntos de referencia de RMS (S_{RMS_d} y F_{RMS}) estimados por las 44 ejecuciones convergentes de los modelos de referencia (ver Tabla 4). Cada punto se basa en la *F* promedio de los últimos tres años. Las barras de error representan el intervalo de confianza de 95% de las estimaciones. Los puntos negros, morados y verdes son las estimaciones combinadas de todos los modelos, todos los modelos pesimistas, y todos los modelos optimistas, respectivamente.

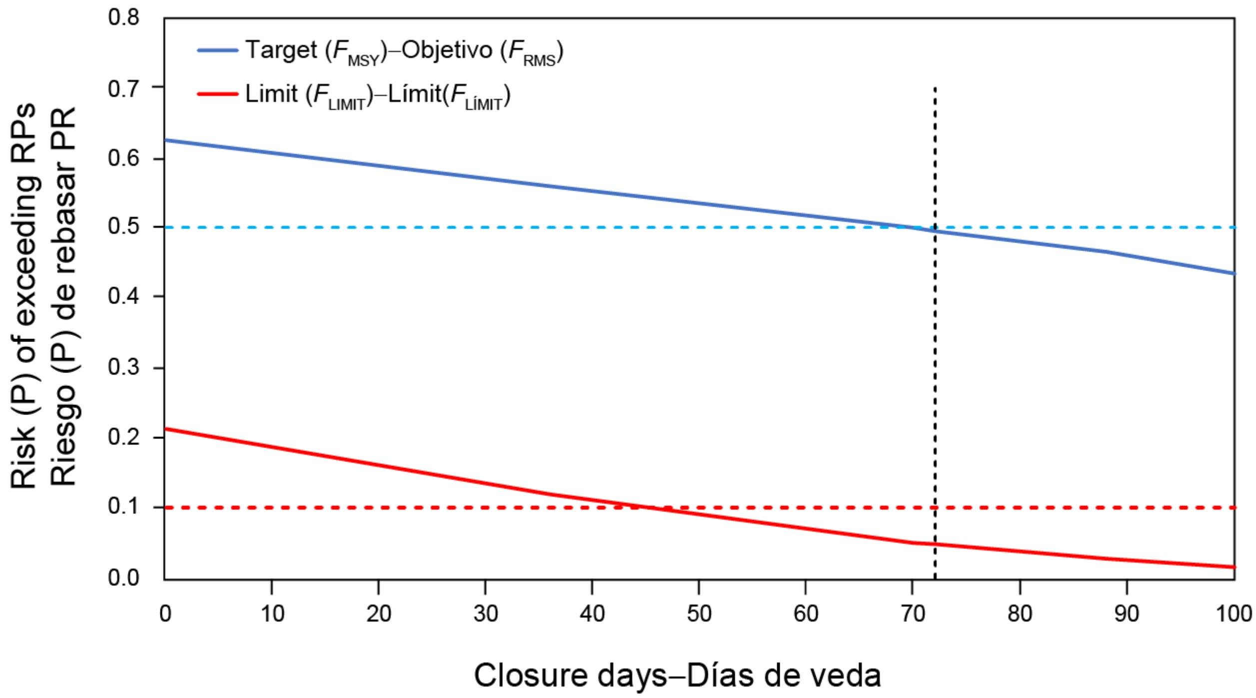


FIGURE D-9. Risk curves showing the probability of exceeding the target (blue) and limit (red) reference points for different durations of the temporal closure.
FIGURA D-9. Curvas de riesgo que señalan la probabilidad de rebasar los puntos de referencia objetivo (azul) y límite (rojo) para diferentes duraciones de la veda temporal.

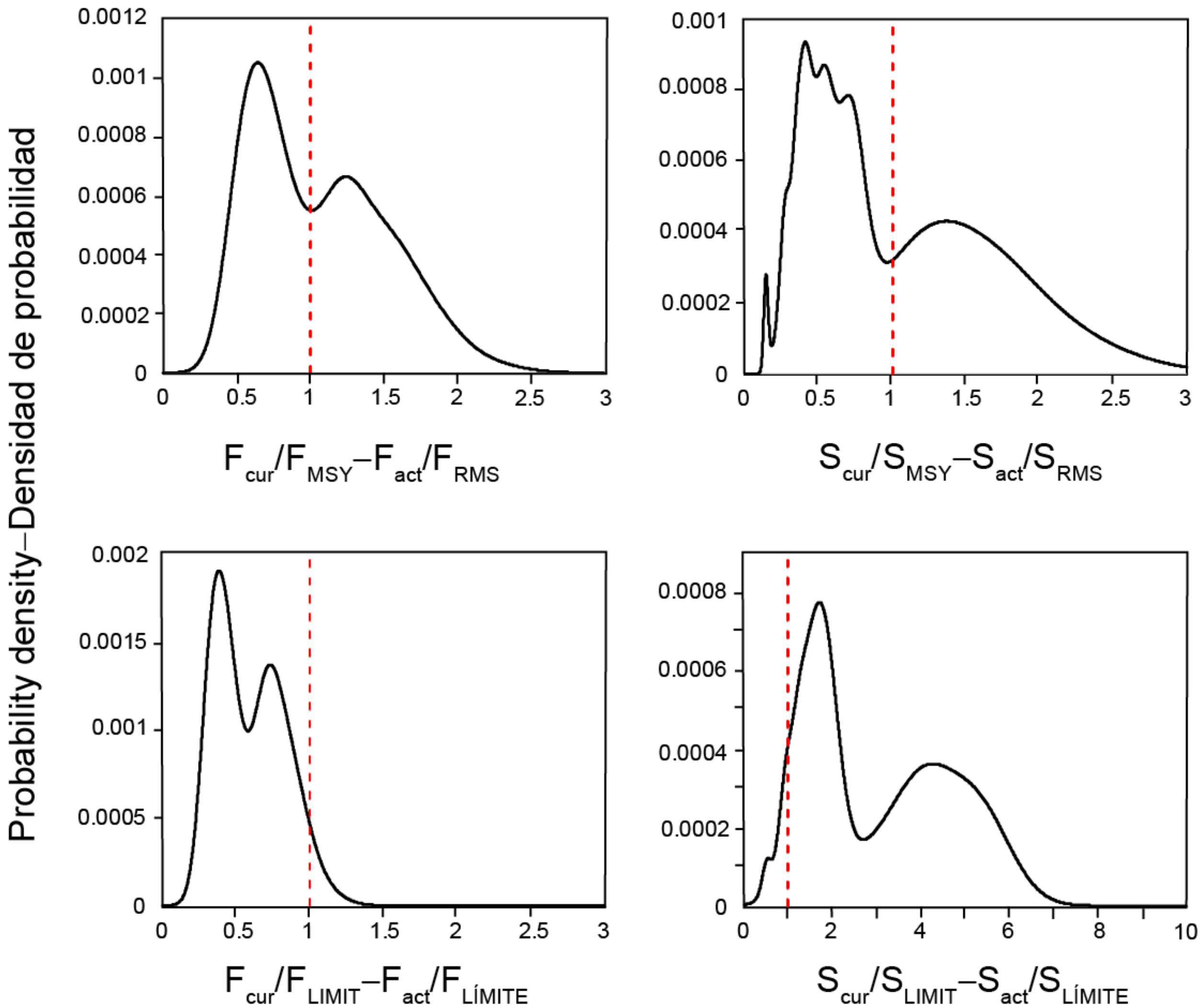


FIGURE D-10. Combined bigeye probability density function for F_{cur}/F_{MSY}, F_{cur}/F_{LIMIT}, S_{cur}/S_{MSY}, and S_{cur}/S_{LIMIT}.
FIGURA D-10. Función de densidad de probabilidad combinada para F_{act}/F_{RMS}, $F_{act}/F_{LÍMITE}$, S_{act}/S_{RMS}, y $S_{act}/S_{LÍMITE}$ de patudo.

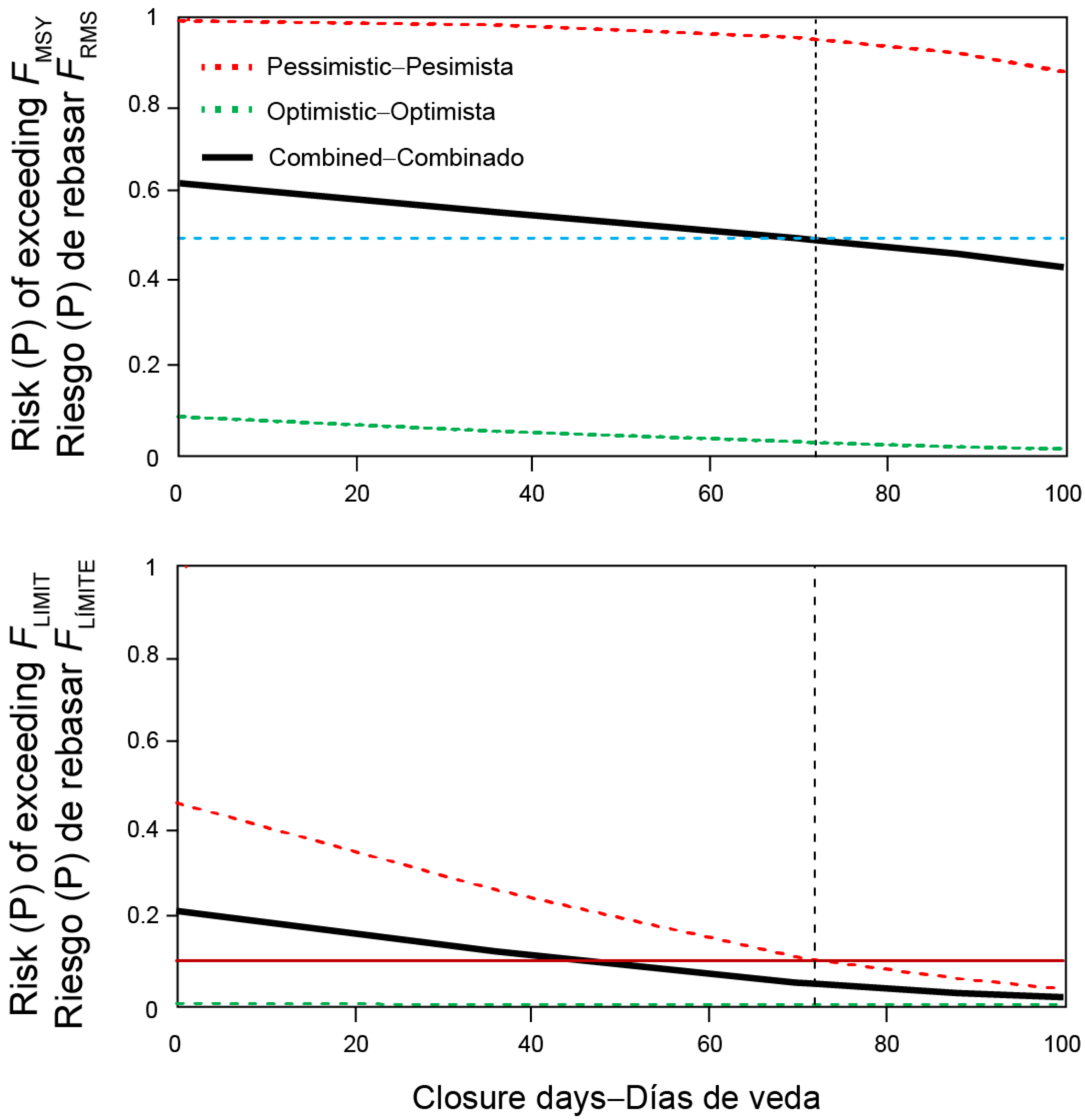


Figure D-11. Risk curves showing the probability of exceeding the target (top) and limit (bottom) reference points for bigeye with different durations of the temporal closure, combined by pessimistic and optimistic models resulting from the bimodal combined distribution.

Figura D-11. Curvas de riesgo que señalan la probabilidad de rebasar los puntos de referencia objetivo (arriba) y límite (abajo) con diferentes duraciones de la veda temporal, combinados por modelos pesimistas y optimistas que resultan de la distribución combinada bimodal.

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 2020. 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 (fishing years 1952-2018); (2) the SSB steadily declined from 1996 to 2010; (3) the slow increase of the stock biomass continues since 2011; (4) total biomass in 2018 exceeded the historical median with an increase in immature fish; and (5) fishing mortality (F%SPR) declined from a level producing about 1% of SPR in 2004-2009 to a level producing 14% of SPR in 2016-2018. Historical recruitment estimates have fluctuated since 1952 without an apparent trend. Relatively low recruitment levels estimated in 2010-2014 were of concern in the 2016 assessment. The 2015 recruitment estimate is lower than the historical average while the 2016 recruitment estimate is higher than the historical average. The recruitment estimates for 2017 and 2018, which are based on fewer observations and more uncertain, are below the historical average. A substantial decrease in estimated *F* is observed in ages 0-2 in 2016-2018 relative to the previous years. Note that stricter management measures in WCPFC and IATTC have been in place since 2015.

The point estimate of the 2018 SSB was 4.5% of the SSB in the absence of fishing (4.5%$SSB_{F=0}$), and the recent (2016-2018) fishing mortality (*F*) corresponds to *F*14%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 t during 2017-2018, respectively. No CPC shall exceed 3,500 t in 2017. In the event that the total actual catch in 2017 is either above or below 3,300 t, the catch limit for 2018 shall be adjusted accordingly to ensure that the total catch for both years does not exceed 6,600 t. 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 with at least 60% probability 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 100% 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 of achieving the second rebuilding target 10 years after the achievement of the initial rebuilding target or by 2034, whichever is earlier, is 99%. This estimate is above the threshold (60% or above in 2034) prescribed by the harvest strategy.

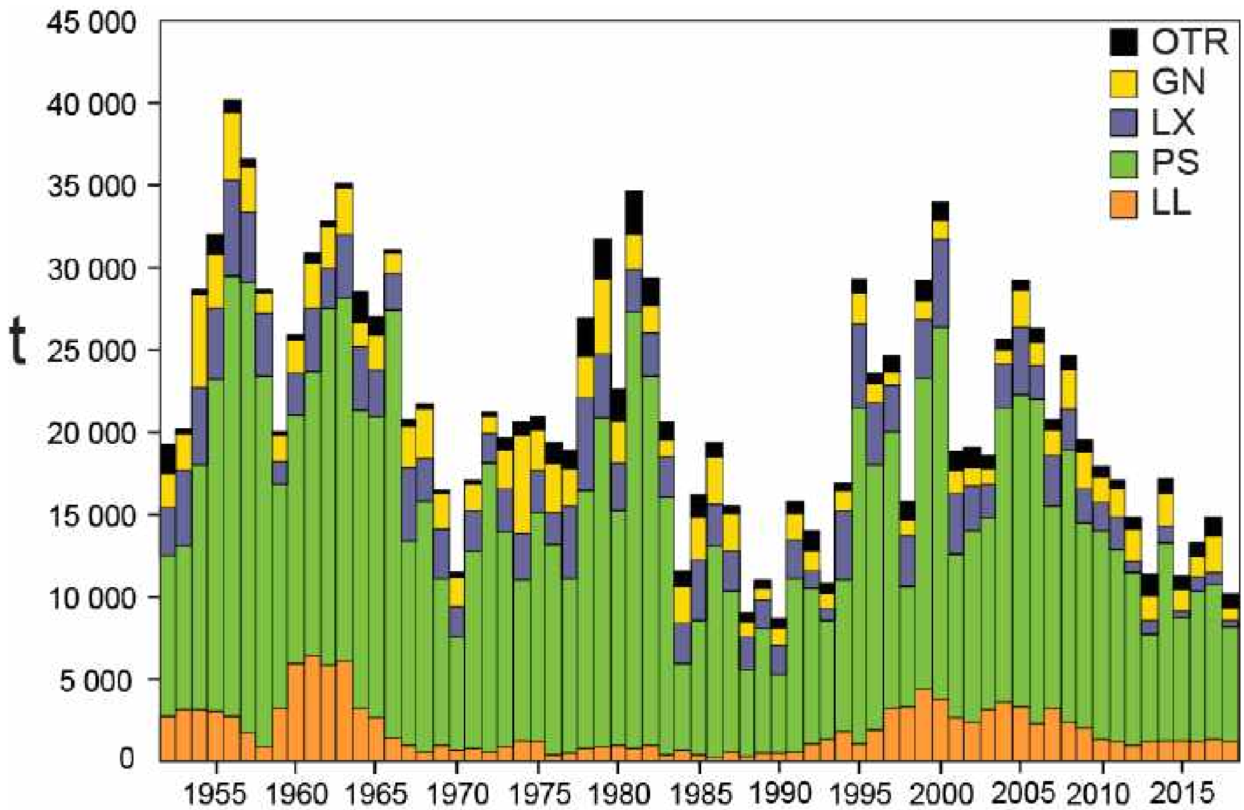


FIGURE E-1. Retained catches of Pacific bluefin tuna, by gear, 1952-2018. GN: gillnet; LL: longline; LX: hook and line; OTR: other; PS: purse seine.

FIGURA E-1. Capturas retenidas de atún aleta azul del Pacífico, por arte, 1952-2018. GN: red agallera; LL: palangre; LX: sedal y anzuelo; OTR: otras; PS: red de cerco.

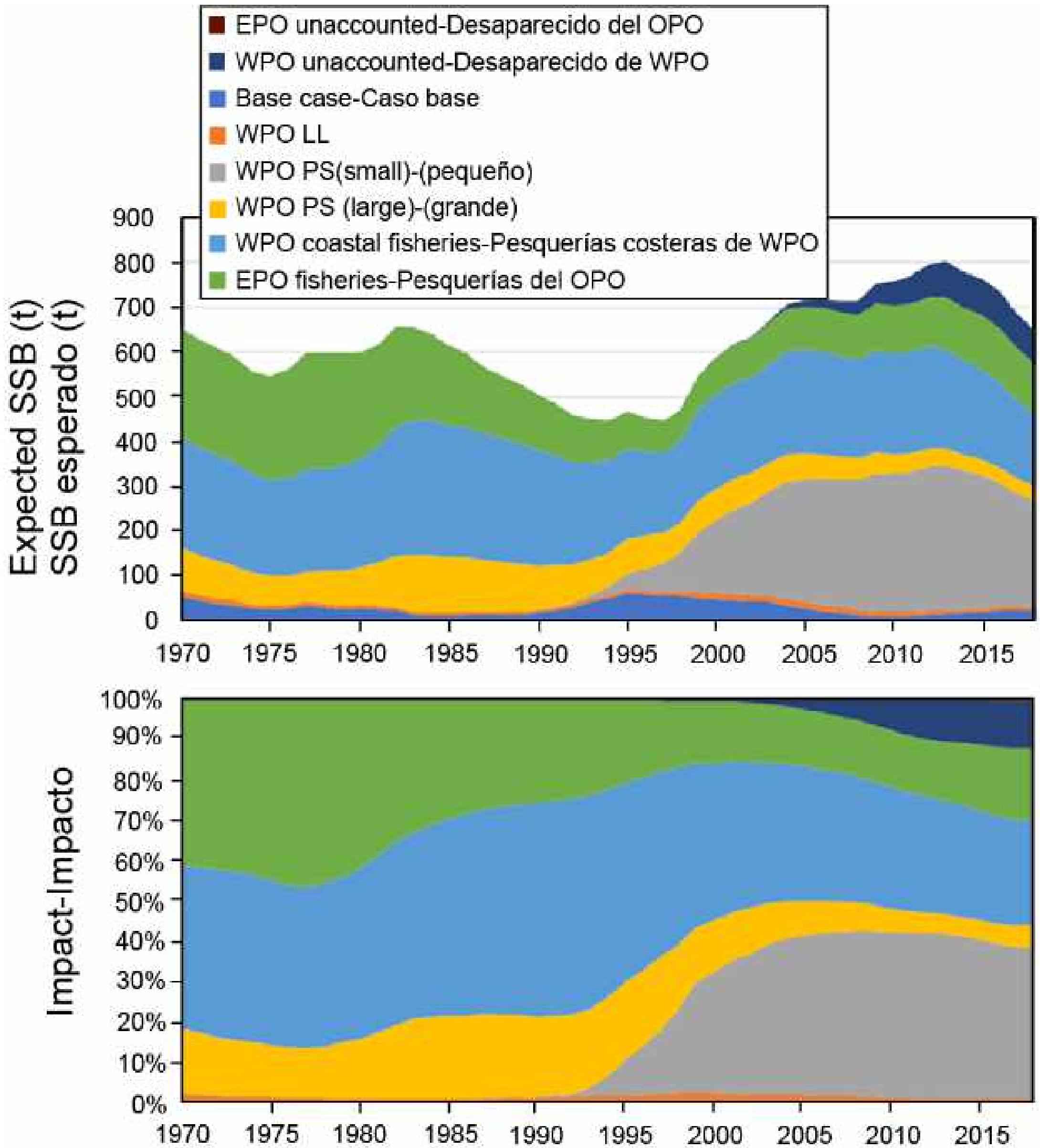


FIGURE E-2. Estimates of the impact on the Pacific bluefin tuna population of fisheries in the EPO and in the WPO (upper panel). The dashed line represents the estimated hypothetical unfished spawning biomass, and the solid line the estimated actual spawning biomass. The shaded areas indicate the impact 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 2020 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 2020 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 40% of the catch is taken by pole-and-line and troll fisheries that catch smaller, younger albacore, and about 50% was taken by longline. In the South Pacific, almost all the albacore was 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 and are currently at the highest levels. During 2016-2018, the albacore catches in the south Pacific averaged about 81,000 t (Figure F-1a), of which about 30% 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 since 2012 they have declined from about 92,000 to about 57,000 t in 2018, averaging about 58,000 t in 2016-2018, of which 23% was taken in the EPO. Those declines in catches coincide with decline in effort in the north EPO (Figure F-2)

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 20°N and 20°S 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 15° and 19.5°C. 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 2018 and 2020, 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 2018 by scientists of the Secretariat of the Pacific Community, using MULTIFAN-CL, covered the 1960-2016 period, and incorporated catch-and-effort, length-frequency, and tagging data, and information on biological parameters. As in the 2015 assessment, the eastern boundary is at 130°W, so not all the catches from the EPO are included. A summary of the conclusions can be found here. The changes from the previous assessment include simplifying the regional structure (from eight to five regions), the inclusion of abundance indices based on standardized operational-level longline data (including Japan) using indices of abundance derived from CPUE standardized using spatiotemporal models and updates maturity at length. Results were reported for a diagnostic case and for an uncertainty grid, which considers key sensitivities. Contradictory signals about stock status were found: a strong signal in the size data that fishing has no impact, and a strong signal in the CPUE data that abundance is declining. The results in the uncertainty grid were highly variable, but no model suggested overfishing or an overfished state, according to the WCPFC limit reference point of 20% of the spawning stock biomass (SSB) in the absence of fishing (20%$SSB_{F=0}$). Fishing mortality (F) generally increased up to about 2012, but has declined sharply in recent years, and is below the MSY level ($F_{2012-2015}/F_{MSY}$ ranged from 0.06 to 0.53). The SSB has declined over time, but increased slightly recently, and in 2016 was above the MSY level (base case SSB_{2016} /SSB_{MSY} ranged from 1.45 to 10.74). It is important to note that SSB_{MSY} is lower than the WCPFC limit reference point ($SSB_{MSY}/SSB_{F=0}$ ranges from 0.06 to 0.22). Notwithstanding these results, the assessment recommended that the WCPFC consider reducing longline fishing mortality and longline catches to avoid a decline in the vulnerable biomass and maintain economically viable catch rates. The IATTC staff plans to undertake an assessment of south Pacific albacore in collaboration with the SPC during 2021-2022 (SAC-11-01a).

North Pacific albacore

A new stock assessment was completed in 2020 by the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) (ISC/20/Annex/12, SAC-11-INF-I). The north Pacific albacore tuna stock has been exploited for a long time, the catches were the highest in 1976 (about 127,000 t) and the lowest in 1991 (about 37,000 t). During the assessment period (1994-2018), the highest catches were in 1999 (about 119,000 t) and the lowest in 2018 (about 52,000 t). About 2/3 of the catches come from surface fisheries (troll and pole-and-line) that harvest mainly juveniles, and the rest from longline fisheries. On average, about 20% of the catches are taken within the area of application of the Antigua Convention.

The assessment was done using the "best model" approach. The working group concluded that the stock was not experiencing overfishing and was probably not overfished (Figure F-2, Table F-1). The current depletion is 0.46 (SSB_{2018}/SSB_d , where SSB_d is the dynamic spawning stock biomass without fishing for 2018). The ratio of SSB_{2018}/S_{MSY} = 3.01). The relative current fishing mortality is $F_{2015-2017}/F_{50\%}$= 1 , $F_{2015-2017}/F_{20\%}$ =0.62, $F_{2015-2017}/F_{MSY}$ =0.60 (Table 1). Ten years projections with either constant catch (average of 2013-2017, 69,000 t) or constant fishing mortality (at the F2015-2017 level) predicted an increase in the female spawning biomass.

The current IATTC conservation and management measures for north Pacific albacore (Resolutions C-05-02, C-13-03 and C-18-03) are based on maintaining the fishing effort below the 2002-2004 levels. The effort levels in eastern Pacific Ocean for 2017-2019 are 72% and 69% of those in 2002-2004, for vessel-days and number of vessels respectively (Figure F-2).

The Working Group is currently undertaking a Management Strategy Evaluation (MSE) for the North Pacific albacore stock. The first round of the MSE was concluded and reported during the 4th ISC ALB MSE workshop in March 2019 (ISC/19/ANNEX/06). Several operating models were developed, and equal weights was assumed for all alternative operating models when evaluating the HCRs. The results indicated that total allowed effort (TAE) control rules performed better than total allowed catch (TAC). In TAE control, catches adjusted quickly, without management interventions, in response to changes in biomass between assessment periods. Across target reference points (TRPs), there was no single best-performing HCR for all performance metrics (PMs). Trade-offs were evident between relative catch and relative biomass, catch stability, and odds of no fishery closure. HCRs with the lowest fishing intensity TRP (F50), maintained the population at a higher level than those with the highest fishing intensity TRP (F30), requiring less management intervention and resulting in lower catch variability between years but had the lowest catches. However, rules with an intermediate TRP of F40 had comparable or higher relative catch than F30 rules despite lower fishing intensity because of fewer closures and higher catch stability. The results of the first round were deemed useful to understand the tradeoffs and potential performance of candidate reference points and harvest control rules by the participants. Additional work was deemed necessary to test all proposed HCR, and to include new operating models. There is a plan to continue into a second round of the MSE. The workshop participants developed a focused list of candidate reference points and harvest control rules to be examined during the 2nd round of MSE, planned to be completed still in 2020. A 5th ISC ALB MSE Workshop is planned for the end 2020, when the results of the 2nd round of the MSE should be presented (ISC/20/PLENARY/02).

The following management objectives for the North Pacific albacore tuna were developed in the context of the MSE process:

Overarching objective: maintain the viability and sustainability of the current NPALB stock and fisheries.

1. Maintain spawning biomass above the limit reference point

2. Maintain total biomass, with reasonable variability, around the historical average depletion of total biomass

3. Maintain harvest ratios by fishery (fraction of fishing impact with respect to SSB) at historical average

4. Maintain catches by fishery above average historical catch

5. If a change in total allowable effort and/or total allowable catch occurs, the rate of change should be relatively gradual

6. Maintain *F* at the target value with reasonable variability

Given the relative stability in the biomass and fishing mortality in recent years, and in view of the 2nd round of MSE, the staff considers that the current resolutions should be continued and that the recommendations from the 4th ISC ALB MSE workshop be adopted. The staff recommends that the management objectives for the North Pacific albacore tuna developed in the context of the MSE process be adopted, then prioritized, ranked, or weighted, to advice the ongoing North Pacific albacore MSE process.

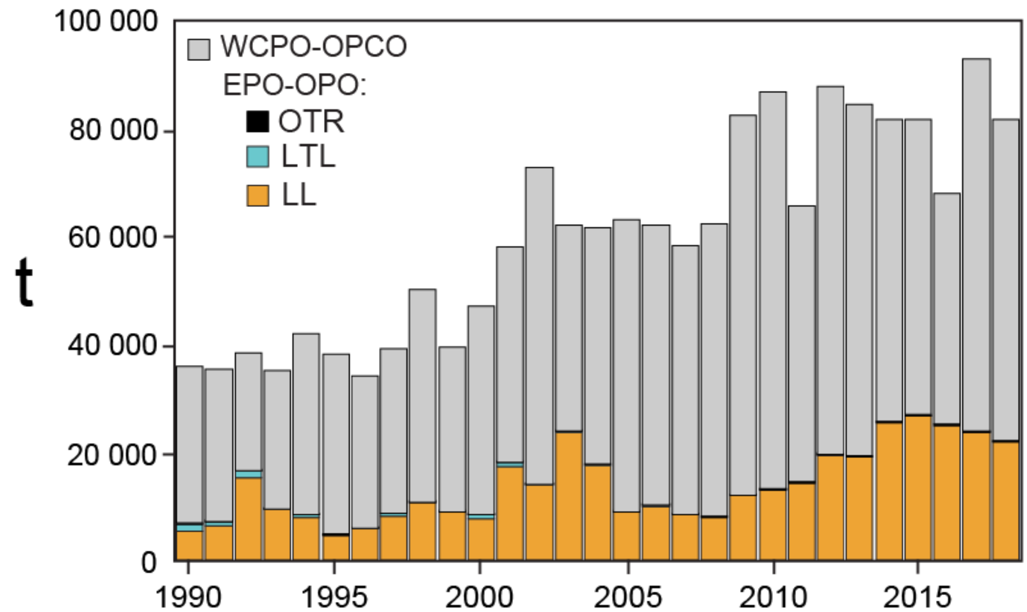


FIGURE F-1a. Retained catches of South Pacific albacore, by region. EPO catches broken down by gear: LL: longline; LTL: troll; OTR: other

FIGURA F-1a. Capturas retenidas de albacora del Pacífico sur, por región. Capturas del OPO desglosadas por arte: LL: palangre; LTL: curricán; OTR: otro.

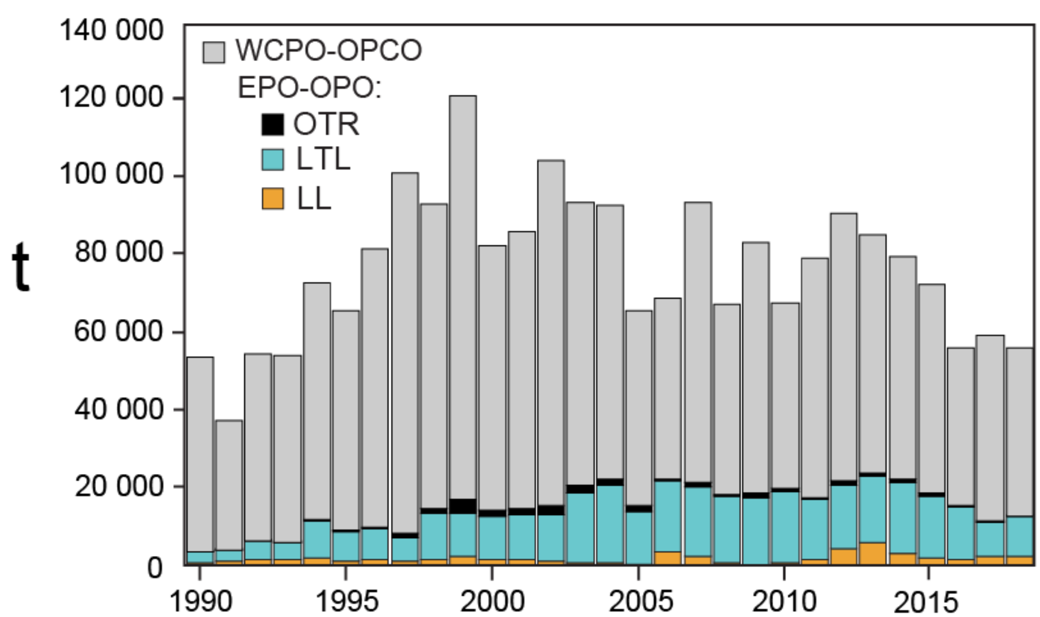


FIGURE F-1b. Retained catches of North Pacific albacore, by region. EPO catches broken down by gear: LL: longline; LTL: troll; OTR: other.

FIGURA F-1b. Capturas retenidas de albacora del Pacífico norte, por región. Capturas del OPO desglosadas por arte: LL: palangre; LTL: curricán; OTR: otro.

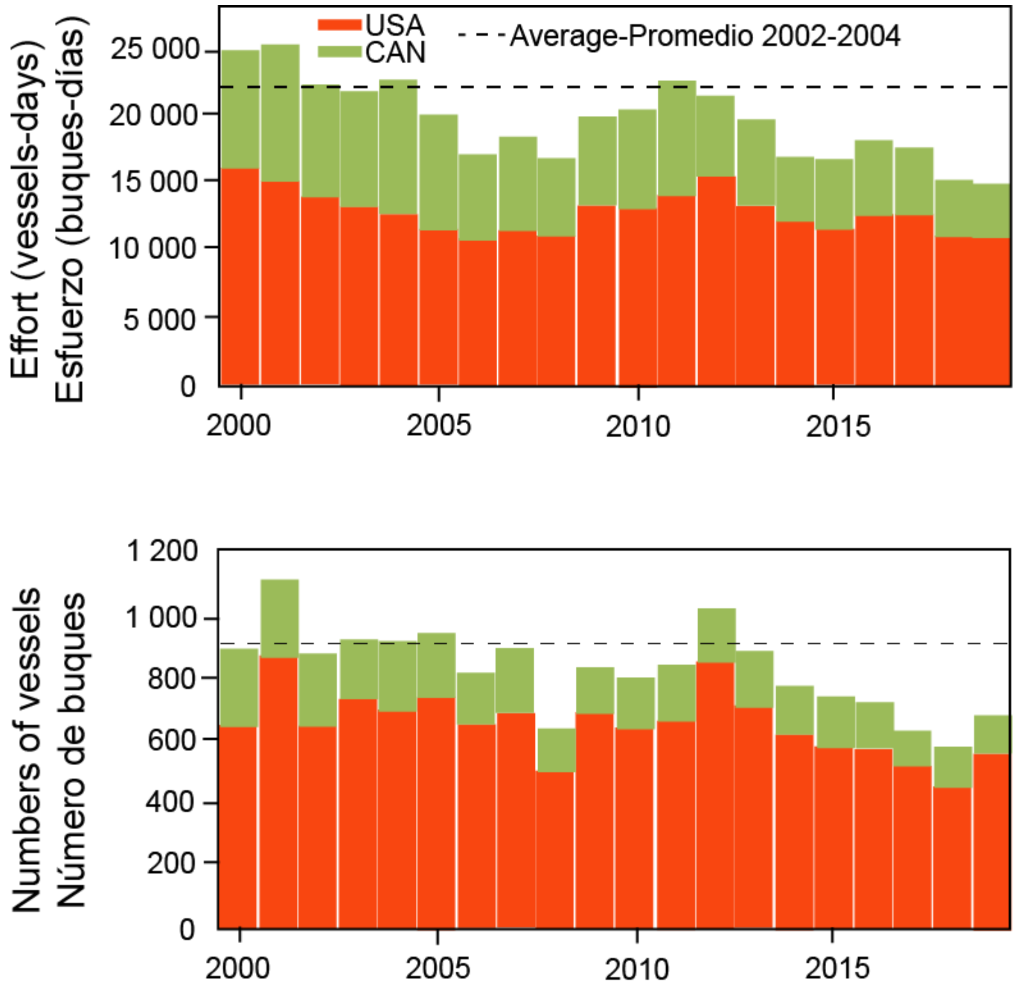


Figure F-2 Effort in vessel-days and number of vessels for the North Pacific albacore tuna in the eastern Pacific Ocean.

Figura F-2. Esfuerzo en días de buque y número de buques para el atún albacora del Pacífico norte en el Océano Pacífico oriental.

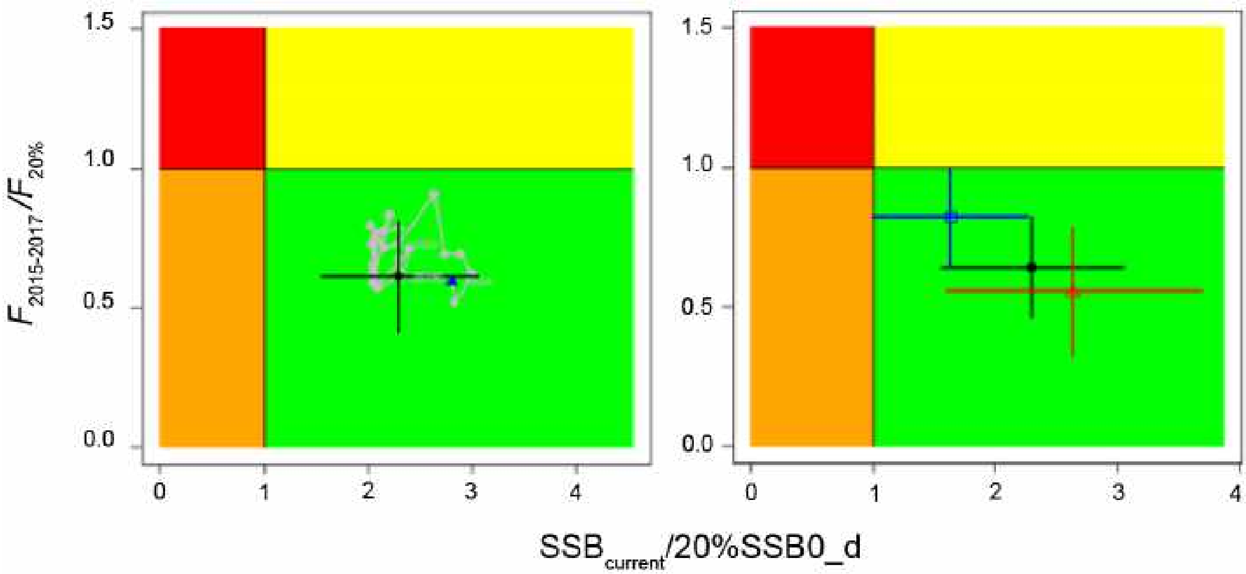


Figure F-3. Kobe plot showing the status of the north Pacific albacore (*Thunnus alalunga*) stock relative to the 20% of the dynamic spawning biomass with no fishing and corresponding fishing intensity (F20%), with 95% confidence intervals: (A) Base-case trajectory (start year, 1994, is a triangle and terminal year, 2018, is a circle). (B) Final year for base-case model (black), sensitivity model with different growth assumptions (blue), update of the 2017 model to 2020 data (red) (SAC-11-INF-I).
Figura F-3. Gráfica de Kobe que muestra la condición de la población de atún albacora del Pacífico norte (*Thunnus alalunga*) con respecto al 20% de la biomasa reproductora dinámica sin pesca y la intensidad de pesca correspondiente (F20%), con intervalos de confianza de 95%: (A) Trayectoria del caso base (el año de inicio, 1994, es un triángulo y el año terminal, 2018, es un círculo). (B) Año final para el modelo de caso base (negro), modelo de sensibilidad con diferentes supuestos de crecimiento (azul), actualización del modelo de 2017 a los datos de 2020 (rojo) (SAC-11-INF-I).

Table F-1. Estimates of maximum sustainable yield (MSY), female spawning biomass (SSB), and fishing intensity (F) based reference point ratios for north Pacific albacore tuna for: 1) the base case model; 2) sensitivity model with different growth assumptions; and 3) update of the 2017 model to 2020 data. $20\%SSB_{0\_}d$ is 20% of the dynamic female spawning biomass with no fishing.

Tabla F-1. Estimaciones del rendimiento máximo sostenible (RMS), la biomasa reproductora de las hembras (SSB) y la intensidad de pesca (F) basadas en los cocientes de puntos de referencia para el atún albacora del Pacífico norte para: 1) el modelo de caso base; 2) el modelo de sensibilidad con diferentes supuestos de crecimiento; y 3) la actualización del modelo de 2017 a los datos de 2020. $20\%SSB_{0\_}d$ es el 20% de la biomasa reproductora dinámica sin pesca.

MSY (t) [A]	102,236	84,385	113,522
SSB_{MSY} (t) [B]	19,535	16,404	21,431
SSB_0 (t) [B]	136,833	113,331	152,301
SSB_{2018} (t) [B]	58,858	34,872	77,077
$SSB_{2018}/20\%SSB_0\_d$ [B]	2.30	1.63	2.63
$F_{2015-2017}$	0.50	0.64	0.43
$F_{2015-2017}/F_{MSY}$	0.60	0.77	0.52
$F_{2015-2017}/F_{0.1}$	0.57	0.75	0.49
$F_{2015-2017}/F_{10\%}$	0.55	0.71	0.48
$F_{2015-2017}/F_{20\%}$	0.62	0.80	0.54
$F_{2015-2017}/F_{30\%}$	0.71	0.91	0.62
$F_{2015-2017}/F_{40\%}$	0.83	1.06	0.72
$F_{2015-2017}/F_{50\%}$	1.00	1.27	0.86

A – MSY includes male and female juvenile and adult fish
B – Spawning stock biomass (SSB) refers to mature female biomass only.
Source: SAC-11-INF-I

G. SWORDFISH

Swordfish (*Xiphias gladius*) occur throughout the Pacific Ocean (PO) between about 50°N and 50°S. In the Eastern Pacific Ocean (EPO), they are caught mostly by the longline fishery—80% of the catch in weight on average 2009-2018—by distant water fleets of Far East and Western Hemisphere nations. Lesser amounts are taken by drifting gillnets (~20%), mainly in South America, and minimal amounts by other gillnets and harpoons. They are seldom caught in the recreational fishery in the EPO.

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.

There is strong evidence that swordfish in the Pacific comprises multiple stocks, especially in the northern EPO. Several specific spawning regions are known, and analyses of fisheries, tagging 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. As many as six stocks may exist in the PO, but the exact boundaries of these stocks, as well as their exchange rates—for the purposes of stock assessment—is currently uncertain. A sex-specific age-structured stock assessment of swordfish in the Pacific Ocean north of the equator from 2007 indicated that, at level of fishing effort of that time 2007, there was negligible risk of the spawning biomass decreasing to less than 40% of its unfished level. The results of a North Pacific swordfish stock assessment for 2002 for the area north of 10°N and west of 140°W (ISC3/SWO-WG/02/04) indicated that stock biomass has been stable and well above 50% of unexploited levels, indicating that the stock was not overexploited at current levels of fishing effort. In the early 2000's, the IATTC produced indicators for swordfish, in five areas of the EPO: two areas north of 10°N, separated at 125°W, a central area between 10°N and 5°S, and two areas south of 5°S, separated at 90°W.

The annual longline fishing effort in the north EPO increased from about 43 million hooks in 2007 to about 66 million hooks in 2011 (Figure G-1). However, the 78 million hooks set in 2018 remains significantly below the 2001-2003 average of 113 million hooks.

Based on these considerations, and the long period of relatively stable catches that have average 3,231 mt over the past 10 years (Figure G-2), swordfish are probably not overfished and overfishing is most likely not occurring in the North EPO.

For the South PO, three assessments are noteworthy, with partially overlapping boundaries. In 2017, the Secretariat of the Pacific Community (SPC) undertook an assessment of the southern hemisphere swordfish stock. The assumed stock included the entire western and central PO and, in the EPO, extended southward from 4°S and eastward to 130°W (SC13-SA-WP-13), which is the overlapping area between the IATTC and the WCPFC jurisdictions. Considerable catch of swordfish east of 130 °W, was not part of that assessment. In 2010, an exploratory stock assessment of swordfish for Chilean EEZ was undertaken and integrating partial information from distant water fleets (IFOP 2010). In 2011, the IATTC performed a south EPO assessment of the area south of 5°S (SAC-02-09), which is the most recent assessment done by the IATTC in the south EPO. The key results from that assessment conducted using Stock Synthesis were that (1) the swordfish stock in the

South EPO was not experiencing overfishing and was not overfished; and (2) the spawning biomass ratio was about 1.45, indicating that the spawning biomass was about 50% above the carrying capacity, and substantially above the level expected to produce catch at the MSY level. There was no indication of a significant impact of fishing on this stock. The results of the assessment did suggest an expansion of the fishery to components of the stock that were previously not, or only lightly, exploited.

The annual longline fishing effort in the South EPO in the last 30 years was the highest in 1991 (260 million hooks), declined steadily to about half that in 2000, increasing again to an average of 220 million hooks in 2001-2003, decreasing to about 70 million hooks in 2008. In the past 5 years the total effort has been relatively stable, averaging 116 million hooks (2014–2018) (Figure G-3). In the South EPO catches have been steadily increasing since about 2005, reaching a peak catch of 29,036 mt in 2016, after which catches declined to 24,649 mt and 23,213 mt in 2017 and 2018, respectively. Nonetheless, the average annual catch over the past 5 years (during 2014–2018) was 25,999 mt, which is in the vicinity of the estimated MSY (~25,000 t) (Figure G-4). The IATTC staff plans to undertake a new benchmark stock assessment for the South EPO in 2021 in collaboration with the main longline fishing nations that operate in the EPO.

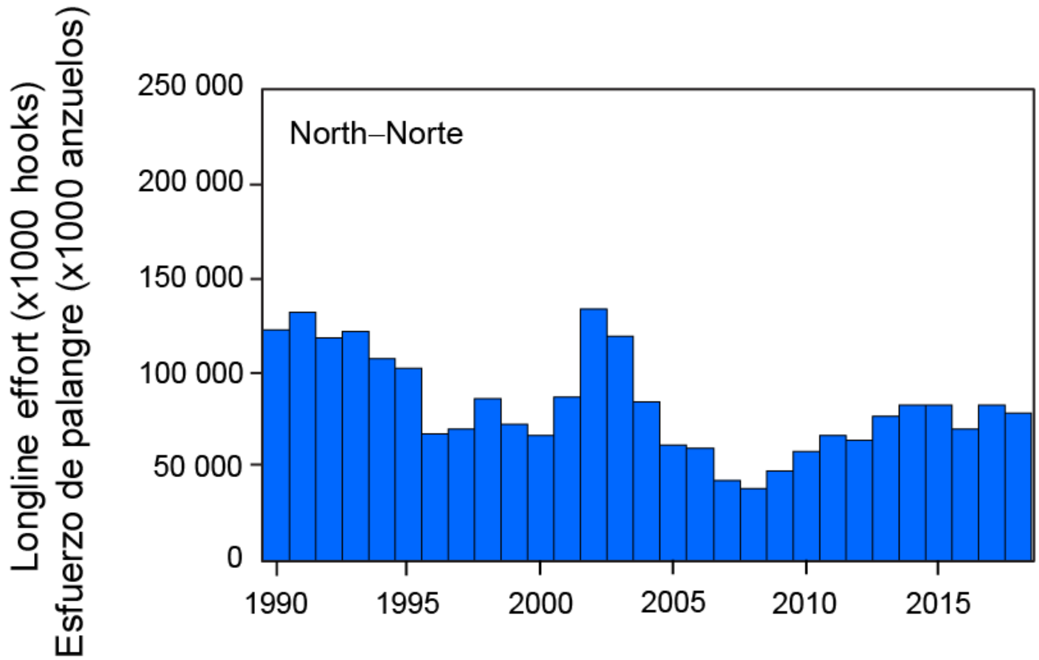


FIGURE G-1. Longline fishing effort (in millions of hooks) in the North EPO for the main longline fleets (Table A-9).
FIGURA G-1. Esfuerzo de pesca de palangre (en millones de anzuelos) en el OPO Norte para las principales flotas palangreras (Tabla A-9).

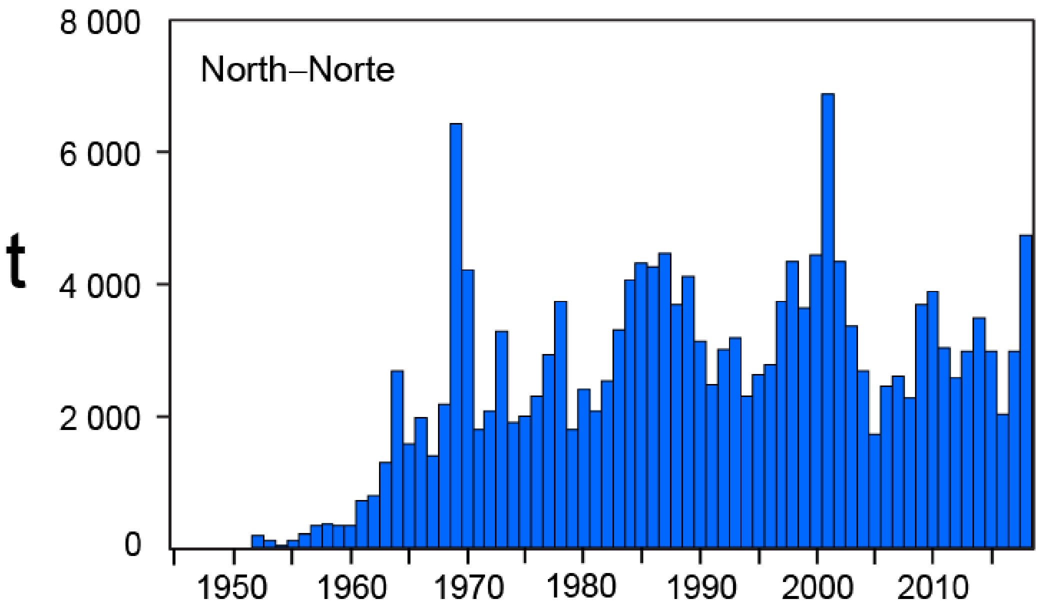


FIGURE G-2. Retained catches of swordfish in the North EPO.
FIGURA G-2. Capturas retenidas de pez espada en el OPO Norte.

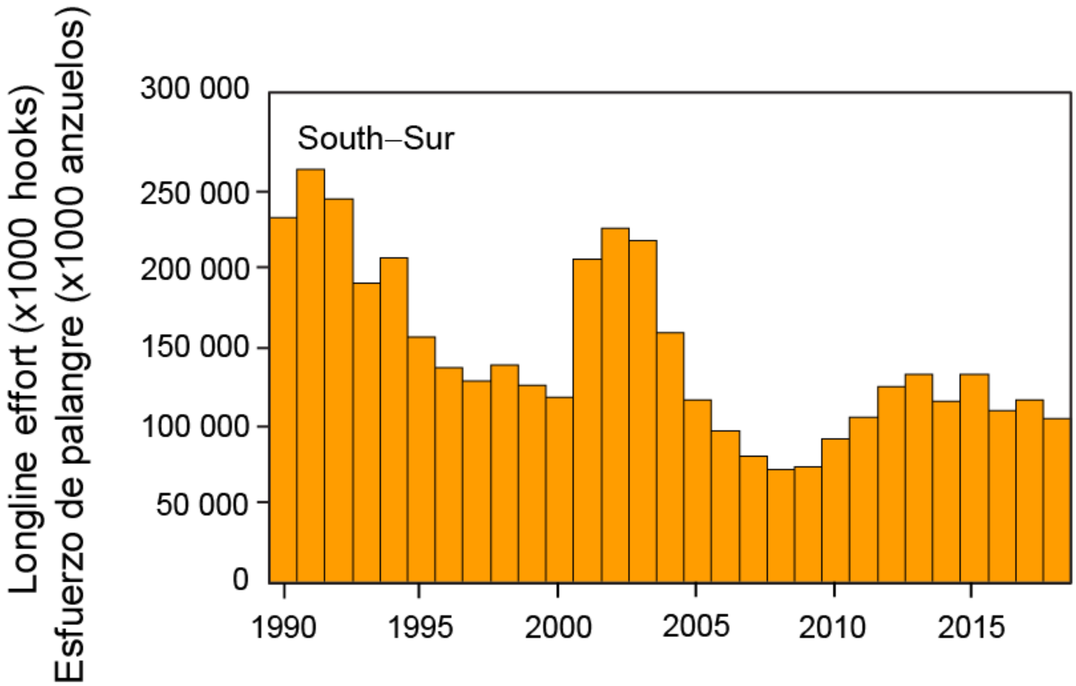


FIGURE G-3. Longline fishing effort (in millions of hooks) in the South EPO for the main longline fleets (Table A-9).
FIGURA G-3. Esfuerzo de pesca de palangre (en millones de anzuelos) en el OPO Sur para las principales flotas palangreras (Tabla A-9).

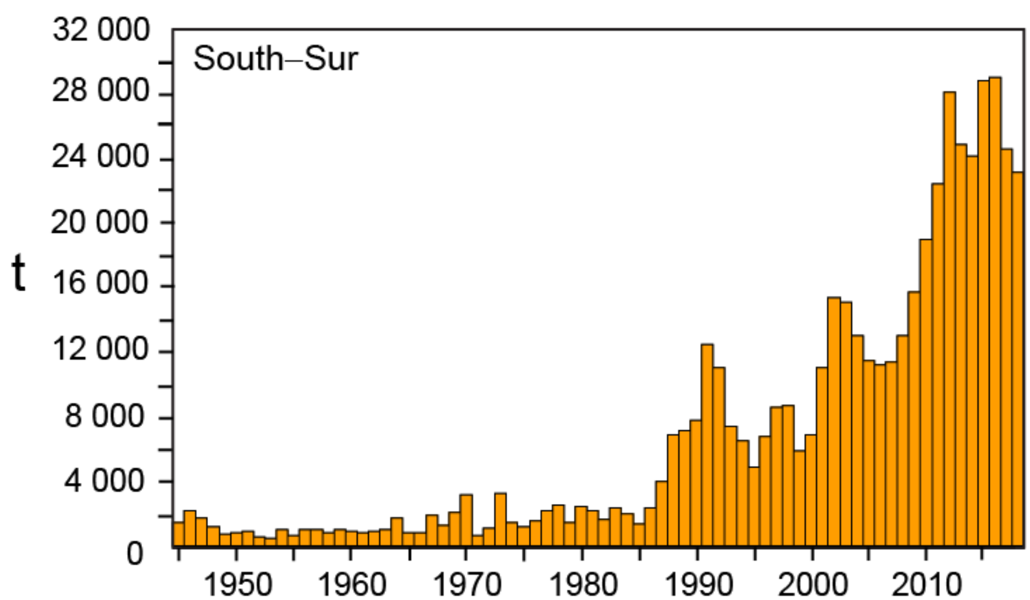


FIGURE G-4. Retained catches of swordfish in the South EPO.
FIGURA G-4. Capturas retenidas de pez espada en el OPO Sur.

H. BLUE MARLIN

The best information currently available indicates that blue marlin constitutes a single world-wide species (*Makaira nigricans*) and a single stock 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, such as purse-seine.

Small numbers of blue marlin have been tagged with conventional dart tags, by researchers. In contrast, over 50,000 blue marlin have been tagged by recreational fishers among the world's five largest volunteer gamefish tagging programs, with over 600 fish being recaptured. While a small number of tagged fish have been recaptured long distances from their release locations (4,000–15,000 km), the majority of tagged fish have been recaptured less than 1000 km from their release location, despite being at liberty for over 3 years. Blue marlin have been tagged in studies of post-release survival and movement, mostly in the Gulf of Mexico and the Atlantic Ocean, using electronic pop-up satellite tags (PSATs) that collected data over periods of about 30–180 days. A number of similar studies are currently being undertaken in the Pacific Ocean as part of the International Gamefish Association's "Great Marlin Race" tagging program.

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

The most recent full assessment of the status and trends of the species was conducted in 2013, with an update assessment being undertaken in 2016, which included data through 2014. It indicated that blue marlin in the Pacific Ocean were near full exploitation, *i.e*. that the population is harvested at levels producing catches near the top of the yield curve, but is neither overfished nor subject to overfishing. Over the past seven years (2012–2018), however, annual catches increased in the EPO, averaging 4,332 t, indicating that catches may currently be in the vicinity of MSY.

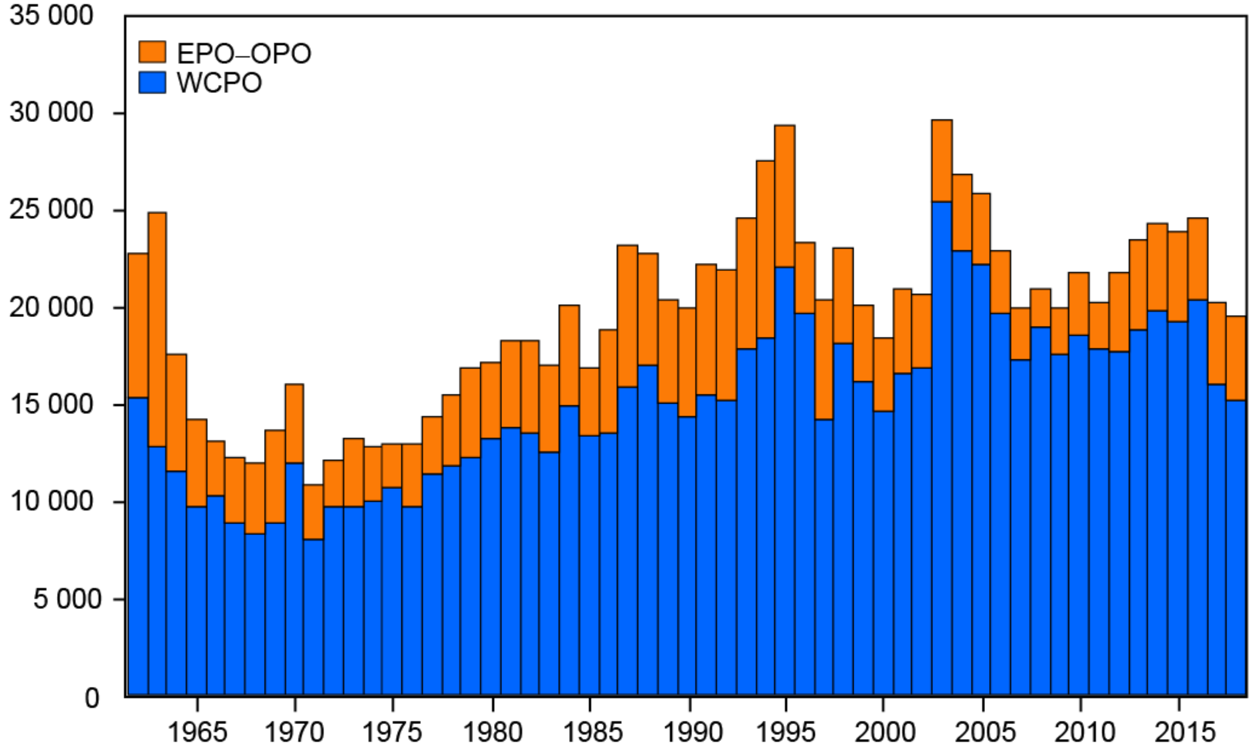


FIGURE H-1. Retained catches of blue marlin in the Pacific Ocean, by region.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, por región.

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 movement from research studies deploying conventional dart tags is limited, although over 40,000 striped marlin have been tagged by various volunteer recreational fisher tagging programs. Although reported recapture rates are below 1%, recapture data show that striped marlin are capable of moving long distances (5,000–6,000 km), however, most recaptures have occurred reasonably close to the release location. In the EPO specifically, fish tagged 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 supports 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). However, the survival rate of released fish is little understood.

Fishing by artisanal longline vessels targeting tuna and other species off Central America, for which data availability is limited, appears to have increased, over the past decade at least. 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 through October 2010. Key results were that (1) the stock was not overfished; (2) overfishing was not occurring; and (3) the spawning stock biomass was above the level that would support MSY. More recently, average annual catches during 2014–2018 (1,659 t) were at about half the estimated MSY level in 2010. If fishing effort and catches continue at the 2010 level (2,129 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 North EPO has increased by about 20% since 2010, but the catch of striped marlin has remained largely unchanged. In 2019, the ISC completed a full assessment of the North Pacific stock of striped marlin for the period 1975–2017. This assessment showed a decline in the estimated spawning stock biomass from 17,000 mt in 1975 to 6,000 mt in 2017. Despite a marked reduction in fishing mortality for 2015–2017, the stock was deemed to be overfished and subject to overfishing relative to MSY-based reference points.

The recreational fishery has increased its contribution to the total annual reported catches of striped marlin in the EPO, particularly in the North EPO, from around 10% in 1990 to 64% and 84% in 2007 and 2008, respectively. However, a paucity of reported data since 2009 probably means that the catches of striped marlin in the EPO have been significantly underestimated since this time. 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, or are incomplete. Therefore, the total catch of striped marlin in the EPO, and thus the total impact of fishing on the stock since about 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.

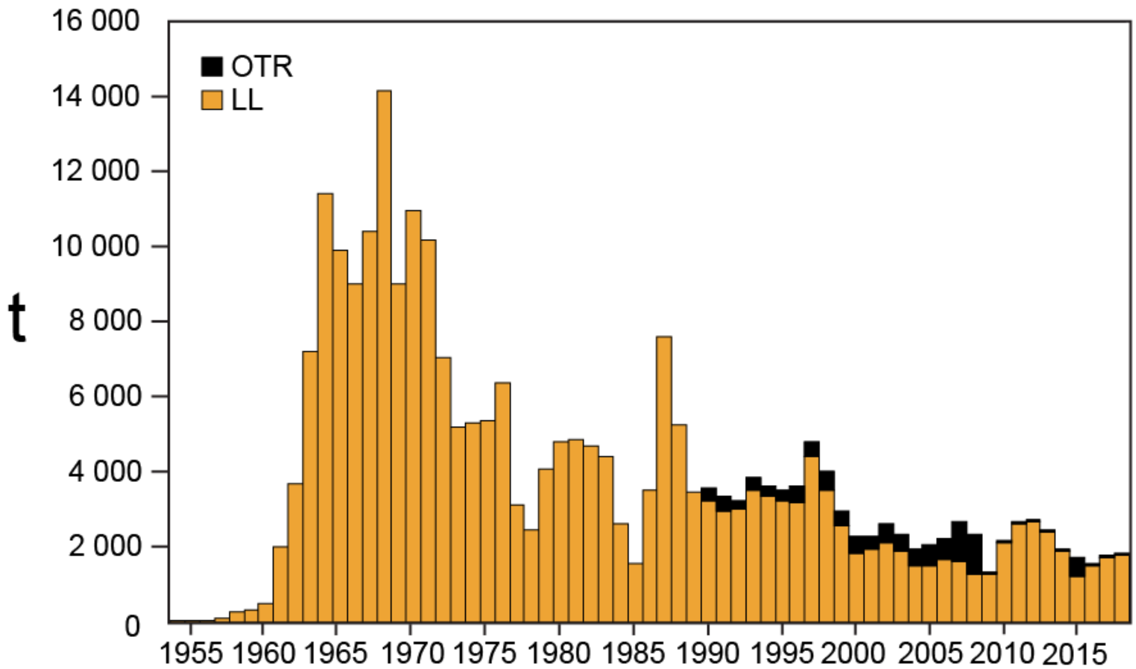


FIGURE I-1. Total reported catches of striped marlin in the North EPO by longline (LL) and other (OTR) fisheries (primarily recreational, 1954–2018. Due to unreported catches by recreational fisheries, estimates for 2009–2018 are minimums.

FIGURA I-1. Capturas totales reportadas de marlín rayado en el OPO Norte por las pesquerías palangreras (LL) y otras (OTR, principalmente recreativas), 1954–2018. Debido a capturas no reportadas por pesquerías recreativas, las estimaciones de 2009–2018 son mínimas.

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 less frequently encountered 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. Sailfish have among the largest number of conventional tag deployment of all billfishes, mainly attributed to their high importance to recreational fisheries worldwide. At least 126,000 sailfish have been tagged among the world's five largest volunteer gamefish tagging programs, although less than 2,000 fish (1.5%) have been recaptured. The data complement genetic information in that there appears to be high population substructure with fish often moving less than 500 km from their release locations. However, there are several instances where sailfish have moved reasonably long distances (2,000–3,500 km) over periods of less than a year, however, these distances can be considered small in comparison to movements of other billfish species in the EPO.

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, particularly in more coastal regions.

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. Average annual reported catches during 2013–2018 were 746 t (Figure J-1), significantly less than the 1993–2007 average of 2,057 t.
3. Sailfish abundance trended downward during 1994–2009, since then it has been relatively constant or slightly increasing (Figure J-2).
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.

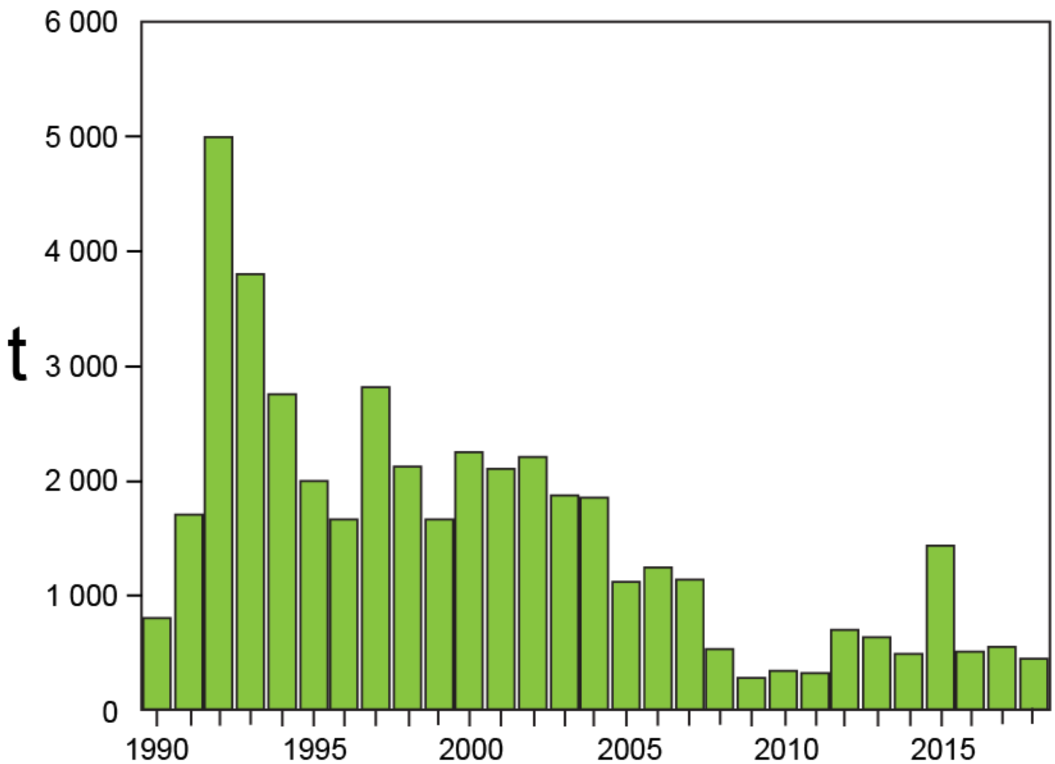


FIGURE J-1. Total reported catches of sailfish in the EPO, 1990–2018. (The actual catches were probably greater.)

FIGURA J-1. Capturas totales reportadas de pez vela en el OPO, 1990–2018. (Las capturas reales fueron probablemente mayores).

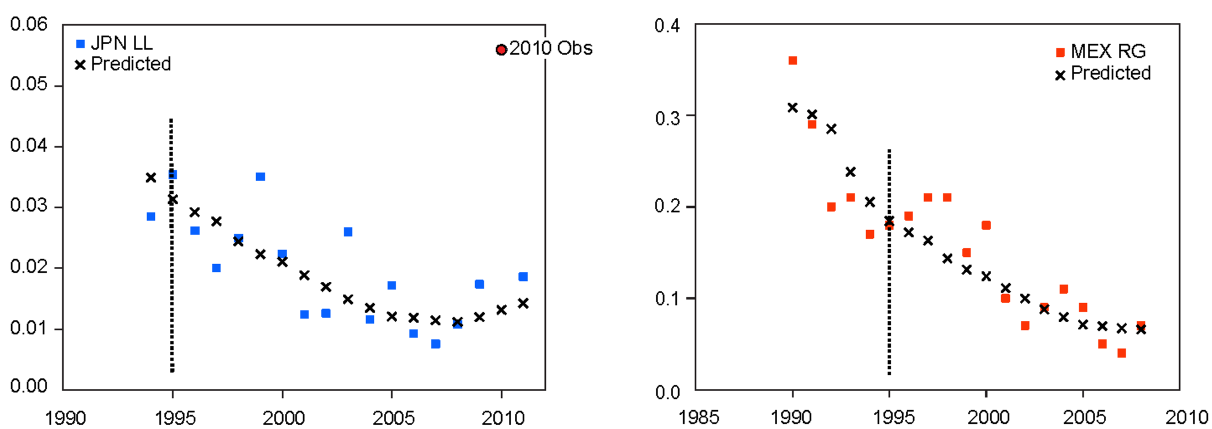


FIGURE J-2. Observed and predicted indices of relative abundance of sailfish in the EPO from Japanese longline (JPN LL) and Mexican recreational (MEX RG) fisheries. The 2010 observation in the JPN LL series was not included in the analyses.

FIGURA J-2. 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.

K. SILKY SHARK

Updated stock status indicators for silky sharks in the eastern Pacific Ocean (1994-2019)

The indices for large silky sharks, based on data from the purse-seine fishery on floating objects, have been updated through 2019 for the north and south EPO (Figure K-1; BYC-10 INF A). Previous analyses (SAC-08-08a(i)) identified a correlation between north EPO indices, particularly those for small and medium silky sharks, and interannual variability in oceanographic conditions, and thus the indices for those size categories, and for all silky sharks, were not updated because of concerns about bias. Because of recent increases in the live release of silky sharks, two sets of indices for large silky sharks were computed, one including live release data and the other not. Taken together, the two sets of indices likely bracket the trend that would have resulted in both the north and south EPO if "finning"[6], shark handling, and data recording practices had continued unchanged since 1994. The real trend is considered to be closer to the index based on dead + live releases because sharks recorded as released alive in recent years would probably have been recorded as dead previously, and thus the dead + live release is likely a more consistent indicator. The terminal point of these indices suggests a relatively stable abundance level for over a decade, with the 2019 values at, or slightly below, the 2018 values, and thus no changes to management measures are recommended. However, the stock status is uncertain, and an assessment has not been possible due to the paucity of data, especially for the longline fleets of coastal nations, which are believed to have the greatest impact on the stock (SAC-05-11a). Thus, the IATTC staff reiterates its previous recommendation (SAC-07-06b(i), SAC-07-06b(iii), SAC-08-11) 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.

[6] Cutting the fins off sharks and discarding the carcass.

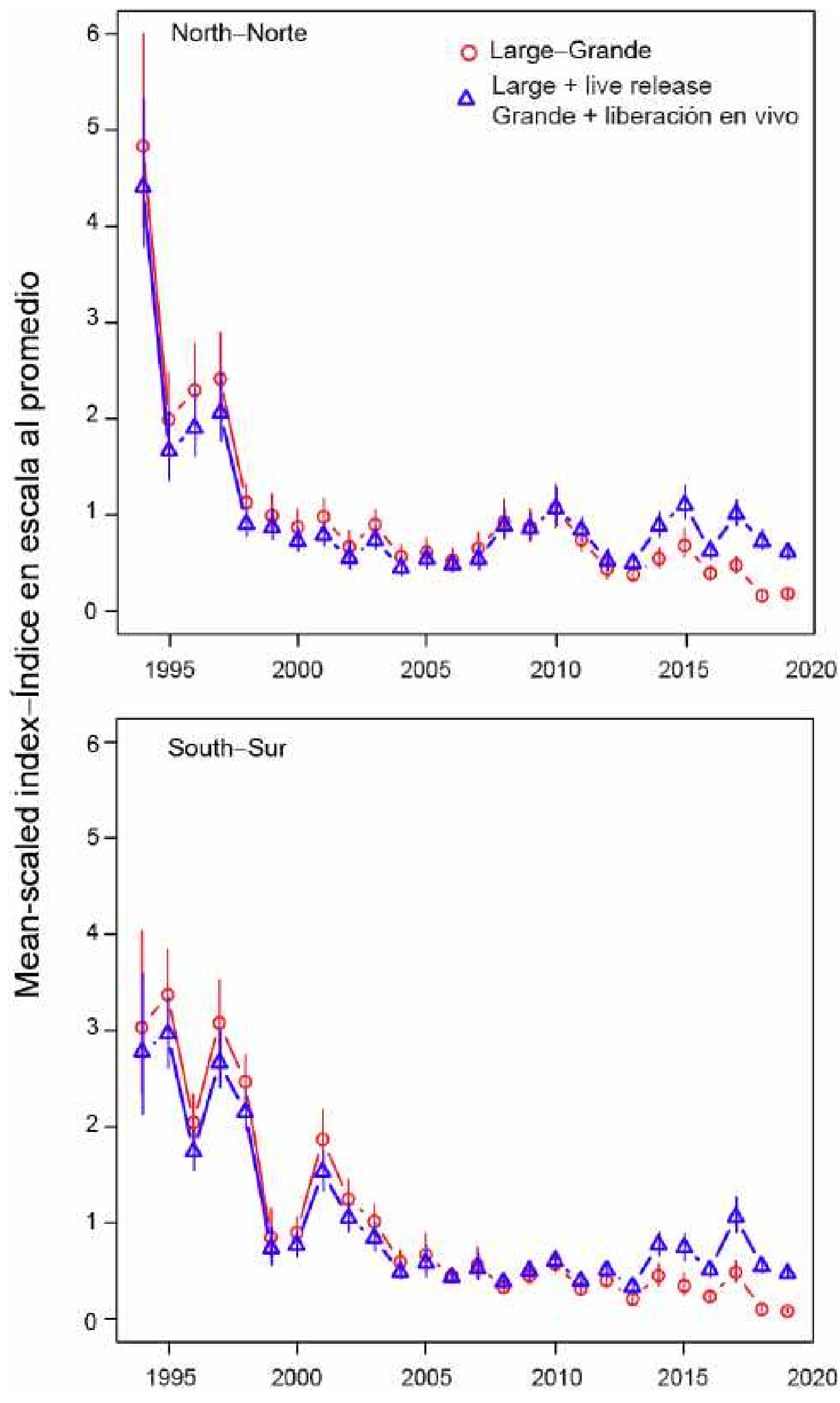


FIGURE K-1. Mean-scaled standardized silky shark bycatch-per-set (BPS; in numbers of sharks per set) in sets on floating objects for large sharks, with and without live release, in the north (top) and south (bottom) EPO. Vertical bars indicate pointwise approximate 95% confidence intervals.

FIGURA K-1. Captura incidental por lance (CIPL, en número de tiburones por lance) estandarizada en lances sobre objetos flotantes de tiburones sedosos grandes, con y sin liberación en vivo, en el OPO norte (arriba) y sur (abajo). Las barras verticales indican los intervalos de confianza de 95% puntuales aproximados.

L. ECOSYSTEM CONSIDERATIONS

1. INTRODUCTION

Over the past two decades, the scope of management of many fisheries worldwide has broadened to take into account the impacts of fishing on non-target species in particular, and the ecosystem generally. This ecosystem approach to fisheries management (EAFM) is important for maintaining the integrity and productivity of ecosystems while maximizing the utilization of commercially-important fisheries resources, but also ecosystem services that provide social, cultural and economic benefits to human society.

EAFM was first formalized in the 1995 FAO *Code of Conduct for Responsible Fisheries*, which 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*". 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.

The IATTC's Antigua Convention, which entered into force in 2010, is consistent with these instruments and principles. Article VII (f) establishes that one of the functions of the IATTC 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*". Prior to that, the 1999 Agreement on the International Dolphin Conservation Program (AIDCP) introduced ecosystem considerations into the management of the tuna fisheries in the EPO. Consequently, for over twenty years the IATTC has been aware of ecosystem issues, and has moved towards EAFM in many of its management decisions (*e.g.* SAC-10 INF-B). Within the framework of the Strategic Science Plan (SSP), the IATTC staff is conducting novel and innovative ecological research aimed at obtaining the data and developing the practical tools required to implement EAFM in the tuna fisheries of the EPO. Current and planned ecosystem-related work by the staff is summarized in the SSP (IATTC-93-06a) and the Staff Activities and Research report (SAC-11-01).

Determining the ecological sustainability of EPO tuna fisheries is a significant challenge, given the wide range of species with differing life histories with which those fisheries interact. While relatively good information is available for catches of tunas and billfishes across the entire fishery, this is not the case for most bycatch species (see section 2). Furthermore, environmental processes that operate on a variety of time scales (*e.g.* El Niño-Southern Oscillation, Pacific Decadal Oscillation, ocean warming, anoxia and acidification) can influence the distribution, abundance and availability of species to different degrees, which in turn affects their potential to be impacted by tuna fisheries.

Biological reference points, based on estimates of fishing mortality, spawning stock biomass, recruitment, and other biological parameters, have been used for traditional single-species management of target species, but the reliable catch and/or biological data required for determining such reference points, or alternative performance measures, are unavailable for most non-target species. Similarly, given the complexity of marine ecosystems, there is no single indicator that can completely represent their structure and internal dynamics and thus be used to monitor and detect the impacts of fishing and the environment.

The staff has presented an *Ecosystem Considerations* report for many years, but this report is significantly different from its predecessors, in content, structure, and purpose. Its primary purpose is to complement the annual report on the fishery (SAC-11-03) with information on non-target species and on the effect of the fishery on the ecosystem, and to describe how ecosystem research can contribute to management advice and the decision-making process. It also describes some important advances in research related to assessing ecological impacts of fishing and the environment on the EPO ecosystem.

2. DATA SOURCES

In this report, catches of bycatch species were obtained from observer data for the large-vessel purse-seine fishery[7], while gross annual removals by the longline fishery were obtained from data reported to the IATTC. Purse-seine data were available through 2019, with data from the last 2 years considered preliminary as of March 2020. Longline data were available through 2018 as the deadline for data reporting for the previous year occurs after the 2019 SAC meeting. Each data source is described in detail below.

2.1. Purse-seine

Data from the purse-seine fishery are compiled from 3 data sources: 1) IATTC and National Program observer data, 2) vessel logbook data extracted by staff at the Commission's field offices in Latin American tuna ports, and 3) cannery data. The observer data from the large-vessel fishery are the most comprehensive in terms of bycatch species. Observers of the IATTC and the various National Programs provide detailed bycatch data by species, catch, disposition and effort for the exact fishing position (*i.e.*, the latitude and longitude of the purse-seine set). Both the logbook and cannery datasets contain very limited data on bycatch species as captains and crew of the vessels who record the logbook data are primarily focused on reporting aspects of the commercially important tuna species. The logbook data, like the purse seine, includes the exact fishing position, but limited effort data are recorded with only one entry per day. The cannery (or "unloading") data do not have an exact fishing position but rather a grouped position (*e.g.*, the eastern Pacific or western Pacific Ocean). These data contain bycatch species only if they were retained in a purse-seine well during the fishing operation.

Because the smaller (Class 1-5) purse-seine vessels are not required to carry observers, logbook records and the port sampling program are the primary data sources for these vessels. As such, the data are limited and contain little or no information on interactions with bycatch species. Some detailed operational data are available from a recent voluntary scheme in Ecuador in which several smaller vessels carried observers, from a small number of Class-5 vessels that have been required to carry observers for limited periods under the AIDCP, and a current IATTC pilot project trialing the efficacy of electronic monitoring methodologies (SAC-11-10). An analysis is planned to evaluate whether such voluntary data may be representative of the fleet as a whole and therefore included in future iterations of this report.

Therefore, in this report we focus on the comprehensive observer dataset from large purse-seine vessels to provide catch data for bycatch species. Under the AIDCP program, an observer is placed on a large purse-seine vessel prior to each trip. The bycatch data provided by the observers is used to estimate total catches, by set type (*i.e*. floating objects (OBJ), unassociated tunas (NOA), and dolphins (DEL))[3]. The numbers

[7] Size class 6 purse-seine vessels with a carrying capacity > 363 t

of sets of each type made in the EPO during 2004–2019 are shown in Table A-7 of Document SAC-11-03.

Despite the observer requirement, some sets are known to have taken place, based on logbooks and other sources, but were not observed. For example, at the start of bycatch data collection in 1993, about 46% of sets were observed, increasing to 70% in 1994. From 1994 to 2008, the average percent of sets observed was around 80%. From 2009 onwards, nearly 100% of sets were observed. Catch-per-day data for both target and non-target bycatch species are extrapolated[8] to account for such instances.

2.2. Longline

The considerable variability in reporting formats of longline data has hindered the staff's ability to estimate EPO-wide catches for bycatch species (SAC-08-07b, SAC-08-07d, SAC-08-07e). Bycatch data for longline fisheries reported here were obtained using data of gross annual removals (*i.e.* the total annual catch by species estimated by each CPC reported to the IATTC in summarized form). This is the same data source used to compile annual longline estimates for principal tuna and tuna-like species in SAC-11-03. Because there is uncertainty in whether the IATTC is receiving all bycatch data from the longline fishery of each CPC, these data are considered incomplete, or "sample data", and are therefore regarded as minimum annual reported catch estimates for 1993–2018. A staff-wide collaboration is underway to revise the data provision Resolution C-03-05 to improve the quality of data collection, reporting, and analysis to align with IATTC's responsibilities set forth in the Antigua Convention and the SSP.

During this process, the staff were able to determine that the longline catches of sharks, reported by CPCs were several times higher than previously reported catches for the longline fishery. A review of the data revealed that a high proportion of shark catches were assigned to "other gears" in the staff's annual Fishery Status Reports since 2006 but were in fact taken by longline. Therefore, the resulting transfer of catch data from "other gears" to "longline" significantly increased the longline catches of sharks from 2006 onwards (see Table A2c in SAC-11-03).

Longline data reporting has been improving since the adoption of Resolution C-19-08. The staff is receiving detailed set-by-set operational level observer data for some CPCs, although the current mandated observer coverage of 5% of the total number of hooks or "effective days fishing" continues to be significantly lower than the 20% coverage recommended by the staff, the Working Group on Bycatch, and the Scientific Advisory Committee. As of August 2020, the staff had received longline observer data from eight CPCs (Chinese Taipei, Ecuador, Japan, Korea, Mexico, the United States, and the EU (Portugal) and EU (Spain)), and exploratory analyses of the data were initiated to identify how representative they are of the activities of the total fleet. The results of these analyses will be presented to the SAC in 2021. As longline data reporting continues to improve, IATTC staff will seek to provide estimates of longline catches in the EPO based on observer data.

[8] The observed data is aggregated by species, year, flag and set type. The number of known unobserved sets is taken from logbooks and other sources. Additionally, there are known EPO trips for which the staff do not know the number and type of sets made. Therefore, known bycatch-per-day from observer data is calculated by species, year, flag and set type, and applied to the number of days-at-sea for each trip to estimate the bycatch.
In some instances, there may be unobserved sets or days-at-sea data by a flag that have no equivalent observer data for that year to facilitate a reliable estimation of catch. For these trips, yearly data from a proxy flag is used. The proxy flag is determined by subsequent 5 trips made by the vessel where an observer was onboard, and adopting the predominant flag used for those trips as the proxy flag. Then the bycatch-per-set or day of the known proxy flag for the year in question is applied to the data for the unrepresented flag.

3. FISHERY INTERACTIONS WITH SPECIES GROUPS

3.1. Tunas and billfishes

Data on catches of the principal species of tunas and bonitos of the genera *Thunnus*, *Katsuwonis*, *Euthynnus*, and *Sarda*, and of billfishes in the Istiophoridae and Xiphiidae families, are reported in Document SAC-11-03. The staff has developed stock assessments and/or stock status indicators (SSIs) for bigeye (SAC-11-06, SAC-11-05), yellowfin (SAC-11-07, SAC-11-05), and skipjack (SAC-11-05) tunas and has collaborated in the assessments of Pacific bluefin and albacore tunas led by the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC).

3.2. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis*), are frequently found associated with yellowfin tuna in the EPO. Purse-seine fishers commonly set their nets around herds of dolphins and the associated schools of yellowfin tuna, and then release the dolphins while retaining the tunas. The incidental mortality of dolphins was high during the early years of the fishery, but declined dramatically in the early 1990s, and has remained at low levels since then (Figure L-1).

Incidental mortality of dolphins and other marine mammals in the purse-seine fishery during 1993-2019 is shown in Table L-1. In 2019, the stock of dolphins with the highest incidental mortality was the eastern spinner (*n*=270), followed by the western-southern spotted (*n*=220), whitebelly spinner (*n*=142), and northeastern spotted dolphins (*n*=104). Common dolphins were least impacted by the fishery, with mortalities of 25 northern, 3 central, and 2 southern common dolphins.

Marine mammals have not been reported in the longline data, although with new observer data, estimates may be able to be provided in future.

3.3. Sea turtles

Sea turtles are occasionally caught in the purse-seine fishery in the EPO, usually when associated with floating objects that are encircled, although they are sometimes also caught by happenstance in sets on unassociated tunas or tunas associated with dolphins. They can also become entangled in the webbing under fish-aggregating devices (FADs) and drown, or be injured or killed by fishing gear.

Figure L-2 shows sea turtle mortalities and interactions recorded by observers on large purse-seine vessels, by set type, during 1993–2019. Interactions were defined from observer information recorded as fate on the dedicated turtle form as: entangled, released unharmed, light injuries, escaped from net, observed but not involved in the set and other/unknown. The olive ridley turtle (*Lepidochelys olivacea*) is, by far, the species of sea turtle most frequently caught, with a total of 19,104 interactions and 874 mortalities during 1993-2019, but only 368 interactions and 1 mortality in 2019 (Table L-2). In 2019, in 110 reported interactions with eastern Pacific green turtles, 70 with loggerheads, 9 with hawksbills, and none with leatherback turtles, only one mortality was recorded, of an unidentified turtle.

In the longline fishery, sea turtles are caught when they swallow a baited hook, are accidentally hooked, or drown after becoming entangled in the mainline, floatlines or branchlines and cannot reach the surface to breathe. They are also caught in coastal pelagic and bottom-set gillnet fisheries, where they become enmeshed in the net or entangled in the floatlines or headrope. Although very few data on incidental mortality of turtles due to longline and gillnet fishing are available, 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. There is also a sizeable fleet of artisanal longline and gillnet fleets from coastal nations that are known to catch sea turtles, but limited data are available.

Data on sea turtle interactions and mortalities in the longline fishery have not been available (SAC-08-07b), although they are expected to improve with the submission of operational-level observer data for longline vessels >20 m beginning in 2019 pursuant to Resolution C-19-08. Recalling the observer coverage for longline vessels is only 5%, compared to 100% of observed trips in the large-vessel purse-seine fishery, the observer data provided in national reports for 2019 (SAC-11-INF-A(a-j)) include 115 turtle interactions, of which eight (7%) resulted in mortalities. The reported interactions/mortalities by species were loggerhead (39/1), green (31/0), olive ridley (29/4), leatherback (13/2), and Kemp's ridley (1/1), plus unidentified sea turtles (2/0). The staff hopes to use the new operational observer data submissions required under C-19-08 to report the first total longline fleet catch estimate for sea turtle species in 2021.

Various IATTC resolutions, most recently C-19-04, have been intended to mitigate fishing impacts on sea turtles and establish safe handling and release procedures for sea turtles caught by purse-seine and longline gears.

A vulnerability assessment was conducted for the eastern Pacific stock of leatherback turtles for 2018, using the Ecological Assessment of Sustainable Impacts of Fisheries (EASI-Fish) approach (see section 5) and a document has been prepared for the meeting of the Bycatch Working Group (BYC-10 INF-B). In brief, the status of the stock was determined to be "most vulnerable" in 2018, while scenario modelling showed that the implementation of improved handling and release practices by the longline fleet would reduce post-release mortality to the extent that the population might be considered "least vulnerable".

3.4. 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; for some, feeding opportunities are dependent on the presence of tuna schools feeding near the surface. Some seabirds, especially albatrosses and petrels, are caught on baited hooks in pelagic longline fisheries.

The IATTC has adopted one resolution on seabirds (C-11-02); 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), BYC-08 INF J(b)). Additionally, ACAP has reported on the conservation status of albatrosses and large petrels (SAC-08-INF-D(c); BYC-08 INF J(a)).

As with sea turtles, data on seabird interactions and mortalities in the longline fishery have been unavailable (SAC-08-07b), although they are expected to improve with the submission of operational-level observer data for longline vessels >20 m beginning in 2019. The observer data available in national reports for 2019 (SAC-11 INF-A(a-j)) include seven interactions with unidentified seabirds, all recorded as dead, and one black-footed albatross (*Phoebastria nigripes*), released alive. The staff hopes to report the first total longline fleet catch estimate for seabird species in 2021 using the operational observer data.

3.5. Sharks

Sharks are caught as bycatch in EPO tuna purse-seine fisheries and as either bycatch or a target in longline and multi-species and multi-gear fisheries of the coastal nations.

Stock assessments or stock status indicators (SSIs) are available for only four shark species in the EPO: silky (*Carcharhinus falciformis*) (Lennert-Cody *et al*. 2018; BYC-10 INF-A), blue (*Prionace glauca*) (ISC Shark Working Group), shortfin mako (*Isurus oxyrinchus*) (ISC Shark Working Group), and common thresher (*Alopias vulpinus*) (NMFS). As part of the FAO Common Oceans Tuna Project, Pacific-wide assessments of the porbeagle shark (*Lamna nasus*) in the southern hemisphere (Clarke 2017) and the bigeye thresher shark (*Alopias superciliosus*) (Fu *et al*. 2018) were completed in 2017, and for the silky shark (Clarke 2018a) in 2018, as well as a risk assessment for the Indo-Pacific whale shark population (Clarke 2018b) also in 2018. 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, not previously mentioned, in the EPO are unknown.

Catches (t) of sharks in the large-vessel purse-seine fishery (1993–2019) and minimum reported catch estimates[9] by longline fisheries (1993–2018) are provided in Table L-3, while catches of the most frequently caught species, discussed below, are shown in Figure L-3. Total longline catch estimates for 2019 were not available at the time of this report and reporting of many shark species began in 2006. The silky shark (family Carcharhinidae) is the species of shark most commonly caught in the purse-seine fishery with annual catches averaging 559 t—primarily from sets on floating objects (Figure L-3)—and being 430 t in 2019. In contrast, minimum reported annual catch in the longline sample data for 2006–2018 averaged 11,813 t and was 15,072 t in 2018. Annual catch for the oceanic whitetip shark (Carcharhinidae) in the purse-seine fishery averaged 61 t (also primarily from sets on floating objects) and was 5 t in 2019. The minimum reported annual catch in the longline fishery averaged 79 t and was 19 t in 2018. Catches of oceanic whitetip have declined in the purse-seine fishery since the early 2000s, while catches have been variable in the longline fishery (Figure L-3). Minimum annual reported catch of blue shark in the longline fishery averaged 5,382 t and was 12,064 t in 2018. By contrast, the annual catch in the purse-seine fishery averaged only 1.9 t, with 1 t caught in 2019.

Other important species of sharks caught in the purse-seine and longline fisheries include the smooth hammerhead (*Sphyrna zygaena*), the pelagic thresher (*Alopias pelagicus*), and mako sharks (*Isurus* spp.) (Table L-3). Catch estimates for the smooth hammerhead shark in the purse-seine fishery averaged 22 t (primarily caught in floating-object sets) and was 18 t in 2019, while in the longline fishery minimum annual reported catch averaged 496 t (2006–2018) and was 851 t in 2018 (Figure L-3). In contrast, the pelagic thresher was caught primarily in unassociated tuna school sets in the purse-seine fishery with estimated annual catch averaging 4.8 t and was 2 t in 2019 (Figure L-3). Minimum annual reported catch of the pelagic thresher in the longline fishery averaged 1,042 t and was 464 in 2018. Catch estimates for the mako sharks in the purse-seine fishery were lower than the aforementioned shark species averaging 2.6 t and was 1 t in 2019. However, in the longline fishery the minimum annual reported catch averaged 1,263 t and was 2,882 t in 2018.

The small-scale artisanal longline fisheries of the coastal CPCs target sharks, tunas, billfishes and dorado (*Coryphaena hippurus*), and some of these vessels are similar to industrial longline fisheries in that they operate in areas beyond national jurisdictions (Martínez-Ortiz *et al.* 2015). However, essential shark data from these longline fisheries are often lacking, and therefore conventional stock assessments and/or stock status indicators cannot be produced (see data challenges outlined in SAC-07-06b(iii)). An ongoing project is being undertaken to improve data collection on sharks, particularly for Central America, for the 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)). A one-year pilot study was completed in 2019, collecting shark-fishery data and developing and testing sampling designs for a long-term sampling program for the shark fisheries throughout Central America (Phase 2 of the project). A progress report on the FAO-GEF ABNJ project has been prepared (SAC-11-13). Data obtained from this

[9] Sharks caught by longline vessels are recorded using different weight metrics (e.g. round, trunk or whole weight) and thus, total annual reported catch estimates may contain a mix of these weight metrics. The staff is working harmonizing shark data collection to improve the reliability of total catch estimates (e.g. SAC-11-13).

project may be included in future iterations of the *Ecosystem Considerations* report to provide improved catch estimates for sharks by the various longline fleets.

3.6. Rays

Estimated annual catches of manta rays (Mobulidae) and stingrays (Dasyatidae) by the large-vessel purse-seine (1993–2019) and minimum reported annual catches by longline (1993–2018) fisheries are provided in Table L-4, while catches of key species are shown in Figure L-4. These rays are primarily caught by the purse-seine fishery, with low catches reported only for the munk's devil ray (2009: 6 t, 2010: 118 t) and Dasyatidae spp. (16 t over a 6-year period), with half the catches made in 2007 by the longline fishery (Table L-4). The giant manta had the largest average catches in the purse-seine fishery (19.4 t), followed by the spinetail (13.9 t), and smoothtail (8.7 t) mobulid rays. Catches of these species in 2019 were 8, 19, and 5 t, respectively. Catches of the pelagic stingray were low, averaging only 2.5 t and being 2 t in 2019 (Table L-4). Although catches of these rays can be variable by set type, they have been highest in unassociated sets, followed by dolphin sets, and lowest in floating-object sets (Figure L-4).

3.7. Other large fishes

Large pelagic fishes caught by the large-vessel purse-seine, primarily on floating-object sets, (1993–2019) and longline (1993–2018) fisheries are shown in Table L-5, with time series of catches of key species presented in Figure L-5. The most commonly-caught pelagic fishes in both fisheries is dorado (Coryphaenidae) with the estimated average annual catch for the purse-seine fishery being 1,309 t (1,237 t in 2019) and the minimum reported annual catch for the longline fishery averaging 5,997 t (3,499 t in 2018). Dorado is also one of the most important species caught in the artisanal fisheries of the coastal nations of the EPO (SAC-07-06a(i)). Recommendations for potential reference points and harvest control rules for dorado in the EPO can be found in document SAC-10-11.

Other key species caught by the purse-seine fishery include wahoo (Scombridae) and rainbow runner (Carangidae). Wahoo had an estimated average annual catch of 386 t, although catches have declined from a peak of 1,025 t in 2001 to 202 t in 2019 (Figure L-5). Minimum reported annual catch of wahoo by the longline fishery have averaged 149 t and was 313 t in 2018. No catches of rainbow runner have been reported by the longline fishery. However, in the purse-seine fishery estimated average annual catches of rainbow runner have been 48 t, peaking in 2007 at 158 t and declining thereafter to 21 t in 2019 (Figure L-5).

Pelagic fishes commonly reported by the longline fishery include opah (Lampridae), snake mackerels (Gempylidae) and pomfrets (Bramidae). Minimum reported annual catches for these species averaged 324 t, 182 t, and 49 t, respectively. Catches of all these species have increased after the mid-2000s (Figure L-5). For the most recent year (2018), there were 1,024 t, 227 t, and 125 t of opah, snake mackerels, and pomfrets reported, respectively (Table L-5).

3.8. 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. 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. Catches of these species are presented in Table L-6 with key species as identified by catch data presented in Figure L-6 for the large-vessel purse-seine fishery, with the majority of catches coming from floating object sets.

Bullet and frigate tunas (Scombridae) are by far the most commonly reported forage species with estimated annual catches averaging 1,075 t from 1993–2019. However, their catches have declined from

1,922 in 2005 to 276 t in 2019 (Figure L-6). Triggerfishes (Balistidae) and filefishes (Monacanthidae) are the second most commonly reported forage group with annual estimated catches averaging 268 t and totaling 58 t in 2019. Catches for this group peaked in 2004 at 914 t but have otherwise been variable. Annual catches of sea chubs (Kyphosidae) have averaged 15 t, which began to increase after 2002 but have steadily decreased to <1 t in 2019. Lastly, annual catches of the various species in the category 'epipelagic forage fishes' averaged 4.2 t with 13 t estimated to be caught in 2019.

4. PHYSICAL ENVIRONMENT

Environmental conditions affect marine ecosystems, the dynamics and catchability of target and bycatch species, and the activities of fishers, and physical factors can have important effects on the distribution and abundance of marine species[10]. The following summary of the physical environment covers: 1) short- and long-term environmental indicators, and 2) environmental conditions and their effect on the fishery during the previous year, in this case, 2019.

4.1. Environmental indicators

The ocean environment changes on a variety of time scales, from seasonal to inter-annual, decadal, and longer. Longer-term climate-induced changes, typically decadal (at intervals of 10–30 years) and characterized by relatively stable average conditions and patterns in physical and biological variables, are called "regimes". However, the dominant source of variability in the upper layers of the EPO is the El Niño-Southern Oscillation (ENSO), an irregular fluctuation involving the entire tropical Pacific Ocean and the world's atmosphere (Fiedler 2002). El Niño events occur at two- to seven-year intervals, and are characterized by weaker trade winds, deeper thermoclines, and higher sea-

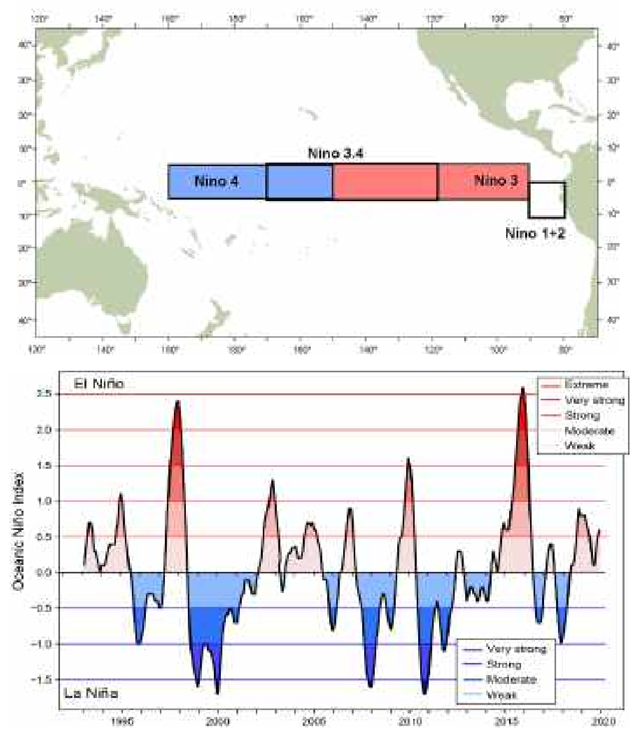


FIGURE L-7. El Niño regions used as indicators of El Niño Southern Oscillation (ENSO) events in the Pacific Ocean (top panel), and the Oceanic Niño Index (ONI) used to monitor ENSO conditions in Niño region 3.4 from 5°N to 5°S and 120°W to 170°W (bottom panel). Time series shows the running 3-month mean ONI values from the start of the IATTC observer program through December 2019. ONI data obtained from: http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

FIGURA L-7. Regiones de El Niño utilizadas como indicadores de los eventos de El Niño-Oscilación del Sur (ENOS) en el Océano Pacífico (panel superior), e Índice de El Niño Oceánico (ONI) usado para dar seguimiento a las condiciones de ENOS en la región Niño 3.4 de 5°N a 5°S y de 120°O a 170°O (panel inferior). Las series de tiempo muestran los valores del promedio móvil de 3 meses del ONI desde el inicio del programa de observadores de la CIAT hasta finales de diciembre de 2019. Datos del ONI obtenidos de: http://www.cpc.noaa.gov/products/analysis_monitoring/ensostuff/ensoyears.shtml

[10] See SAC-04-08, *Physical Environment*, and SAC-06 INF-C for a comprehensive description of the effects of physical and biological oceanography on tunas, prey communities, and fisheries in the EPO.

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 biogeochemical environment caused by ENSO have an impact on the biological productivity, feeding, and reproduction of fishes, seabirds, and marine mammals (Fiedler 2002).

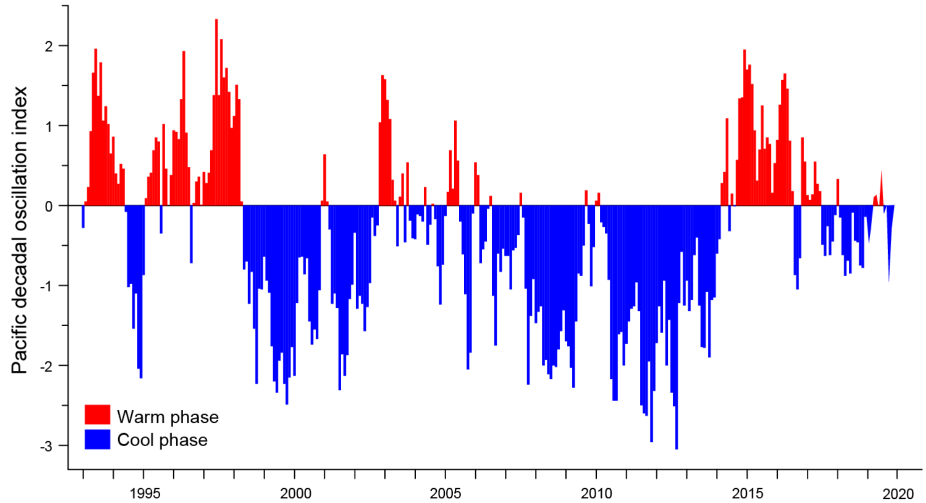


FIGURE L-8. Monthly values of the Pacific Decadal Oscillation (PDO) Index, January 1993-December 2019. PDO data obtained from: https://www.ncdc.noaa.gov/teleconnections/pdo/data.csv

FIGURA L-8. Valores mensuales del índice de Oscilación Decadal del Pacífico (PDO), enero de 1993–diciembre de 2019. Datos de la PDO obtenidos de: https://www.ncdc.noaa.gov/teleconnections/pdo/data.csv

ENSO is thought to cause considerable variability in the availability for capture of commercially-important tunas and billfishes in the EPO (Bayliff 1989). For example, the shallow thermocline during a La Niña event can increase purse-seine catch rates for tunas by compressing the preferred thermal habitat of small tunas near the sea surface, while the deeper thermocline during an El Niño event likely makes tunas less vulnerable to capture, and thus reduces catch rates. Furthermore, warmer- or cooler-than-average SSTs can also cause the fish to move to more favorable habitats, which may also affect catch rates as fishers expend more effort on locating the fish.

Recruitment of tropical tunas in the EPO may also be affected by ENSO events. For example, strong La Niña events in 2007–2008 may have been partly responsible for the subsequent lower recruitment of bigeye tuna, while the largest recruitments corresponded to the extreme El Niño events in 1982–1983 and 1998 (SAC-09-05). Yellowfin recruitment was also low in 2007, but high during 2015–2016, after the extreme El Niño event in 2014–2016 (SAC-09-06).

The Climate Diagnostics Bulletin of the US National Weather Service reported that in 2019 anomalies—defined in the Bulletin as a departure from the monthly mean—in oceanic and atmospheric characteristics (surface and sub-surface temperatures, thermocline depth, wind, convection, *etc*.) were indicative of El Niño conditions during January-June and ENSO-neutral conditions during July-December.

Indices of variability in such conditions are commonly used to monitor the direction and magnitude of ENSO events in the Pacific Ocean. In this report, the Oceanic Niño Index (ONI), used by the US National Oceanic and Atmospheric Administration (NOAA) as the primary indicator of warm El Niño and cool La Niña conditions within the Niño 3.4 region in the east-central tropical Pacific Ocean (Dahlman 2016) (Figure L-7), is used to characterize inter-annual variability in SST anomalies. The ONI is a measure of El Niño defined by NOAA as "a phenomenon in the equatorial Pacific Ocean characterized by a five consecutive 3-month running mean of SST anomalies in the Niño 3.4 region that is above (below) the threshold of +0.5°C (-0.5°C)." The ONI categorizes ENSO events from "extreme" to "weak" (Figure L-7).

For example, the “extreme” El Niño event in 1997–1998 was followed by a “very strong” La Niña event in 1998–2000. “Strong” La Niña events were also observed in 2007–2008 and 2010–2011. The highest ONI values (>2.5) were recorded during the 2015–2016 El Niño event, while moderate-weak El Niño conditions persisted in 2019.

The Pacific Decadal Oscillation (PDO; Figure L-8) index is used to describe longer-term fluctuations in the Pacific Ocean, and has also been used to explain, for example, the influence of environmental drivers on the vulnerability of silky sharks to fisheries in the EPO (Lennert-Cody *et al.* 2018). The PDO—a long-lived El Niño-like pattern of Pacific climate variability, with events persisting 20–30 years—tracks large-scale interdecadal patterns of environmental and biotic changes, primarily in the North Pacific Ocean (Mantua 1997), with secondary patterns observed in the tropical Pacific, the opposite of ENSO (Hare and Mantua 2000). As with ENSO, PDO phases are classified as “warm” or “cool”. PDO values peaked at 2.79 in August 1997 and at 2.62 in April 2016, both of which coincided with the extreme El Niño events indicated by the ONI. During 2019, PDO conditions were primarily cool.

4.2. Spatio-temporal exploration of environmental conditions

A time series of SST and CHL-a (Figure L-9) in the eastern tropical Pacific (ETP) from 5°N to 5°S—the same latitudinal band used in the ONI—was explored to show the variability in these variables across space and time using time-longitude Hovmöller diagrams. The SST time series show mean monthly values from 1993–2019, while that for CHL-a concentrations covers data for 2003–2019 due to data availability. The SST plot (Figure L-9) clearly shows the extension of warmer waters during the extreme El Niño events of 1997–1998 and 2015–2016 and cooler waters during the strong La Niña events in 1999–2000, 2007–2008 and 2010–2011

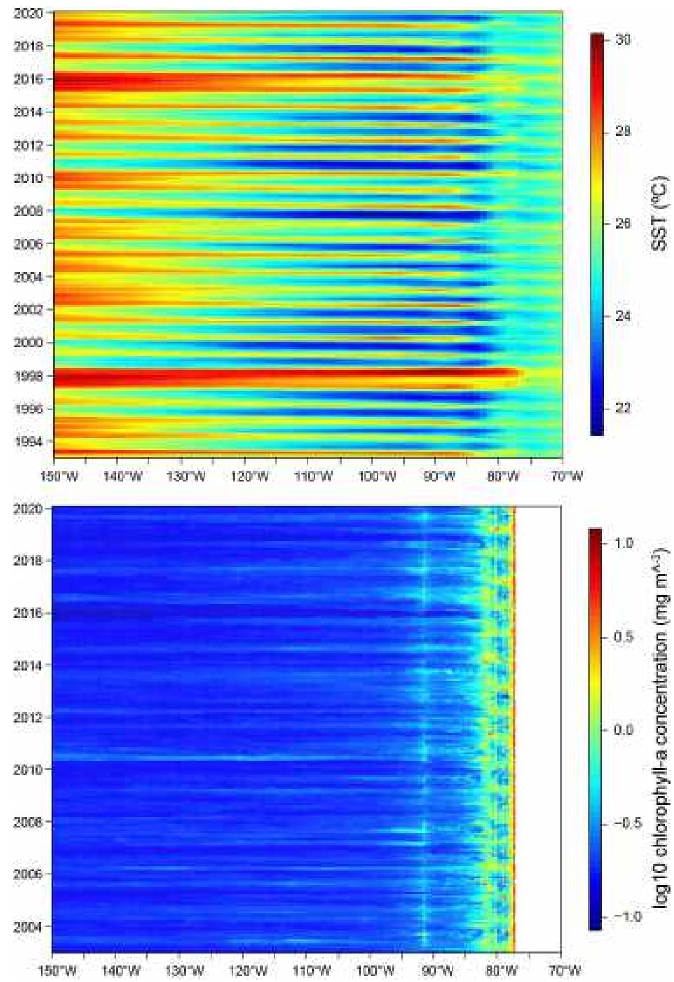


FIGURE L-9. Time-longitude Hovmöller diagram with data averaged across the tropical eastern Pacific Ocean from 5°N to 5°S for mean monthly SST for January 1993–January 2020 (top panel) (https://www.esrl.noaa.gov/psd/) and mean monthly chlorophyll-a concentration for January 2003–January 2020 (bottom panel) (https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday/index.html)

FIGURA L-9. Diagrama de Hovmöller tiempo-longitud con datos promediados en el Océano Pacífico tropical oriental de 5°N a 5°S para la TSM promedio mensual de enero de 1993 a enero de 2020 (panel superior) (https://www.esrl.noaa.gov/psd/) y concentración promedio mensual de clorofila-a de enero de 2003 a enero de 2020 (panel inferior) (https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH across the ETP. The CHL-a plot (Figure L-9), although the pattern is less clear than the SST plot, shows an increase in CHL-a concentrations following the strong La Niña events in 2007–2008 and 2010–2011, likely due to increases in nutrient availability. Because large interannual variability was not observed with the CHL-a time series, SST may be a more important driver of any observed changes in catches.

4.3. Environmental conditions and distribution of catches

The availability of fish, and thus catches, are strongly related to environmental conditions and processes, particularly in pelagic waters (Fiedler and Lavín 2017; Chassot *et al*. 2011). ENSO conditions are influenced by many oceanic and atmospheric factors, but both SST and chlorophyll-a (CHL-a) levels (an indicator of primary productivity biomass) are known to be good explanatory variables to describe and predict the habitat and distributions of oceanic animals (Hobday and Hartog 2014).

Figures L-10 and L-11 show quarterly mean SSTs and CHL-a concentrations, respectively, to: 1) provide a general indication of seasonal variability, and 2) overlay the distribution of tropical tuna catches, as a first step, to illustrate the potential influence of environmental conditions on catches across the EPO during 2019. In future, staff plan to incorporate the catch distribution of bycatch species and apply sophisticated models to better describe relationships between environment and catches.

Cooler waters occurred off northern Mexico and the southwestern United States around 30°N and extended westwards during quarters 1 (January–March) and 2 (April–June), and off South America, predominantly around 5°S to 100°W, in quarters 3 (July–September) and 4 (October–December). Warmer waters developed off Central America and extended westwards during quarters 2 and 3. A secondary warm pool was observed in the southwestern EPO (0–20°S, 130°–150°W) all year long, but waters were warmer and larger in area in this region during quarters 1 and 2 compared to 3 and 4.

CHL-a concentrations were higher along the equator and the coast of the Americas year-round. The oligotrophic[11] South Pacific Gyre—located between around 20°–40°S—present in quarter 1 retracted in quarters 2 and 3 but returned in quarter 4.

During quarters 1 and 2, skipjack predominated in the catches in the cooler waters (~25°C) off the coast of South America, where CHL-a concentration was high. During quarter 3, a large portion of the tuna catches consisted of skipjack along a warm-water front (25–~28°C) slightly north of the equator from the coast of South America to about 120°W, also a region of high CHL-a concentration, and these persisted through quarter 4, although with greater catches east of 100°W. A secondary concentration of catches occurred west of 130°W, close to the western boundary of the EPO.

During quarter 1 most of the catch along the equator from about 110°W to 140°W consisted of yellowfin, while skipjack and bigeye constituted an increased proportion of catches during quarters 2–4.

5. IDENTIFICATION OF SPECIES AT RISK

The primary goal of EAFM 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 reliable catch and biological data for single-species assessments are lacking. An alternative for such data-limited situations, reflected in Goal L of the SSP, are Ecological Risk Assessments (ERAs), vulnerability assessments that are designed to identify and prioritize at-risk species for data collection, research and management.

'Vulnerability' is defined as the potential for the productivity of a stock to be diminished by the direct and indirect impacts of fishing activities. The IATTC staff has applied qualitative assessments, using

[11] An area of low productivity, nutrients, and surface chlorophyll, often referred to as an "oceanic desert".

Productivity-Susceptibility Analysis (PSA) to estimate the relative vulnerability of data-limited, non-target species caught in the EPO by large (Class-6) purse-seine vessels (Duffy *et al*. 2019) and by the longline fishery (SAC-08-07d).

Because PSA is unable to quantitatively estimate the cumulative effects of multiple fisheries on data-poor bycatch species, a new approach—Ecological Assessment of Sustainable Impacts of Fisheries (EASI-Fish)—was developed by the IATTC staff in 2018 (SAC-09-12) to overcome this issue. This flexible, spatially-explicit method uses a smaller set of parameters than PSA to first produce a proxy for the fishing mortality rate (F) of each species, based on the 'volumetric overlap' of each fishery on the geographic distribution of these species. The estimate of F is then used in length-structured per-recruit models to assess the vulnerability of each species using conventional biological reference points (*e.g.* F_{MSY}, $F_{0.1}$).

EASI-Fish was successfully applied to 24 species representing a range of life histories, including tunas, billfishes, tuna-like species, elasmobranchs, sea turtles and cetaceans caught in EPO tuna fisheries as a 'proof of concept' in 2018 (SAC-09-12). It was subsequently used to assess the vulnerability status of the spinetail devil ray (*Mobula mobular*), caught by all industrial tuna fisheries in the EPO (BYC-09-01), and the EPO stock of the critically-endangered leatherback turtle (*Dermochelys coriacea*) (BYC-10 INF-B). Therefore, EASI-Fish will be used in future to assess the vulnerability of all species groups (*e.g*., elasmobranchs, sea turtles, teleosts) impacted by EPO tuna fisheries.

6. ECOSYSTEM DYNAMICS

Although vulnerability assessments (*e.g*. EASI-Fish) are useful for assessing the ecological impacts of fishing by assessing the populations of individual species, ecosystem models are required to detect changes in the structure and internal dynamics of an ecosystem. These models are generally data- and labor-intensive to construct, and consequently, few fisheries worldwide have access to a reliable ecosystem model to guide conservation and management measures. These models require a good understanding of ecosystem components and the direction and magnitude of the trophic flows between them, which require detailed ecological studies involving stomach contents and/or stable isotope studies. Purposefully, IATTC staff have had a long history of undertaking such trophic studies, beginning from the experimental determination of consumption estimates of yellowfin tuna at the IATTC's Achotines laboratory in the 1980s, to more recent analyses of stomach content and chemical indicators of a range of top-level predators.

In 2003, the IATTC staff compiled the trophic data to complete the development of a model of the pelagic ecosystem in the tropical EPO (IATTC Bulletin, Vol. 22, No. 3)—named "ETP7"—to explore how fishing and climate variation might affect target species (*e.g.* tunas), byproduct species (*e.g*. wahoo, dorado), elasmobranchs (*e.g.* sharks), forage groups (*e.g*. flyingfishes, squids) and species of conservation importance (*e.g.* sea turtles, cetaceans). A simplified food-web diagram, with approximate trophic levels (TLs), from the model is shown in Figure L-12.

The model was calibrated to time series of biomass and catch data for a number of target species for 1961–1998. There have been significant improvements in data collection programs in the EPO since 1998, that has allowed the model to be updated with these new data up to 2018 (ETP8).

6.1. Ecological indicators

Since 2017, ETP8 has been used in the *Ecosystem Considerations* report to provide annual values for six ecological indicators that, together, can identify changes in the structure and internal dynamics of the ETP ecosystem. These indicators are: mean trophic level of the catch (TL_c), the Marine Trophic Index (MTI), the Fishing in Balance (FIB) index, Shannon' index, and the mean trophic level of the modelled community for trophic levels 2.0–3.25 ($TL_{2.0}$), ≥3.25–4.0 ($TL_{3.5}$), and >4.0 ($TL_{4.0}$). A full description of these indicators is provided in SAC-10-14. Additionally, simulations using ETP8 were conducted to assess potential impacts of the FAD fishery on the structure of the ecosystem (SAC-10-15).

An update assessment of the ETP8 model was not undertaken in 2020 due to a significant change in how the IATTC staff have reclassified the catch data submitted by the CPCs for “other gears” into longline and other gear types following an internal review of the data. This resulted in a dramatic increase in reported longline catches of high trophic level predators (sharks), which can have a strong influence on ecosystem dynamics. Although catch estimates are now finalized for 2019 the staff is now tasked to assign species-specific catch to the relevant functional groups in the ETP8 model, and then rebalance and recalibrate the model to provide an updated ecosystem status for 2019 at SAC-12 in 2021.

The most recent report on ecological indicators undertaken in 2019 (SAC-10-14) showed that values for TL_c and MTI increased from 4.65 and 4.67 in 1970 to 4.69 and 4.70 in 1991, respectively, as the purse-seine fishing effort on FADs increased significantly (Figure L-13). TL_c continued to decrease to a low of 4.65 in 1997, due to the rapid expansion of the fishery from 1993 where there was increasing catches in the intervening period of high trophic level bycatch species that tend to aggregate around floating objects (*e.g.* sharks, billfish, wahoo and dorado). This expansion is seen in the FIB index that exceeds zero during the same period, and also a change in the evenness of biomass of the community indicated by Shannon’s index. By the early 2000s, TL_c, MTI, and Shannon’s index all show a gradual decline, while the FIB gradually increased further from zero to its peak in 2017 at 0.66 (Figure L-13). Both TL_c and MTI reached their lowest historic levels of 4.64 and 4.65 in 2017, respectively. Since its peak in 1991, TL_c declined by 0.05 of a trophic level in the subsequent 27 years, or 0.02 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 $TL_{MC4.0}$ community was at one of its highest values (4.449) in 1993 but has continued to decline to 4.443 in 2017 (Figure L-13). As a result of changes in predation pressure on lower trophic levels, between 1993 and 2017 the biomass of the $TL_{MC3.25}$ community increased from 3.800 to 3.803, while interestingly, the biomass of the $TL_{MC2.0}$ community also increased from 3.306 to 3.308.

Together, these indicators show that the ecosystem structure has likely changed over the 50-year analysis period. However, these changes, even if they are a direct result of fishing, do not appear to be currently 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. FUTURE DEVELOPMENTS

It is unlikely, in the near future at least, that there will be stock assessments for most of the bycatch species. Therefore, the IATTC must continue to undertake ecological research that can provide managers with reliable information to guide the development of science-based conservation and management measures, where required, to ensure the IATTC continues to fulfil its responsibilities under the Antigua Convention and the objectives of the IATTC’s 5-year SSP. The priority research areas that have been identified by the scientific staff that require further development are detailed below:

- Following the development of the EASI-Fish approach, analysis of the full suite of over 100 impacted bycatch species will be conducted in stages, by taxonomic group, beginning in 2021. The priority of groups to be assessed will likely be elasmobranchs, teleosts, turtles and cetaceans.

- A shortcoming of the ETP8 ecosystem model, from which the ecological indicators are derived, is that its structure is based on stomach content data from fish collected in 1992–1994. Given the significant environmental changes that have been observed in the EPO over the past decade, there is a critical need to collect updated trophic information. There have been proposals made by the staff in 2018, 2019 and 2020 to establish an ecological monitoring program to collect stomach content data to update the ecosystem model.

- A second limitation of the ETP8 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, after updated diet information is collected, future work will aim to develop a spatially-explicit model that covers the entire EPO and calibrate the model with available time series of catches, ideally for species representing different trophic levels, and effort data for key fisheries in the EPO.
- Environmental variables can have a profound influence on the catches of target and bycatch species, as has been shown previously by IATTC staff and now undertaken annually in this report. However, the staff's research to investigate the impact of environmental conditions on the fishery could be greatly improved with the availability of high-resolution operational level data for the longline fishery. Although IATTC Members and CPCs are now required to submit operational level observer data to the IATTC that covers at least 5% of their fleets, future work is required to assess the representativeness of these data for future environmental analyses.

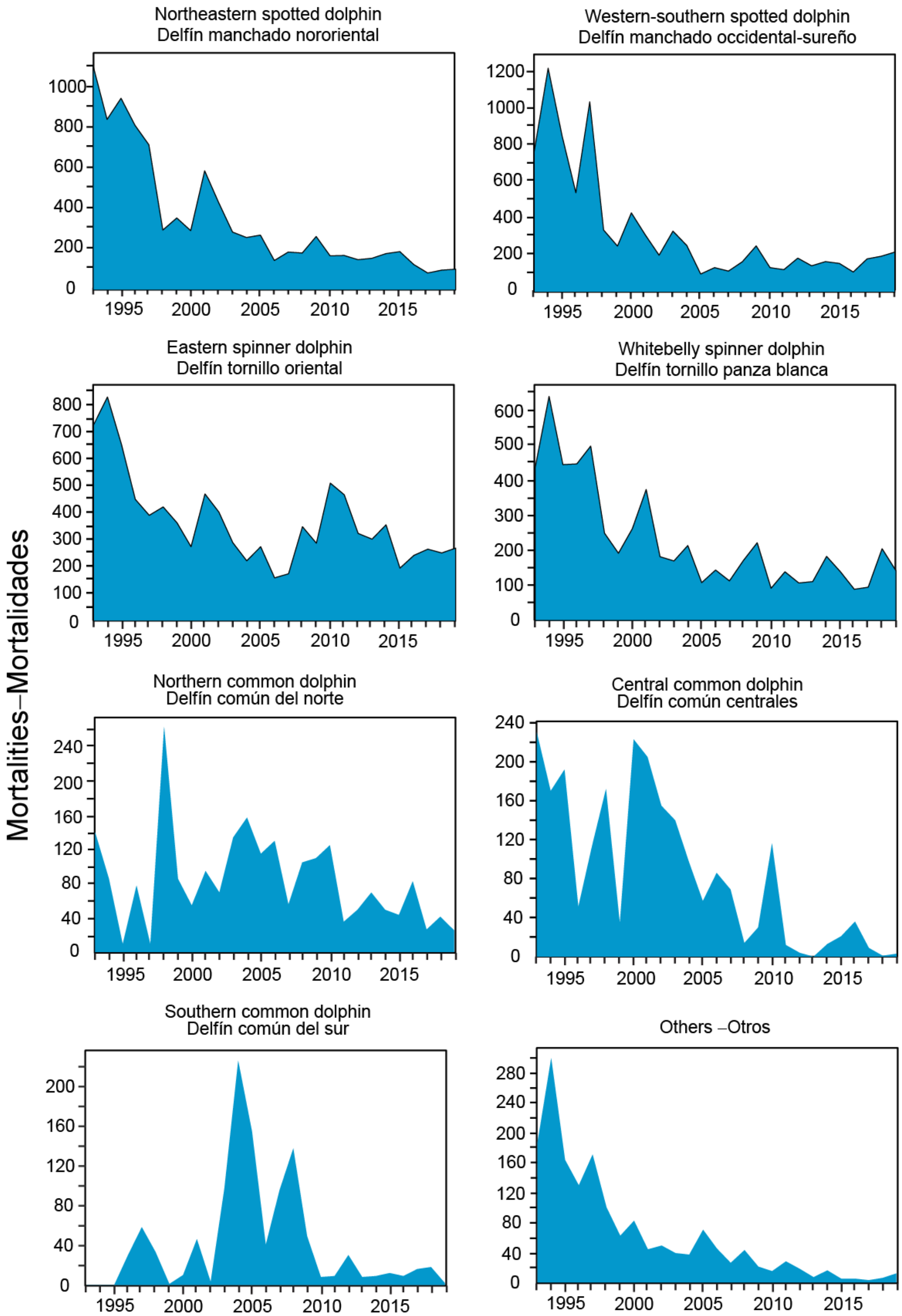
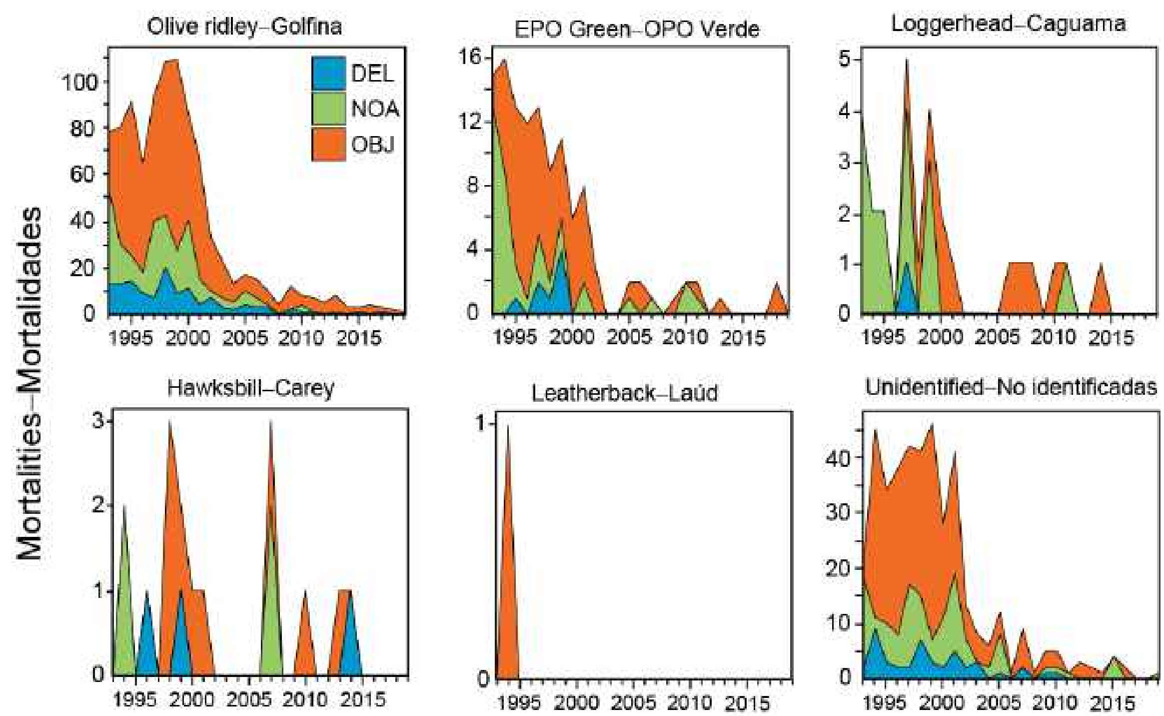


FIGURE L-1. Incidental dolphin mortalities, in numbers of animals, by purse-seine vessels, 1993–2019.
FIGURA L-1. Mortalidades incidentales de delfines, en número de animales, por buques cerqueros, 1993–2019.

a.



b.

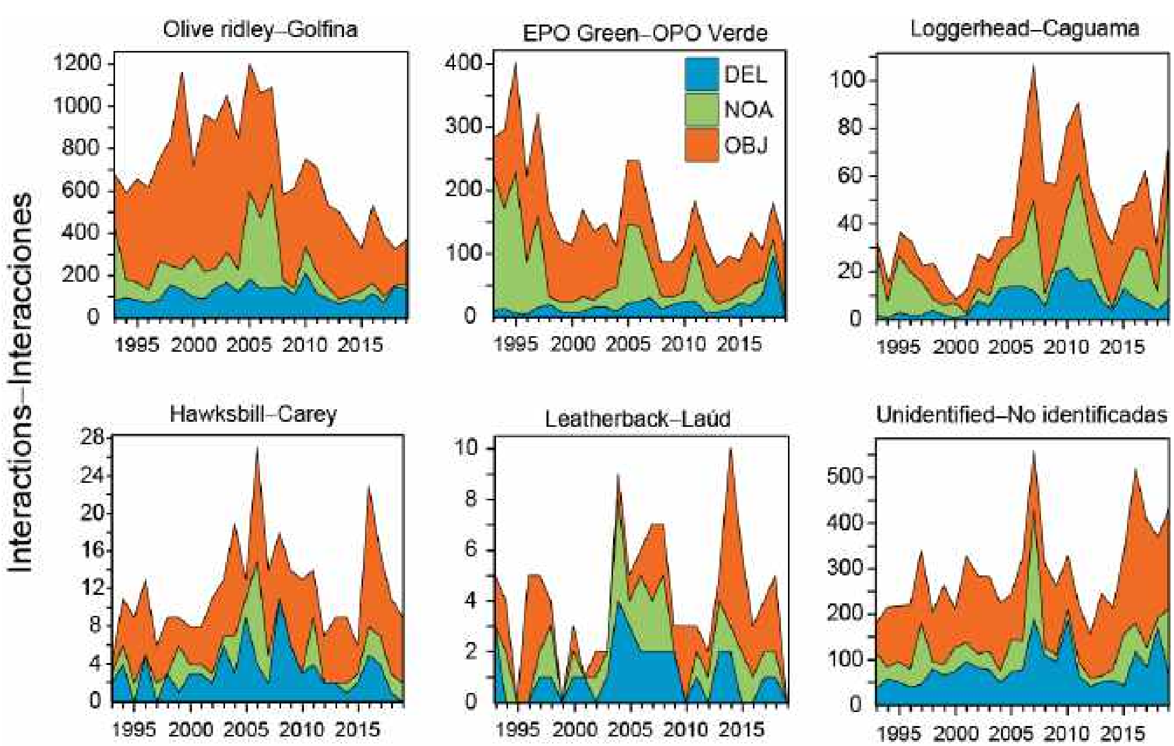


FIGURE L-2. Sea turtle a) mortalities and b) interactions, in numbers of animals, for large purse-seine vessels, 1993–2019, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)).
FIGURA L-2. a) Mortalidades y b) interacciones de tortugas marinas, en número de animales, por buques cerqueros grandes, 1993-2019, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)).

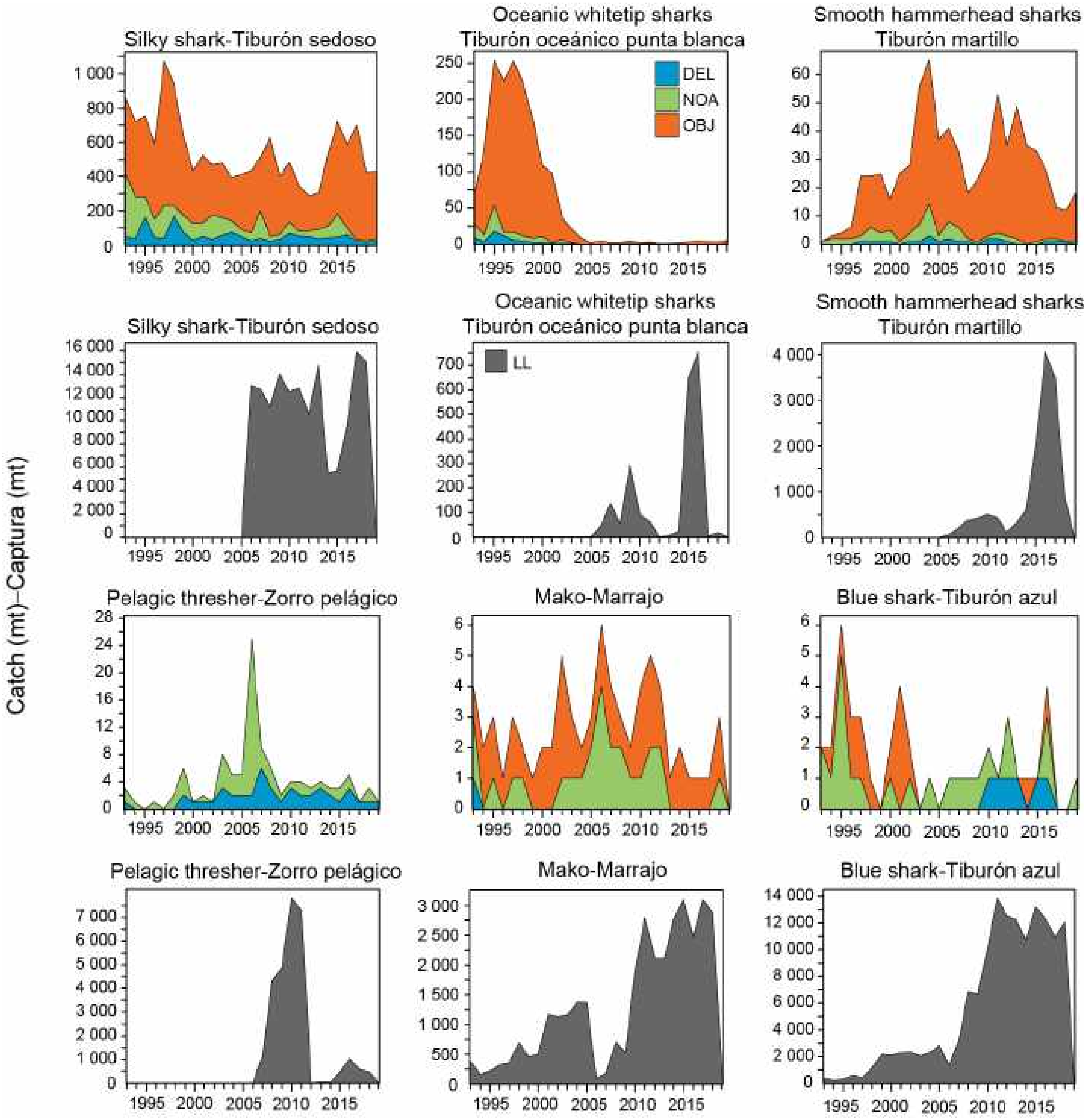


FIGURE L-3. Estimated purse-seine (top panel) and longline (bottom panel) catches in metric tons (t) of key species of sharks in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2019) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline catches are minimum reported gross-annual removals that may have been estimated using a mixture of different weight metrics (see footnote in section 3.5).

FIGURA L-3. Capturas cerqueras (panel superior) y palangreras (panel inferior) estimadas en toneladas (t) de especies clave de tiburones en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2019) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras son extracciones anuales brutas mínimas reportadas que pueden haber sido estimadas usando una mezcla de diferentes métricas de peso (ver nota al pie de página en la sección 3.5).

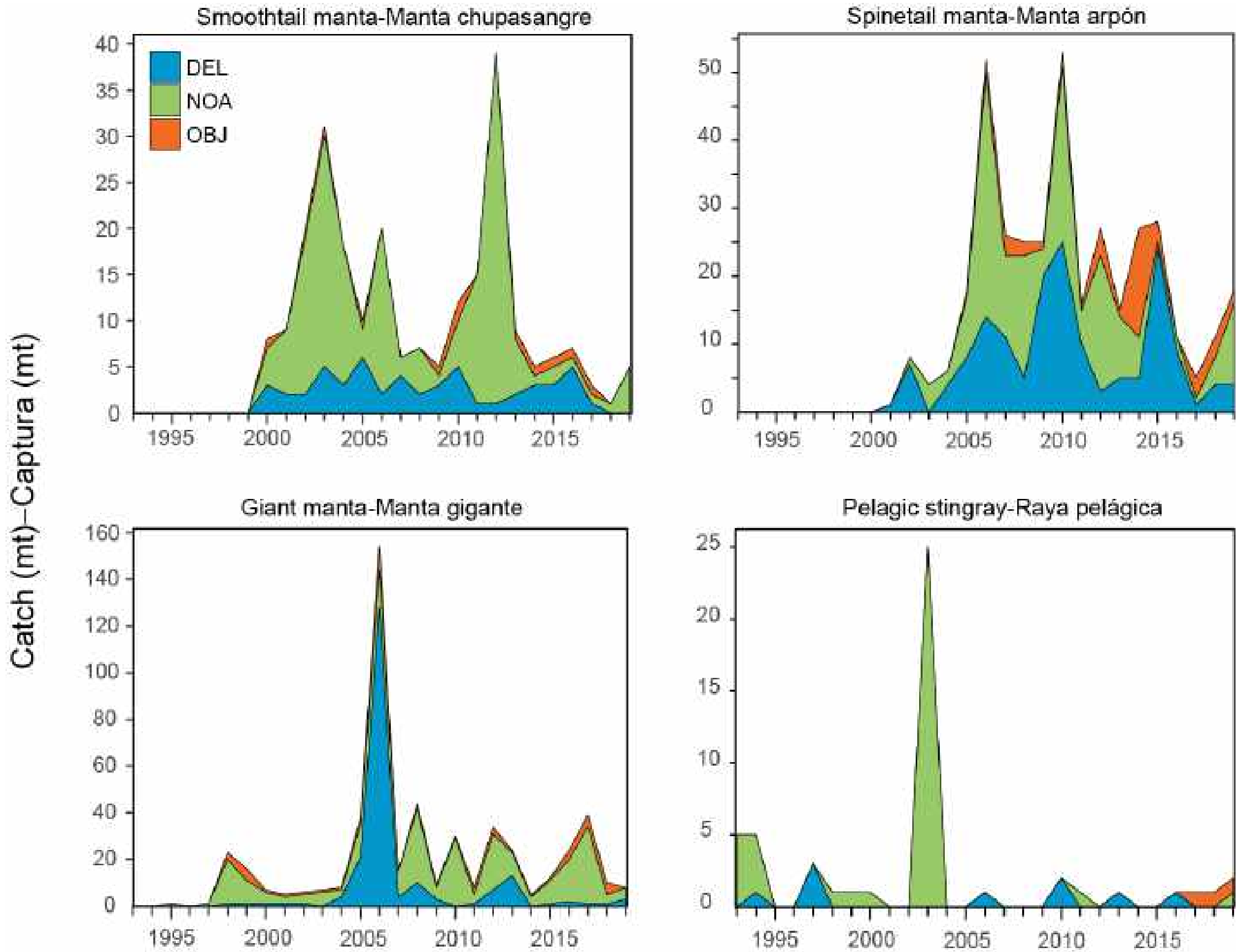


FIGURE L-4. Estimated purse-seine catches in metric tons (t) of key species of rays in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2019) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL).

FIGURA L-4. Capturas cerqueras estimadas en toneladas (t) de especies clave de rayas en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2019) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL).

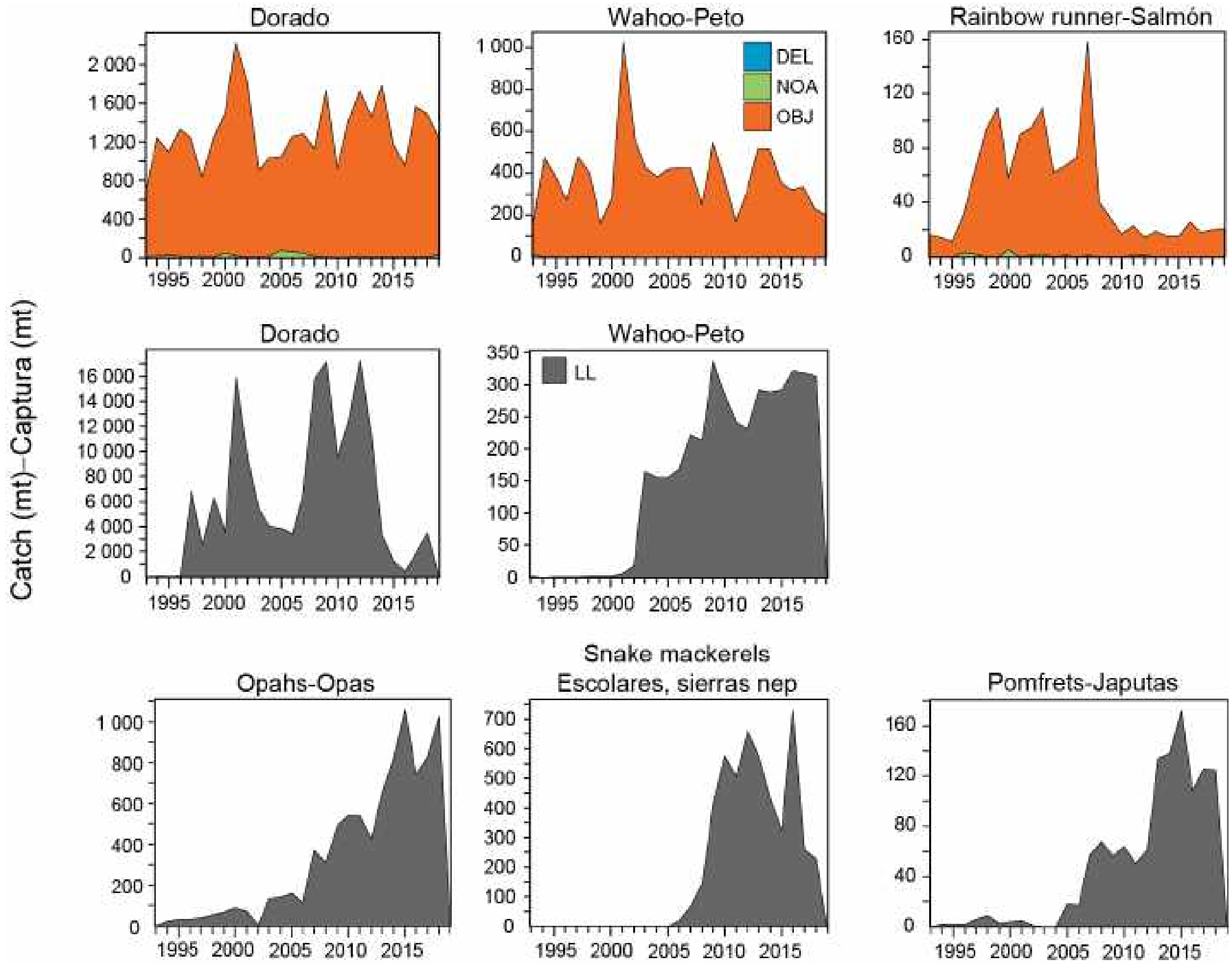


FIGURE L-5. Estimated purse-seine and longline catches in metric tons (t) of key species of large fishes in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2019) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline catches are minimum reported gross-annual removals.

FIGURA L-5. Capturas cerqueras y palangreras estimadas en toneladas (t) de especies clave de peces grandes en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2019) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras son extracciones anuales brutas mínimas reportadas.

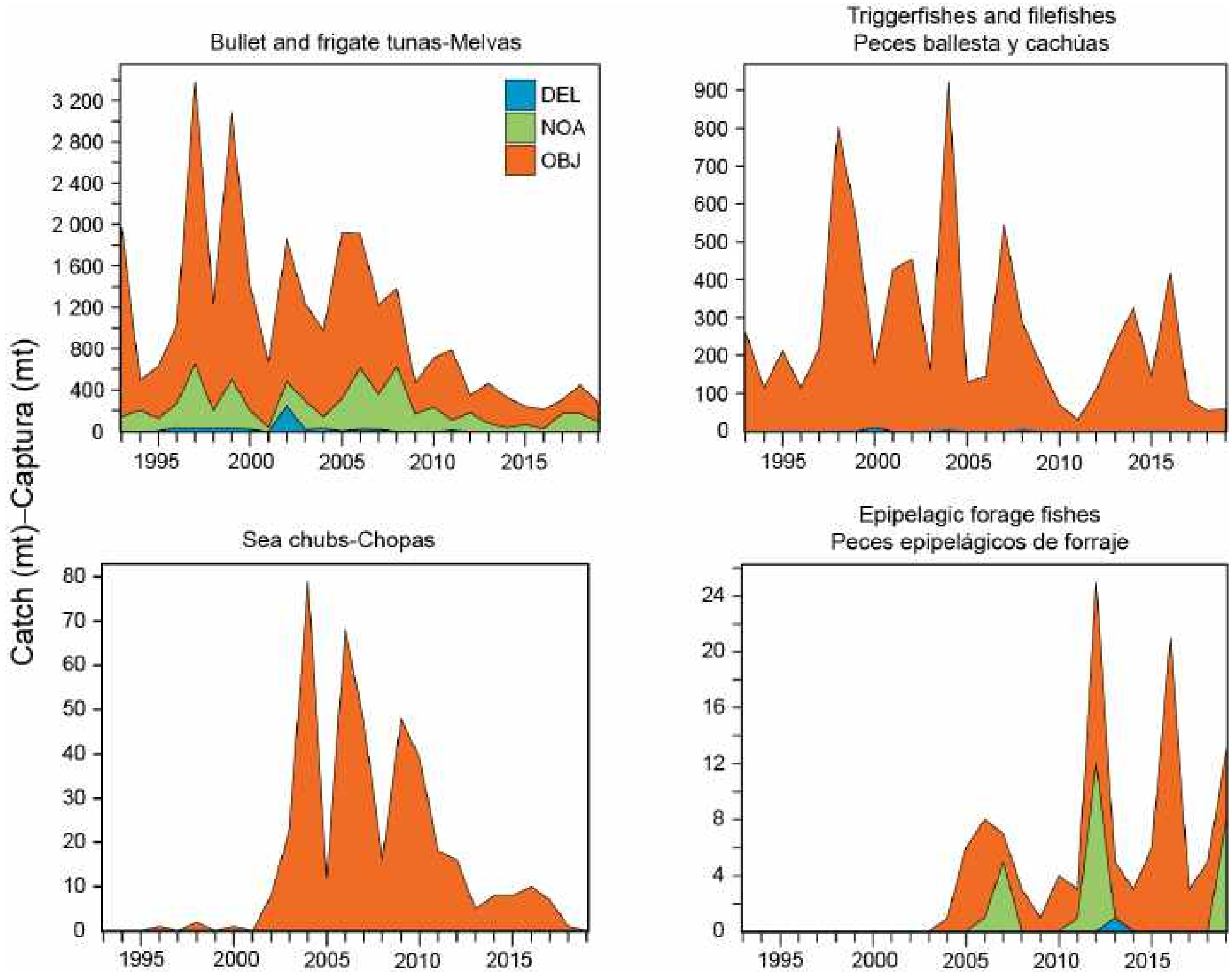


FIGURE L-6. Estimated purse-seine catches in metric tons (t) of key species of small fishes in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2019) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL).

FIGURA L-6. Capturas cerqueras estimadas en toneladas (t) de especies clave de peces pequeños en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2019) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL).

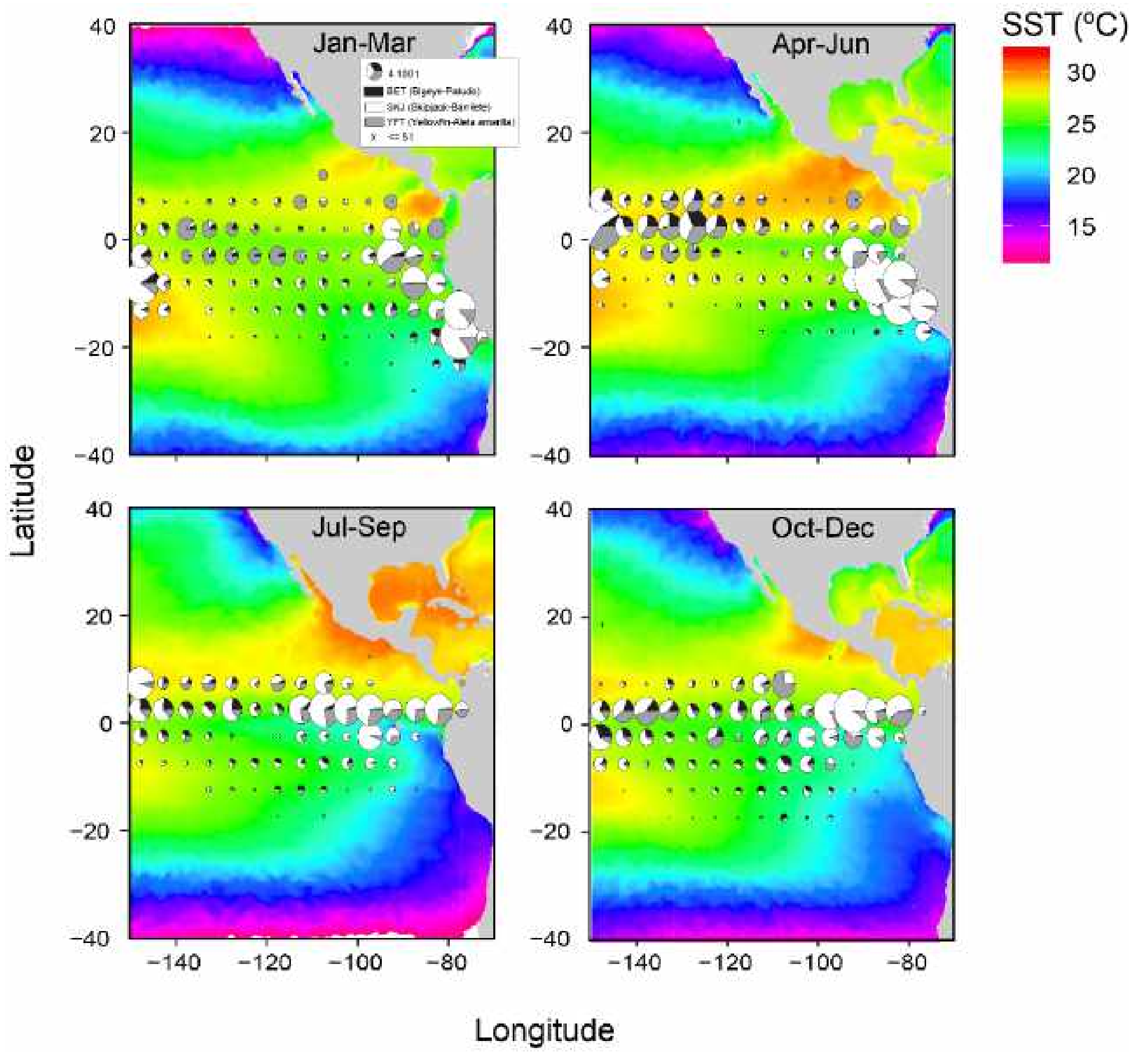


FIGURE L-10. Mean sea surface temperature (SST) for each quarter during 2019 with catches of tropical tunas overlaid. SST data obtained from NOAA NMFS SWFSC ERD on March 5, 2020, “Multi-scale Ultra-high Resolution (MUR) SST Analysis fv04.1, Global, 0.01°, 2002–present, Monthly”, https://coastwatch.pfeg.noaa.gov/erddap/info/jplMURSST41mday/index.html.

FIGURA L-10 Temperatura superficial del mar (TSM) promedio para cada trimestre de 2019 con las capturas de atunes tropicales superpuestas. Datos de TSM obtenidos de NOAA NMFS SWFSC ERD el 5 de marzo de 2020, “Multi-scale Ultra-high Resolution (MUR) SST Analysis fv04.1, Global, 0.01°, 2002–present, Monthly”, https://coastwatch.pfeg.noaa.gov/erddap/info/jplMURSST41mday/index.html.

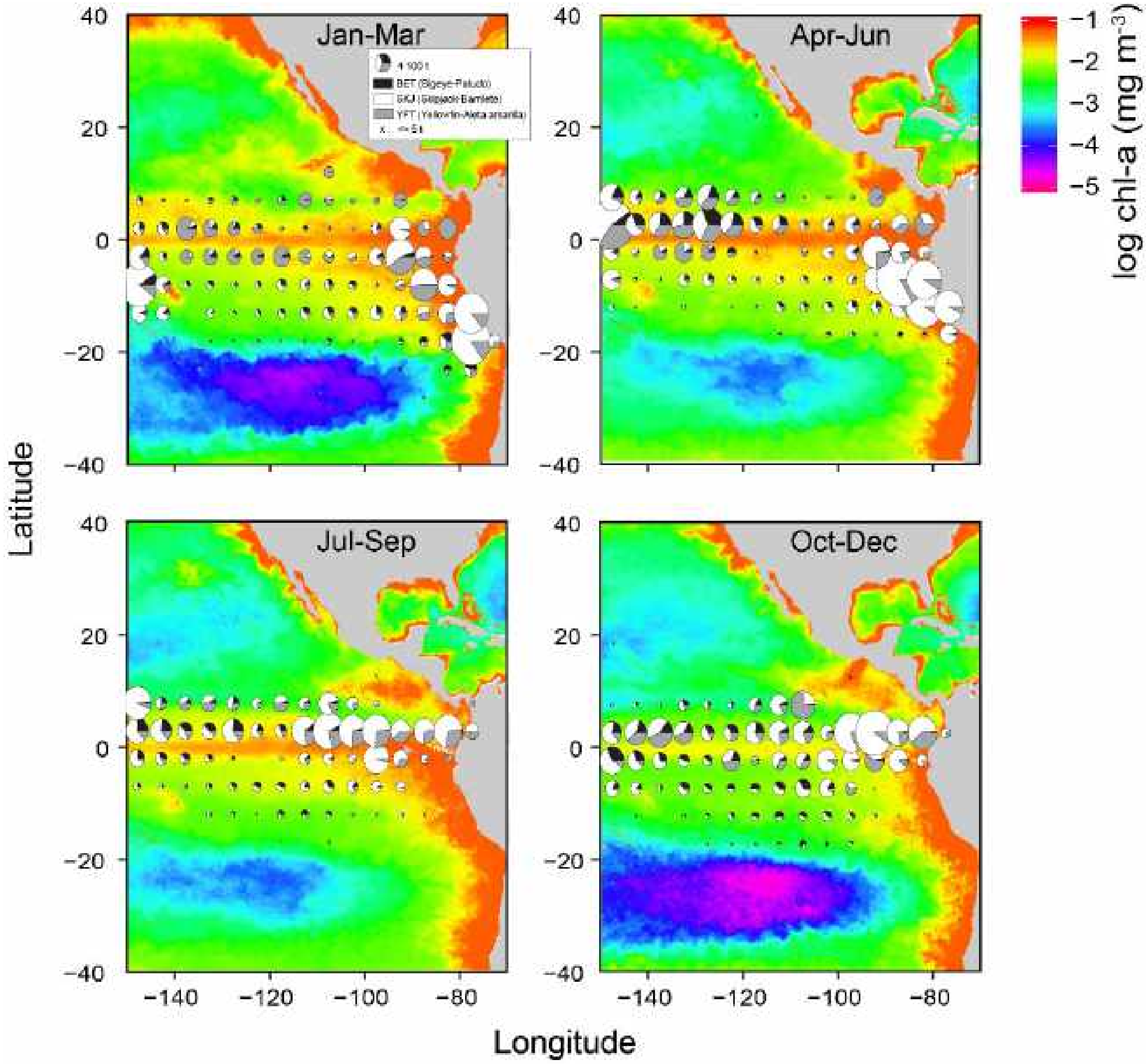


FIGURE L-11. Mean log chlorophyll-a concentration (in mg m^3) for each quarter during 2019 with catches of tropical tunas overlaid. Chlorophyll data obtained from NOAA CoastWatch on February 19, 2020, "Chlorophyll, NOAA, VIIRS, Science Quality, Global, Level 3, 2012-present, Monthly", NOAA NMFS SWFSC ERD, https://coastwatch.pfeg.noaa.gov/erddap/info/nesdisVHNSQchlaMonthly/index.html.

FIGURA L-11. Concentración promedio de clorofila-a (en mg m^3) para cada trimestre de 2019 con las capturas de atunes tropicales superpuestas. Datos de clorofila obtenidos de NOAA CoastWatch el 19 de febrero de 2020, "Chlorophyll, NOAA, VIIRS, Science Quality, Global, Level 3, 2012-present, Monthly", NOAA NMFS SWFSC ERD, https://coastwatch.pfeg.noaa.gov/erddap/info/nesdisVHNSQchlaMonthly/index.html.

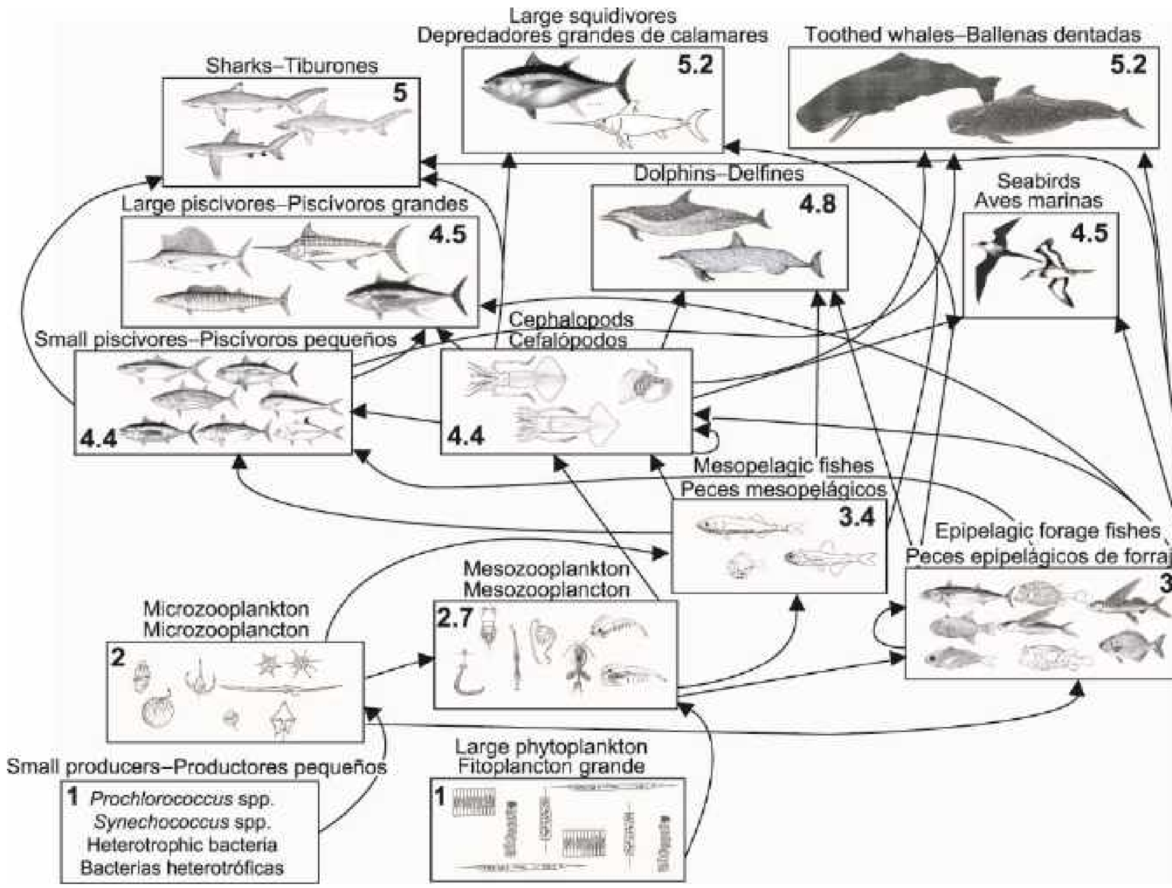


FIGURE L-12. Simplified food-web diagram of the pelagic ecosystem in the tropical EPO. The numbers inside the boxes indicate the approximate trophic level of each group.

FIGURA L-12. 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.

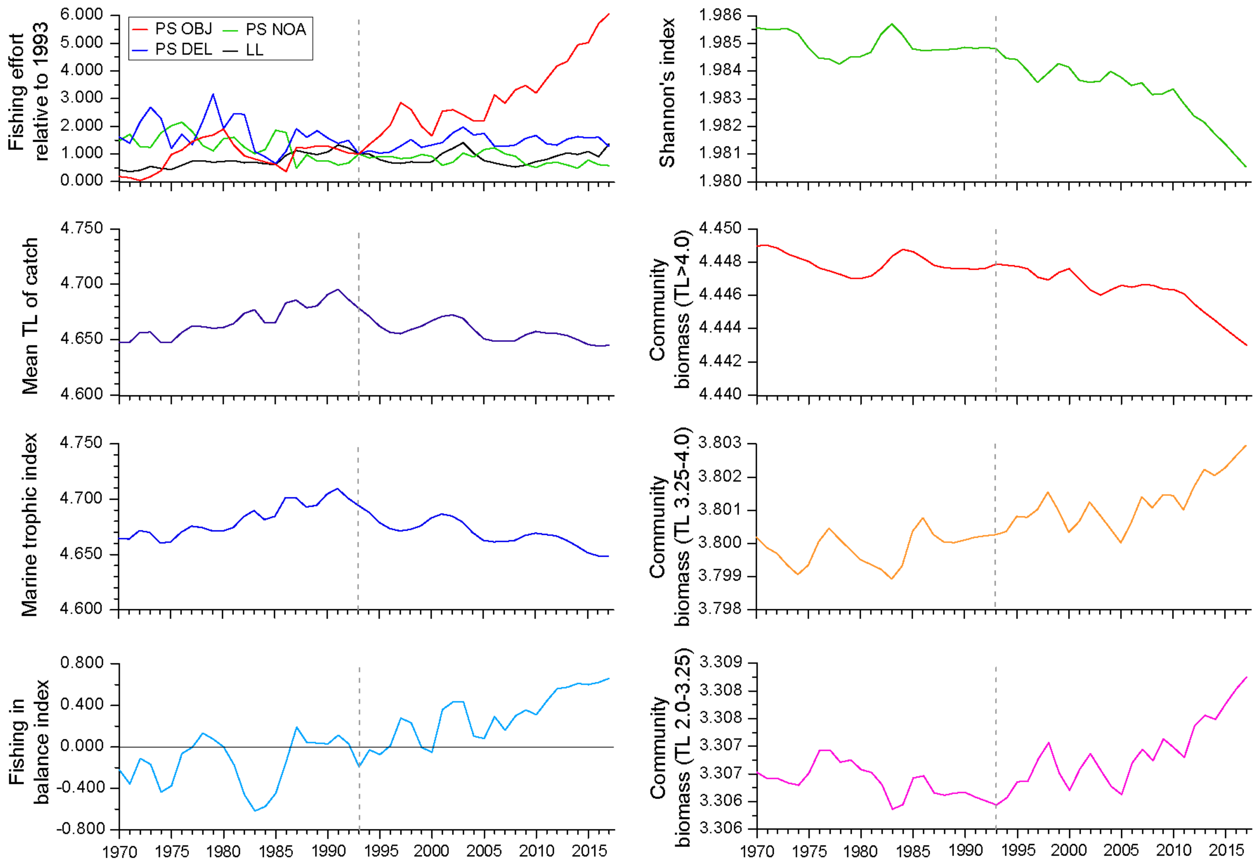


FIGURE L-13. Annual values for seven ecological indicators of changes in different components of the tropical EPO ecosystem, 1970–2017 (see Section 6 of text for details), and an index of longline (LL) and purse-seine (PS) fishing effort, by set type (dolphin (DEL), unassociated (NOA), floating object (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-13 Valores anuales de siete indicadores ecológicos de cambios en diferentes componentes del ecosistema tropical del OPO, 1970–2017 (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.

Table L-1. Incidental dolphin mortalities in numbers of individuals (Num) and average weights in metric tons (t) by stock in the eastern Pacific Ocean caused by the purse-seine fishery from 1993–2019.

Tabla L-1. Mortalidades incidentales de delfines, en número de individuos (Núm.) y peso promedio en toneladas (t), por población, en el océano Pacífico oriental ocasionadas por la pesquería cerquera durante 1993-2019.

	Stenella attenuata				***Stenella longirostris***				***Delphinus delphis***							
	Offshore[1]				**Spinner**				**Common**							
	Northeastern		**Western-southern**		**Eastern**		**Whitebelly**		**Northern**		**Central**		**Southern**		**Other mammals**	
Year	**Num**	**t**	**Num**	**t**	**Num**	**t**	**Num**	**t**	**Num**	**t**	**Num**	**t**	**Num**	**t**	**Num**	**t**
1993	1,112	56	773	44	725	34	437	22	139	9	230	15	0	0	185	8
1994	847	43	1228	71	828	39	640	33	85	6	170	11	0	0	298	12
1995	952	48	859	49	654	31	445	23	9	1	192	13	0	0	163	13
1996	818	41	545	31	450	21	447	23	77	5	51	3	30	2	129	5
1997	721	37	1044	60	391	19	498	26	9	1	114	7	58	4	170	14
1998	298	15	341	20	422	20	249	13	261	17	172	11	33	2	100	8
1999	358	18	253	15	363	17	192	10	85	6	34	2	1	<1	62	4
2000	295	15	435	25	275	13	262	13	54	4	223	15	10	1	82	5
2001	592	30	315	18	470	22	374	19	94	6	205	13	46	3	44	1
2002	435	22	203	12	403	19	182	9	69	5	155	10	3	<1	49	3
2003	288	15	335	19	290	14	170	9	133	9	140	9	97	6	39	3
2004	261	13	256	15	223	11	214	11	156	10	97	6	225	15	37	1
2005	273	14	100	6	275	13	108	6	114	7	57	4	154	10	70	3
2006	147	7	135	8	160	8	144	7	129	8	86	6	40	3	45	2
2007	189	10	116	7	175	8	113	6	55	4	69	5	95	6	26	1
2008	184	9	167	10	349	17	171	9	104	7	14	1	137	9	43	3
2009	266	13	254	15	288	14	222	11	109	7	30	2	49	3	21	1
2010	170	9	135	8	510	24	92	5	124	8	116	8	8	1	15	1
2011	172	9	124	7	467	22	139	7	35	2	12	1	9	1	28	2
2012	151	8	187	11	324	15	107	6	49	3	4	<1	30	2	18	0
2013	158	8	145	8	303	14	111	6	69	5	0	0	8	1	7	1
2014	181	9	168	10	356	17	183	9	49	3	13	1	9	1	16	0
2015	191	10	158	9	196	9	139	7	43	3	21	1	12	1	5	0
2016	127	6	111	6	243	12	89	5	82	5	36	2	9	1	5	0
2017	85	4	183	11	266	13	95	5	26	2	9	1	16	1	3	0
2018	99	5	197	11	252	12	205	11	41	3	1	<1	18	1	6	0
2019	104	5	220	13	270	13	142	7	25	2	3	<1	2	<1	12	0
Total	**9,474**	**480**	**8,987**	**517**	**9,928**	**471**	**6,170**	**317**	**2,225**	**146**	**2,254**	**148**	**1,099**	**72**	**1,678**	**91**

[1]Estimates for offshore spotted dolphins include mortalities of coastal spotted dolphins

Table L-2. Purse-seine a) mortalities and b) interactions reported by onboard observers in numbers of turtles for size-class 6 vessels with a carrying capacity >363 t (1993–2019). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Data for 2019 are considered preliminary.
Tabla L-2. a) Mortalidades e b) interacciones cerqueras reportadas por observadores a bordo, en número de tortugas, para buques de clase 6 con una capacidad de acarreo >363 t (1993–2019). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Los datos de 2019 se consideran preliminares.

	***Lepidochelys olivacea*, olive ridley**			***Chelonia agassizii*, *C. mydas*, eastern Pacific green**			***Caretta caretta*, loggerhead**			**Eretmochelys imbricata, hawksbill**			***Dermochelys coriacea*, leatherback**			**Unidentified turtles**		
	Purse seine			**Purse seine**			**Purse seine**			**Purse seine**			**Purse seine**			**Purse seine**		
Year	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**
1993	23	40	12	2	13	0	0	2	0	0	0	0	0	0	0	3	16	2
1994	50	15	10	7	9	0	0	1	0	0	1	0	1	0	0	34	2	7
1995	66	10	11	10	2	1	0	1	0	0	0	0	0	0	0	24	7	3
1996	47	6	7	11	1	0	0	0	0	0	0	1	0	0	0	30	4	2
1997	52	14	6	8	3	2	1	1	1	0	0	0	0	0	0	25	15	2
1998	66	19	16	7	1	1	1	0	0	3	0	0	0	0	0	26	8	6
1999	81	14	8	4	2	2	1	2	0	1	0	1	0	0	0	39	4	3
2000	45	25	8	6	0	0	1	0	0	1	0	0	0	0	0	17	8	2
2001	49	9	3	5	2	0	1	0	0	1	0	0	0	0	0	22	14	5
2002	21	3	6	3	0	0	0	0	0	0	0	0	0	0	0	6	5	2
2003	16	4	3	0	0	0	0	0	0	0	0	0	0	0	0	5	0	2
2004	8	3	2	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0
2005	7	3	3	1	1	0	0	0	0	0	0	0	0	0	0	4	4	1
2006	8	4	3	2	0	0	1	0	0	0	0	0	0	0	0	1	0	0
2007	6	1	2	0	1	0	1	0	0	1	1	0	0	0	0	7	0	2
2008	4	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
2009	10	0	2	1	0	0	0	0	0	0	0	0	0	0	0	3	1	1
2010	4	3	1	0	2	0	1	0	0	1	0	0	0	0	0	3	1	1
2011	6	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0
2012	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
2013	6	1	0	1	0	0	0	0	0	1	0	0	0	0	0	2	0	0
2014	3	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0
2015	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
2016	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
2017	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Total	**594**	**174**	**106**	**71**	**38**	**6**	**10**	**8**	**1**	**9**	**2**	**3**	**1**	**0**	**0**	**262**	**95**	**41**

Continued

	Lepidochelys olivacea, *olive ridley*			*Chelonia agassizii*, *Chelonia mydas*, eastern Pacific green			*Caretta caretta*, loggerhead			*Eretmochelys imbricata*, hawksbill			*Dermochelys coriacea*, leatherback			Unidentified turtles		
	Purse seine			Purse seine			Purse seine			Purse seine			Purse seine			Purse seine		
Year	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**
1993	254	338	82	59	214	10	3	26	2	1	1	2	2	-	3	65	78	35
1994	412	85	92	123	159	12	7	7	1	5	2	4	2	2	-	132	25	57
1995	487	82	83	173	223	5	9	24	3	7	2	-	-	-	-	121	46	49
1996	484	60	68	135	83	4	12	18	2	8	-	5	5	-	-	141	38	39
1997	485	179	87	164	144	14	6	14	2	4	2	-	3	1	1	160	134	44
1998	601	87	155	137	12	19	14	5	4	6	-	3	1	2	1	107	17	78
1999	926	99	131	99	15	8	8	4	2	3	5	1	-	-	-	174	24	64
2000	423	197	94	90	17	5	1	6	1	4	1	3	1	1	1	83	53	73
2001	738	126	89	137	23	8	9	1	2	4	1	3	-	-	1	189	41	95
2002	692	93	138	108	11	15	14	5	8	8	1	2	1	1	-	172	31	80
2003	741	143	165	107	25	15	14	4	6	6	1	6	-	1	1	164	40	77
2004	616	107	119	65	38	8	10	11	13	12	4	3	1	4	4	149	26	48
2005	603	412	181	102	124	21	5	15	14	2	2	9	1	1	3	100	70	72
2006	587	333	137	104	119	23	38	19	14	12	11	4	1	3	2	183	64	77
2007	453	492	139	83	55	30	56	38	12	9	3	2	3	2	2	129	240	188
2008	405	29	145	54	20	12	46	5	6	7	-	11	2	3	2	183	18	107
2009	472	30	108	56	12	18	31	5	20	8	-	6	1	-	2	151	15	94
2010	417	121	211	68	16	23	34	24	22	10	-	3	3	-	-	119	23	185
2011	497	96	113	70	88	25	29	45	16	5	5	4	1	1	1	125	30	63
2012	389	53	87	77	38	5	20	19	17	5	-	2	1	1	-	95	19	40
2013	409	21	66	58	13	7	24	9	8	7	-	2	1	2	2	181	14	49
2014	307	19	83	69	16	10	26	1	4	7	1	1	7	1	2	135	24	53
2015	201	49	76	55	12	21	28	6	13	3	1	2	4	2	-	182	113	42
2016	367	49	113	82	34	17	19	21	9	15	3	5	2	1	-	339	62	117
2017	291	25	71	50	22	34	33	22	7	9	3	4	2	1	1	280	43	83
2018	169	5	147	58	25	96	19	8	4	8	2	1	3	1	1	177	22	169
2019	210	30	128	87	13	10	15	46	9	7	2	-	-	-	-	221	153	58
Total	**12,636**	**3,360**	**3,108**	**2,470**	**1,571**	**475**	**530**	**408**	**221**	**182**	**53**	**88**	**48**	**31**	**30**	**4,257**	**1,463**	**2,136**

Table L-3. Estimated purse-seine catches by set type in metric tons (t) of sharks for size-class 6 vessels with a carrying capacity >363 t (1993–2019) and minimum reported longline (LL) catches of sharks (gross-annual removals in t) (1993–2018, *data not available). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2019 are considered preliminary. "Other sharks" include whale shark (*Rhincodon typus*), basking shark (*Cetorhinus maximus*) and unidentified sharks (Euselachii).

Tabla L-3. Capturas cerqueras estimadas de tiburones, por tipo de lance, en toneladas (t) para buques de clase 6 con una capacidad de acarreo >363 t (1993–2019) y capturas palangreras (LL) mínimas reportadas de tiburones (extracciones anuales brutas en t) (1993-2018, *datos no disponibles). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las especies en negritas se discuten en el texto principal. Los datos de 2019 se consideran preliminares. "Otros tiburones" incluyen el tiburón ballena (*Rhincodon typus*), el tiburón peregrino (*Cetorhinus maximus*) y tiburones (Euselachii) no identificados.

	Carcharhinidae															
	***Carcharhinus falciformis*, silky shark**				***Carcharhinus longimanus*, oceanic whitetip**				***Prionace glauca*, blue shark**				**Other Carcharhinidae, requiem sharks**			
	Purse seine				**Purse seine**				**Purse seine**				**Purse seine**			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	447	360	51	-	44	18	9	-	<1	2	<1	360	2	5	3	-
1994	439	244	38	-	119	9	4	-	<1	1	<1	209	24	14	5	-
1995	471	120	162	-	200	36	18	-	<1	5	<1	280	4	2	11	-
1996	442	107	47	-	209	5	12	-	2	<1	<1	606	12	<1	7	-
1997	843	188	42	-	236	11	6	-	2	<1	<1	425	18	3	5	-
1998	710	59	171	-	211	7	5	-	1	<1	<1	1,164	4	<1	<1	-
1999	460	100	74	-	163	7	2	-	<1	<1	<1	2,185	9	<1	<1	-
2000	308	97	30	-	98	9	2	-	<1	<1	<1	2,112	5	<1	<1	-
2001	399	76	53	-	96	<1	<1	-	4	<1	<1	2,304	9	<1	-	-
2002	291	142	35	-	31	6	<1	<1	1	<1	<1	2,356	4	17	<1	-
2003	320	102	59	-	19	<1	<1	-	<1	<1	<1	2,054	7	6	<1	-
2004	247	68	76	-	9	<1	<1	<1	<1	<1	-	2,325	5	3	<1	-
2005	322	41	51	-	2	-	<1	-	<1	<1	-	2,825	4	2	3	-
2006	361	46	27	13,053	5	<1	<1	46	<1	1	<1	1,341	13	3	8	280
2007	316	156	41	12,771	2	-	<1	136	<1	1	-	3,169	8	24	11	419
2008	577	27	25	11,205	2	-	<1	55	<1	1	<1	6,838	11	<1	1	741
2009	339	31	33	14,042	4	<1	<1	294	<1	<1	<1	6,678	29	4	20	431
2010	347	66	70	12,510	2	-	<1	94	<1	1	1	10,130	17	10	21	4,259
2011	266	26	55	12,866	2	-	<1	63	<1	<1	1	13,863	20	6	4	4,730
2012	200	33	52	10,585	<1	<1	-	1	<1	2	<1	12,565	8	<1	1	4,082
2013	212	55	38	14,762	<1	<1	-	5	<1	<1	1	12,237	12	2	3	753
2014	422	68	45	5,511	2	-	-	25	1	<1	<1	10,728	13	<1	5	1,515
2015	540	133	48	5,690	3	<1	<1	647	<1	<1	<1	13,194	31	7	2	1,901
2016	488	36	63	9,610	5	<1	<1	755	<1	2	1	12,381	35	<1	3	2,755
2017	665	12	21	15,893	4	<1	<1	3	<1	<1	-	10,931	54	<1	2	2,562
2018	398	12	16	15,072	3	-	<1	19	<1	<1	<1	12,064	28	3	1	1,360
2019	392	13	25	*	5	<1	<1	*	<1	<1	<1	*	26	4	6	*
Total	**11,224**	**2,420**	**1,448**	**153,569**	**1,478**	**111**	**64**	**2,143**	**18**	**23**	**9**	**145,326**	**411**	**123**	**126**	**25,789**

Continued

	Sphyrnidae															
	***Sphyrna zygaena*, smooth hammerhead**				***Sphyrna lewini*, scalloped hammerhead**				***Sphyrna mokarran*, great hammerhead**				***Sphyrna* spp., hammerheads, nei**			
	Purse seine				**Purse seine**				**Purse seine**				**Purse seine**			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	-	<1	-	-	<1	1	-	-	<1	-	-	-	41	17	8	-
1994	1	2	<1	-	<1	4	<1	-	-	-	-	-	102	24	2	-
1995	2	2	-	-	<1	<1	<1	-	<1	-	-	-	71	15	4	-
1996	4	2	-	-	1	<1	-	-	<1	-	-	-	87	39	5	-
1997	21	2	<1	-	10	3	<1	-	1	<1	<1	-	63	10	3	-
1998	18	5	1	-	8	9	<1	-	3	<1	3	-	37	12	5	-
1999	21	3	<1	-	16	3	1	-	1	<1	<1	-	18	5	3	-
2000	11	4	<1	-	7	15	1	-	7	<1	<1	-	7	2	7	-
2001	24	1	<1	-	12	1	<1	-	5	-	<1	-	23	<1	1	-
2002	24	3	1	-	47	<1	1	-	7	-	<1	-	46	4	2	-
2003	49	6	1	-	38	3	3	-	13	<1	<1	-	52	3	2	-
2004	51	11	3	-	25	3	2	-	3	<1	<1	-	60	2	<1	-
2005	34	2	<1	-	25	10	3	-	2	-	<1	-	19	<1	<1	<1
2006	33	6	2	58	19	3	1	-	1	<1	<1	-	3	<1	<1	5
2007	27	5	<1	200	12	3	1	<1	-	<1	<1	-	1	1	<1	43
2008	16	<1	<1	381	16	11	<1	64	<1	-	<1	-	6	<1	1	42
2009	22	<1	<1	423	13	2	1	50	<1	-	-	-	5	1	<1	22
2010	28	1	2	508	13	1	1	143	<1	-	<1	-	3	<1	<1	118
2011	49	2	2	443	13	6	2	191	3	<1	<1	-	12	<1	1	131
2012	32	2	<1	118	9	4	<1	89	<1	<1	<1	-	5	2	1	130
2013	47	2	<1	311	22	2	<1	87	<1	<1	<1	-	9	1	<1	296
2014	35	<1	<1	593	23	2	<1	5	1	<1	<1	-	14	<1	<1	208
2015	32	1	<1	1,961	9	<1	<1	11	<1	<1	-	-	9	<1	<1	392
2016	24	1	<1	4,052	12	1	<1	6	5	<1	-	-	11	1	<1	338
2017	11	<1	<1	3,495	8	3	<1	83	<1	<1	<1	-	6	<1	<1	197
2018	11	<1	<1	851	7	<1	<1	<1	<1	-	-	-	6	<1	<1	173
2019	17	<1	<1	*	11	2	<1	*	1	-	<1	*	5	<1	<1	*
Total	**645**	**68**	**21**	**13,394**	**379**	**96**	**25**	**731**	**59**	**4**	**5**	**-**	**719**	**146**	**52**	**2,096**

Continued

	Alopias pelagicus, pelagic thresher				*Alopias superciliosus*, bigeye thresher				*Alopias vulpinus*, thresher shark				*Alopias* spp., thresher shark, nei			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	-	2	<1	-	<1	2	3	-	-	<1	-	-	2	7	1	14
1994	-	<1	<1	-	-	6	<1	-	-	3	<1	-	<1	11	3	87
1995	<1	<1	<1	-	<1	2	<1	-	<1	1	1	-	1	6	3	200
1996	-	1	-	-	<1	1	<1	-	<1	<1	<1	-	<1	2	4	28
1997	<1	<1	-	-	<1	1	<1	-	<1	<1	<1	-	<1	4	<1	5
1998	<1	2	<1	-	<1	4	1	-	<1	2	<1	-	<1	5	3	5
1999	<1	4	2	-	<1	1	6	-	<1	<1	<1	-	<1	3	2	5
2000	<1	<1	<1	-	<1	8	1	-	<1	<1	<1	-	<1	<1	6	64
2001	<1	<1	<1	-	<1	4	2	-	<1	<1	<1	-	<1	4	1	172
2002	<1	<1	<1	-	2	8	1	-	<1	2	<1	-	<1	6	4	88
2003	1	5	3	-	<1	8	6	-	<1	<1	<1	-	<1	4	3	134
2004	6	3	2	-	<1	16	1	-	<1	2	<1	-	<1	4	2	43
2005	1	3	2	-	<1	6	3	-	<1	1	2	-	<1	<1	<1	12
2006	2	23	2	-	<1	22	3	187	<1	7	<1	60	<1	3	<1	8
2007	3	3	6	1,133	2	3	3	115	<1	<1	<1	35	<1	1	1	15
2008	1	3	3	4,323	<1	3	3	240	<1	2	<1	38	<1	1	2	17
2009	<1	<1	1	4,909	<1	<1	2	343	<1	<1	<1	76	<1	<1	1	4
2010	<1	<1	3	7,828	<1	<1	2	373	1	<1	<1	34	<1	<1	1	389
2011	<1	2	2	7,302	<1	2	2	458	<1	<1	<1	61	<1	1	<1	430
2012	<1	1	2	7	<1	1	2	326	<1	<1	<1	86	<1	1	<1	526
2013	<1	<1	3	46	<1	<1	2	543	<1	<1	<1	49	<1	<1	1	109
2014	<1	1	2	36	<1	3	2	636	<1	<1	<1	-	<1	<1	<1	850
2015	<1	2	1	463	<1	1	<1	859	<1	-	<1	11	<1	<1	<1	283
2016	<1	2	3	1,045	<1	<1	4	944	<1	1	<1	547	<1	<1	1	96
2017	<1	<1	<1	582	<1	<1	<1	1,148	-	<1	<1	1,677	<1	<1	<1	153
2018	<1	2	<1	464	<1	<1	<1	32	<1	<1	<1	1,683	<1	<1	<1	39
2019	<1	<1	<1	*	<1	<1	<1	*	-	-	<1	*	<1	<1	<1	*
Total	**22**	**65**	**43**	**28,138**	**17**	**108**	**53**	**6,203**	**5**	**28**	**12**	**4,357**	**14**	**69**	**45**	**3,775**

Continued

	Lamnidae								Triakidae											
	Isurus spp., mako sharks				Lamnidae spp., mackerel sharks, porbeagles nei				Triakidae spp., houndsharks, nei				Other sharks				All sharks			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	<1	2	<1	383	-	-	-	-	-	-	-	-	84	19	14	271	623	437	90	1,028
1994	2	<1	<1	156	-	-	-	-	-	-	-	-	69	47	7	782	759	367	62	1,234
1995	2	<1	<1	216	-	-	-	-	-	-	-	-	103	29	13	226	856	220	213	922
1996	1	<1	<1	318	-	-	-	-	-	-	-	-	69	41	34	168	830	202	110	1,120
1997	2	1	-	361	-	-	-	-	-	-	-	-	88	4	2	166	1,287	230	62	956
1998	1	<1	<1	693	-	-	-	-	-	-	-	-	90	10	6	237	1,085	116	198	2,099
1999	<1	<1	<1	460	-	-	-	-	-	-	-	-	50	12	4	3,347	739	140	97	5,997
2000	2	<1	-	502	-	-	-	-	-	-	-	-	21	67	178	5,740	466	207	227	8,418
2001	2	<1	<1	1,168	-	-	-	-	-	-	-	-	29	4	2	8,896	605	94	62	12,540
2002	4	<1	<1	1,131	-	-	-	-	-	-	-	1,484	40	11	3	7,339	497	201	51	12,398
2003	2	<1	<1	1,156	-	-	-	-	-	-	-	1,287	12	37	4	9,866	516	177	83	14,498
2004	1	<1	<1	1,374	-	-	-	-	-	-	-	846	36	10	5	6,684	446	125	95	11,273
2005	1	2	<1	1,367	-	-	-	-	-	-	-	838	5	1	1	7,075	417	71	67	12,117
2006	2	4	<1	95	-	-	-	2	-	-	-	674	8	<1	<1	4,770	449	118	46	20,579
2007	2	2	-	181	-	-	-	1	-	-	-	996	5	3	1	5,786	380	203	67	25,000
2008	<1	2	<1	707	-	-	-	1	-	-	-	1,398	12	<1	2	4,091	644	52	40	30,141
2009	1	<1	<1	534	-	-	-	7	-	-	-	695	19	3	1	2,478	434	46	63	30,988
2010	3	<1	<1	1,901	-	-	-	<1	-	-	-	<1	17	4	2	2,246	433	87	104	40,533
2011	3	2	<1	2,802	-	-	-	26	-	-	-	7	30	<1	<1	2,074	401	51	72	45,449
2012	2	2	<1	2,120	-	-	-	12	-	-	-	-	10	<1	<1	1,242	272	50	62	31,889
2013	1	<1	<1	2,121	-	-	-	44	-	-	-	211	45	2	<1	1,517	351	67	49	33,090
2014	2	<1	<1	2,775	-	-	-	51	-	-	-	4,067	24	<1	<1	2,075	540	78	56	29,076
2015	<1	<1	<1	3,118	-	-	-	79	-	-	-	621	18	3	3	10,593	645	151	58	39,821
2016	1	<1	<1	2,475	-	-	-	91	-	-	-	538	19	3	<1	2,245	602	50	78	37,877
2017	<1	<1	-	3,107	-	-	-	95	-	-	-	986	16	1	<1	1,263	766	21	27	42,174
2018	2	<1	<1	2,882	-	-	-	86	-	-	-	729	5	<1	<1	1,157	460	21	20	36,612
2019	<1	<1	<1	*	-	-	-	*	-	-	-	*	6	<1	<1	*	465	23	34	*
Total	**44**	**26**	**4**	**34,103**	**-**	**-**	**-**	**496**	**-**	**-**	**-**	**15,378**	**931**	**316**	**287**	**92,333**	**15,965**	**3,603**	**2,194**	**527,829**

Table L-4. Estimated purse-seine catches by set type in metric tons (t) of rays for size-class 6 vessels with a carrying capacity >363 t (1993–2019) and minimum reported longline (LL) catches of rays (gross-annual removals in t) (1993–2018, *data not available). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2019 are considered preliminary. "Other rays" include Chilean torpedo (*Torpedo tremens*), Pacific cownose (*Rhinoptera steindachneri*), and unidentified eagle rays (Myliobatidae).

Tabla L-4. Capturas cerqueras estimadas de rayas, por tipo de lance, en toneladas (t) para buques de clase 6 con una capacidad de acarreo >363 t (1993–2019) y capturas palangreras (LL) mínimas reportadas de rayas (extracciones anuales brutas en t) (1993-2018, *datos no disponibles). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las especies en negritas se discuten en el texto principal. Los datos de 2019 se consideran preliminares. "Otras rayas" incluyen la raya temblara (*Torpedo tremens*), raya gavilán dorado (*Rhinoptera steindachneri*), y águilas de mar (Myliobatidae) no identificadas.

	Mobulidae																				
	***Mobula thurstoni*, smoothtail manta**				***Mobula mobular*, spinetail manta**				***Mobula munkiana*, munk's devil ray**				***Mobula tarapacana*, chilean devil ray**				***Mobula birostris*, giant manta**			
	Purse seine				**Purse seine**				**Purse seine**				**Purse seine**				**Purse seine**			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	-	-
1998	-	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	19	<1	-
1999	-	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	5	10	<1	-
2000	1	4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	5	<1	-
2001	<1	7	2	-	<1	<1	1	-	-	-	<1	-	<1	-	-	-	1	3	<1	-
2002	<1	17	2	-	<1	<1	7	-	<1	<1	<1	-	<1	1	<1	-	1	4	1	-
2003	<1	25	5	-	<1	4	<1	-	<1	<1	<1	-	-	-	<1	-	<1	6	<1	-
2004	<1	15	3	-	<1	2	4	-	-	<1	<1	-	<1	2	<1	-	1	3	4	-
2005	<1	3	6	-	1	9	8	-	-	<1	<1	-	<1	4	7	-	3	14	21	-
2006	<1	18	2	-	2	36	14	-	-	2	<1	-	<1	6	3	-	10	16	128	-
2007	<1	2	4	-	3	12	11	-	<1	<1	<1	-	2	4	2	-	<1	11	4	-
2008	<1	5	2	-	2	18	5	-	<1	3	<1	-	<1	24	3	-	2	32	10	-
2009	<1	1	3	-	1	4	20	-	<1	1	<1	6	<1	<1	8	-	<1	5	3	-
2010	2	5	5	-	2	26	25	-	<1	1	<1	118	<1	1	8	-	1	29	<1	-
2011	<1	14	<1	-	1	5	10	-	<1	1	<1	-	<1	3	7	-	3	4	<1	-
2012	<1	38	1	-	4	20	3	-	<1	1	<1	-	<1	7	1	-	3	24	7	-
2013	<1	6	2	-	1	9	5	-	<1	1	<1	-	<1	3	1	-	<1	10	13	-
2014	<1	<1	3	-	16	6	5	-	<1	<1	<1	-	<1	<1	<1	-	<1	4	-	-
2015	<1	2	3	-	3	1	24	-	<1	<1	1	-	1	2	6	-	<1	10	<1	-
2016	<1	<1	5	-	<1	2	9	-	<1	2	2	-	1	2	2	-	4	18	2	-
2017	<1	<1	1	-	3	1	1	-	<1	<1	<1	-	<1	-	<1	-	5	33	<1	-
2018	<1	1	<1	-	3	4	4	-	<1	-	<1	-	1	<1	<1	-	5	4	<1	-
2019	<1	5	<1	-	2	12	4	-	<1	-	<1	-	3	<1	1	-	<1	5	3	-
Total	**11**	**172**	**53**	**-**	**45**	**170**	**160**	**-**	**2**	**15**	**9**	**124**	**16**	**64**	**53**	**-**	**51**	**272**	**201**	**-**

Continued

	Mobulidae				Dasyatidae															
	Mobulidae spp., mobulid rays, nei				*Pteroplatytrygon violacea*, pelagic stingray				Dasyatidae spp., stingrays, nei				Other rays				All rays			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	9	213	27	-	<1	5	<1	-	-	-	-	-	-	-	-	-	9	219	27	-
1994	3	73	19	-	<1	4	<1	-	-	-	-	-	-	-	-	-	3	77	20	-
1995	3	29	30	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	3	30	30	-
1996	4	73	16	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	4	74	16	-
1997	5	41	17	-	<1	<1	3	-	-	-	-	-	-	-	-	-	5	42	20	-
1998	5	228	18	-	<1	<1	<1	-	-	3	-	-	<1	<1	-	-	7	251	20	-
1999	8	84	16	-	<1	1	<1	-	-	-	-	-	-	-	-	-	13	96	17	-
2000	2	94	23	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	4	104	27	-
2001	3	20	23	-	<1	<1	<1	-	-	-	-	-	-	-	-	-	5	30	27	-
2002	2	69	37	-	<1	<1	<1	-	<1	-	-	-	-	-	-	-	6	92	48	-
2003	9	61	37	-	<1	25	<1	-	-	-	-	-	-	-	-	-	11	121	44	-
2004	4	46	19	-	<1	<1	<1	-	<1	5	<1	-	-	-	-	-	6	75	31	-
2005	2	19	11	-	<1	<1	<1	-	<1	<1	<1	-	-	31	-	-	8	80	53	-
2006	3	23	14	-	<1	<1	<1	-	<1	12	<1	-	-	-	3	-	16	115	166	-
2007	2	12	12	-	<1	<1	<1	-	<1	3	<1	2	-	<1	-	-	8	44	35	2
2008	3	10	5	-	<1	<1	<1	-	<1	<1	<1	2	-	-	-	-	8	93	27	2
2009	2	7	15	-	<1	<1	<1	-	<1	<1	1	8	-	-	-	-	6	19	50	13
2010	7	20	17	-	<1	<1	2	-	<1	-	<1	3	-	20	-	-	13	103	58	121
2011	1	11	5	-	<1	<1	<1	-	<1	<1	<1	<1	-	<1	-	-	7	40	25	<1
2012	1	10	3	-	<1	<1	<1	-	<1	<1	<1	-	<1	<1	<1	-	9	100	16	-
2013	<1	6	6	-	<1	<1	<1	-	<1	<1	<1	-	-	-	1	-	5	36	28	-
2014	1	4	1	-	<1	<1	<1	-	<1	<1	<1	-	-	-	-	-	20	17	11	-
2015	1	4	9	-	<1	<1	<1	-	<1	<1	1	1	-	-	-	-	7	20	46	1
2016	3	12	11	-	<1	<1	<1	-	<1	-	<1	-	-	-	-	-	10	37	32	-
2017	7	20	6	-	<1	<1	<1	-	<1	<1	<1	-	-	-	<1	-	18	56	11	-
2018	6	5	6	-	<1	<1	<1	-	<1	<1	<1	-	-	-	-	-	17	15	12	-
2019	4	16	8	-	<1	<1	<1	-	<1	<1	<1	-	-	<1	<1	-	11	40	18	-
Total	**100**	**1,210**	**411**	**-**	**9**	**41**	**16**	**-**	**3**	**27**	**6**	**16**	**0**	**52**	**5**	**-**	**238**	**2,024**	**914**	**140**

Table L-5. Estimated purse-seine catches by set type in metric tons (t) of large fishes for size-class 6 vessels with a carrying capacity >363 t (1993–2019) and minimum reported longline (LL) catches of large fishes (gross-annual removals in t) (1993–2018, *data not available). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2019 are considered preliminary. "Other large fishes" include unidentified mackerels (Scombridae), luvar (*Luvarus imperialis*), and large fishes nei (not elsewhere identified).

Tabla L-5. Capturas cerqueras estimadas de peces grandes, por tipo de lance, en toneladas (t) para buques de clase 6 con una capacidad de acarreo >363 t (1993–2019) y capturas palangreras (LL) mínimas reportadas de peces grandes (extracciones anuales brutas en t) (1993-2018, *datos no disponibles). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las especies en negritas se discuten en el texto principal. Los datos de 2019 se consideran preliminares. "Otros peces grandes" incluyen caballas (Scombridae) no identificadas, pez emperador (*Luvarus imperialis*), y peces grandes nep (no identificados en otra parte).

	Coryphaenidae				**Scombridae**				**Carangidae**											
	Coryphaenidae spp., dorado				***Acanthocybium solandri, wahoo***				***Elagatis bipinnulata, rainbow runner***				***Seriola spp., amberjacks, nei***				***Caranx* spp., jacks, crevalles, nei**			
	Purse seine				**Purse seine**				**Purse seine**				**Purse seine**				**Purse seine**			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	702	14	<1	17	152	11	<1	2	16	<1	<1	-	-	-	-	-	-	-	-	-
1994	1,221	20	<1	46	472	1	1	<1	14	<1	<1	-	<1	-	-	-	-	-	-	-
1995	1,071	22	3	39	379	<1	<1	1	11	<1	<1	-	<1	<1	-	-	-	-	-	-
1996	1,312	18	<1	43	271	<1	<1	1	28	3	<1	-	4	-	-	-	-	-	-	-
1997	1,225	12	<1	6,866	475	3	1	<1	60	2	<1	-	1	-	-	-	<1	-	-	-
1998	816	18	<1	2,528	396	<1	4	2	93	<1	<1	-	4	-	-	-	<1	-	-	-
1999	1,238	4	<1	6,283	161	<1	<1	2	110	<1	<1	-	<1	-	-	-	<1	-	-	-
2000	1,437	51	2	3,537	277	2	<1	2	53	5	<1	-	<1	-	-	-	<1	-	-	-
2001	2,202	17	3	15,942	1,023	2	<1	6	90	<1	<1	-	1	-	-	-	<1	-	-	-
2002	1,815	8	<1	9,464	571	<1	<1	18	94	1	<1	-	<1	<1	-	-	<1	-	-	-
2003	894	11	1	5,301	428	<1	<1	164	108	2	-	-	1	<1	-	-	<1	-	-	-
2004	1,018	17	1	3,986	380	<1	<1	155	62	<1	-	-	56	9	<1	1	2	<1	-	-
2005	972	75	1	3,854	420	<1	<1	155	66	<1	<1	-	26	2	<1	-	2	1	-	-
2006	1,197	58	<1	3,408	424	1	<1	167	73	<1	<1	-	53	8	<1	-	10	220	<1	-
2007	1,235	47	1	6,907	421	2	<1	221	157	<1	-	-	18	80	<1	-	1	11	-	-
2008	1,112	17	2	15,845	249	1	<1	213	40	<1	<1	-	27	<1	-	-	17	18	-	-
2009	1,722	7	<1	17,136	547	<1	<1	336	28	<1	<1	-	13	<1	-	-	11	8	-	-
2010	912	3	<1	9,484	373	1	<1	284	17	<1	<1	-	3	23	-	-	1	48	-	-
2011	1,410	7	<1	12,438	169	2	<1	242	22	<1	-	-	7	33	-	<1	4	14	-	1
2012	1,705	18	<1	17,255	313	<1	<1	230	13	1	-	-	10	7	-	-	2	15	<1	-
2013	1,455	7	<1	11,249	518	1	<1	291	19	<1	-	-	6	<1	<1	-	4	2	<1	-
2014	1,777	9	<1	3,340	517	2	<1	287	15	<1	<1	-	6	2	-	-	3	<1	<1	-
2015	1,167	8	<1	1,201	357	1	<1	291	15	<1	-	-	6	<1	-	-	9	8	<1	-
2016	949	7	<1	447	318	2	<1	321	26	<1	<1	-	12	<1	<1	-	4	<1	8	-
2017	1,555	11	<1	1,804	335	<1	<1	318	18	<1	<1	-	12	5	<1	-	4	12	-	-
2018	1,483	5	5	3,499	230	<1	<1	313	20	<1	-	-	62	<1	-	-	9	<1	-	-
2019	1,207	29	<1	*	201	<1	<1	*	21	<1	<1	*	12	4	<1	*	5	<1	-	*
Total	**34,811**	**521**	**30**	**161,918**	**10,379**	**41**	**10**	**4,023**	**1,289**	**19**	**<1**	**-**	**344**	**174**	**<1**	**2**	**89**	**359**	**9**	**1**

Continued

	Carangidae				Molidae				Lobotidae				Sphyraenidae				Lampridae			
	Seriola, Caranx spp., amberjacks, jacks, crevalles, nei				*Molidae spp., molas, nep*				*Lobotes surinamensis, tripletail*				*Sphyraenidae spp., barracudas*				*Lampris spp., opahs*			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	13	35	<1	-	-	20	<1	-	<1	<1	-	-	-	-	-	-	-	-	-	1
1994	19	6	<1	-	1	3	2	-	<1	-	-	-	<1	34	-	-	-	-	-	23
1995	17	19	-	-	2	4	<1	-	<1	<1	-	-	<1	3	-	-	-	-	-	33
1996	29	153	-	-	5	6	<1	-	<1	-	-	-	<1	<1	-	-	-	-	-	33
1997	68	16	3	-	5	4	3	-	1	<1	<1	-	<1	<1	-	-	-	-	-	40
1998	72	7	<1	-	2	2	1	-	16	<1	-	-	<1	<1	-	-	-	-	-	54
1999	52	46	-	-	2	5	1	-	8	<1	-	-	-	-	-	-	-	-	-	68
2000	29	19	<1	4	2	4	1	-	4	<1	-	-	<1	-	<1	-	-	-	-	88
2001	70	<1	<1	18	6	2	1	-	<1	-	-	-	<1	<1	-	-	-	-	-	73
2002	26	9	<1	15	6	2	1	-	3	-	-	-	<1	-	-	-	-	-	-	6
2003	43	<1	<1	54	<1	4	<1	-	3	<1	-	-	<1	-	-	-	-	-	-	132
2004	8	7	<1	-	6	<1	1	-	1	<1	-	-	<1	-	-	-	-	-	-	139
2005	1	<1	-	-	2	9	2	-	7	<1	<1	-	<1	-	<1	-	-	-	-	159
2006	29	-	-	-	26	14	2	-	9	<1	<1	-	<1	-	-	-	-	-	-	109
2007	2	2	-	6	9	8	2	-	3	<1	<1	-	<1	1	-	-	-	-	-	370
2008	4	-	-	5	9	6	4	-	2	<1	-	-	<1	-	<1	-	-	-	-	308
2009	3	<1	<1	10	6	5	1	-	7	<1	<1	-	1	<1	-	-	-	-	-	488
2010	<1	4	-	8	9	44	1	-	<1	-	-	-	<1	-	<1	-	-	<1	-	539
2011	<1	4	-	7	4	113	<1	-	3	<1	-	-	<1	2	<1	8	-	-	-	539
2012	7	1	-	1	9	12	<1	-	3	<1	-	-	<1	<1	-	-	-	<1	-	425
2013	2	<1	-	<1	9	28	2	-	2	-	<1	-	<1	-	<1	-	-	<1	-	648
2014	2	2	-	11	3	9	1	-	2	-	<1	-	<1	<1	-	-	-	<1	-	818
2015	2	-	<1	11	6	12	1	87	2	<1	-	-	<1	-	-	-	-	-	-	1,057
2016	7	5	<1	11	10	7	<1	275	2	-	-	-	<1	<1	-	-	-	-	-	741
2017	4	4	-	-	8	4	<1	<1	5	-	<1	-	<1	-	-	-	-	-	-	826
2018	2	-	-	-	5	2	<1	-	3	<1	-	-	<1	<1	-	-	-	-	-	1,024
2019	3	<1	-	*	2	6	<1	*	2	-	<1	*	<1	-	-	*	-	-	<1	*
Total	**516**	**339**	**5**	**162**	**156**	**334**	**34**	**362**	**91**	**<1**	**<1**	**-**	**9**	**41**	**<1**	**8**	**-**	**<1**	**<1**	**8,740**

Continued

	Gempylidae				Bramidae															
	Gempylidae *spp., snake mackerels, nei*				Bramidae *spp., pomfrets, nei*				Other large fishes				Unidentified fishes				All fishes			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	-	-	-	-	-	-	-	<1	3	<1	<1	-	<1	-	<1	183	887	79	1	203
1994	-	-	-	-	-	-	-	2	3	87	<1	-	<1	<1	12	250	1,731	152	16	321
1995	-	-	-	-	-	-	-	2	<1	3	<1	-	3	1	<1	209	1,485	53	4	285
1996	-	-	-	-	-	-	-	2	3	125	<1	-	3	<1	<1	456	1,655	306	1	535
1997	-	-	-	-	-	-	-	6	7	5	<1	-	7	2	-	847	1,850	44	7	7,760
1998	-	-	-	-	-	-	-	9	13	10	<1	-	7	<1	<1	1,338	1,420	38	7	3,931
1999	-	-	-	-	-	-	-	3	4	54	<1	-	22	4	<1	974	1,599	114	2	7,330
2000	-	-	-	-	-	-	-	4	1	1	-	-	1	<1	<1	1,485	1,804	82	4	5,119
2001	-	-	-	-	-	-	-	5	2	9	<1	-	3	<1	<1	1,720	3,398	30	4	17,763
2002	-	-	-	-	-	-	-	<1	2	<1	<1	-	2	6	<1	1,895	2,521	27	2	11,399
2003	-	-	-	-	-	-	-	-	4	<1	-	-	2	2	-	4,386	1,484	19	2	10,037
2004	-	-	-	-	-	-	-	-	4	<1	<1	-	10	<1	<1	377	1,548	35	3	4,658
2005	-	-	-	-	-	-	-	18	<1	<1	<1	-	3	<1	<1	303	1,501	89	3	4,489
2006	-	-	-	18	-	<1	-	17	<1	<1	<1	7	3	<1	<1	285	1,824	302	3	4,011
2007	-	-	-	65	-	-	-	57	1	<1	<1	5	1	5	<1	1,763	1,849	158	4	9,394
2008	-	-	-	144	-	-	-	68	1	<1	<1	-	<1	<1	<1	793	1,462	44	6	17,375
2009	-	-	-	412	-	-	-	56	1	<1	<1	67	2	-	<1	1,077	2,343	21	2	19,581
2010	-	-	-	575	-	-	-	64	<1	-	<1	-	<1	<1	-	879	1,318	122	2	11,833
2011	-	-	-	506	-	<1	-	50	<1	<1	-	15	<1	-	<1	612	1,621	175	-	14,418
2012	-	-	-	661	-	-	-	61	<1	2	<1	23	1	<1	-	1,293	2,065	57	1	19,949
2013	-	-	-	574	-	-	-	134	<1	<1	<1	36	<1	<1	-	1,112	2,016	40	3	14,045
2014	-	-	-	431	-	-	-	138	<1	<1	-	77	<1	-	-	1,013	2,327	25	2	6,114
2015	-	-	-	322	<1	-	-	172	<1	<1	-	7	2	<1	-	1,367	1,568	30	2	4,516
2016	<1	-	-	730	-	-	-	108	<1	<1	<1	100	<1	1	-	506	1,328	23	9	3,238
2017	-	-	-	258	-	-	-	126	<1	<1	-	62	1	-	-	1,532	1,944	36	1	4,926
2018	-	-	-	227	-	-	-	125	<1	-	-	<1	-	-	-	222	1,816	9	6	5,411
2019	-	-	-	*	-	-	-	*	<1	-	-	*	<1	<1	<1	*	1,455	41	1	*
Total	**<1**	**-**	**-**	**4,924**	**<1**	**<1**	**-**	**1,226**	**56**	**298**	**1**	**400**	**75**	**24**	**13**	**26,877**	**47,816**	**2,151**	**100**	**208,643**

Table L-6. Estimated purse-seine catches by set type in metric tons (t) of small forage fishes for size-class 6 vessels with a carrying capacity >363 t (1993–2019) and minimum reported longline (LL) catches of small forage fishes (gross-annual removals in t) (1993–2018, *data not available). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2019 are considered preliminary. “Epipelagic forage fishes” include various mackerels and scad (*Decapterus* spp., *Trachurus* spp., *Selar crumenophthalmus*), Pacific saury (*Cololabis saira*), and tropical two-wing flyingish (*Exocoetus volitans*). “Other small fishes” include various Tetraodontiformes, driftfishes (Nomeidae), Pacific chub mackerel (*Scomber japonicus*), Pacific tripletail (*Lobotes pacificus*), remoras (Echeneidae), longfin batfish (*Platax teira*), and small fishes not elsewhere identified (nei).

Tabla L-6. Capturas cerqueras estimadas de peces forrajeros pequeños, por tipo de lance, en toneladas (t) para buques de clase 6 con una capacidad de acarreo >363 t (1993–2019) y capturas palangreras (LL) mínimas reportadas de peces forrajeros pequeños (extracciones anuales brutas en t) (1993-2018, *datos no disponibles). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las especies en negritas se discuten en el texto principal. Los datos de 2019 se consideran preliminares. “Peces epipelágicos de forraje” incluyen varias caballas y jureles (*Decapterus* spp., *Trachurus* spp., *Selar crumenophthalmus*), paparda del Pacífico (*Cololabis saira*), y volador tropical (*Exocoetus volitans*). “Otros peces pequeños” incluyen varios Tetraodontiformes, derivantes (Nomeidae), estornino del Pacífico (*Scomber japonicus*), dormilona del Pacífico (*Lobotes pacificus*), remoras (Echeneidae), pez murciélago teira (*Platax teira*), y peces pequeños (nep) no identificados en otra parte.

	***Auxis* spp., bullet and frigate tunas**				**Balistidae, Monacanthidae spp., triggerfishes and filefishes**				**Kyphosidae, sea chubs**				**Epipelagic forage fishes**				**Small Carangidae spp., carangids, nei**				**Other small fishes**			
	Purse seine				**Purse seine**				**Purse seine**				**Purse seine**				**Purse seine**				**Purse seine**			
Year	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**	**OBJ**	**NOA**	**DEL**	**LL**
1993	1,832	142	2	-	261	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	182	3	4	-
1994	294	200	2	-	114	<1	<1	-	<1	-	-	-	-	-	-	-	<1	-	-	-	53	15	2	-
1995	501	119	6	-	208	4	<1	-	<1	-	-	-	-	-	-	-	<1	-	-	-	319	4	4	-
1996	761	234	33	-	113	2	<1	-	<1	-	-	-	-	-	-	-	-	<1	-	-	55	8	25	-
1997	2,734	623	25	-	219	<1	<1	-	<1	<1	-	-	-	-	-	-	<1	-	-	-	151	12	2	-
1998	1,033	168	32	-	801	2	1	-	2	-	-	-	<1	-	-	-	<1	-	-	-	91	15	3	-
1999	2,589	473	29	-	551	3	<1	-	<1	-	-	-	<1	-	-	-	<1	<1	-	-	85	3	2	-
2000	1,210	181	19	-	168	<1	9	-	<1	-	-	-	-	-	-	-	<1	-	-	-	68	8	6	-
2001	641	38	-	-	426	1	-	-	<1	-	-	-	-	-	-	-	<1	-	-	-	27	2	<1	-
2002	1,382	234	248	-	453	<1	-	-	8	<1	<1	-	-	-	-	-	<1	-	-	-	25	3	<1	-
2003	944	278	16	-	157	4	<1	-	23	<1	<1	-	<1	-	-	-	<1	-	-	-	75	1	1	-
2004	834	115	24	-	914	7	2	-	79	<1	<1	-	<1	<1	-	-	<1	<1	-	-	22	1	<1	-
2005	1,606	309	6	-	129	<1	<1	-	12	<1	<1	-	6	<1	<1	-	2	<1	<1	-	<1	9	<1	-
2006	1,300	591	19	-	145	<1	<1	-	68	<1	<1	-	7	1	-	-	2	<1	<1	-	5	1	<1	-
2007	868	336	18	-	544	1	<1	-	47	<1	-	-	2	5	-	-	<1	<1	<1	-	4	<1	<1	-
2008	759	619	2	-	276	7	2	-	16	-	<1	-	3	<1	-	-	10	<1	-	-	2	<1	<1	-
2009	303	165	1	-	174	1	<1	-	48	<1	-	-	<1	<1	-	-	<1	<1	<1	-	1	<1	<1	-
2010	474	234	<1	-	69	<1	<1	-	39	-	-	-	4	<1	<1	-	1	<1	-	-	<1	-	<1	-
2011	677	97	11	-	31	<1	-	-	18	-	<1	-	2	<1	<1	-	<1	<1	-	-	<1	<1	<1	-
2012	173	179	1	-	110	<1	-	-	16	-	-	-	13	12	-	-	<1	<1	-	-	4	2	<1	-
2013	385	77	-	-	228	<1	<1	-	5	-	<1	-	4	-	<1	-	<1	4	<1	-	2	<1	1	-
2014	297	30	<1	-	325	<1	<1	-	8	-	-	-	3	<1	<1	-	<1	<1	-	-	1	<1	<1	-
2015	177	64	-	-	140	4	<1	-	8	-	-	-	6	-	-	-	<1	<1	-	-	1	<1	<1	-
2016	189	23	<1	-	416	2	<1	-	10	-	-	-	21	-	<1	<1	<1	<1	-	-	3	1	<1	77
2017	131	172	-	-	83	<1	-	-	7	<1	<1	-	3	-	-	-	<1	<1	-	-	<1	<1	-	-
2018	276	172	-	-	54	<1	<1	-	<1	-	-	-	5	<1	-	-	<1	-	-	-	<1	<1	<1	-
2019	182	94	<1	-	57	<1	<1	-	<1	<1	-	-	5	8	<1	-	<1	<1	-	-	<1	5	-	-
Total	**22,552**	**5,967**	**495**	**-**	**7,164**	**46**	**15**	**-**	**416**	**<1**	**<1**	**-**	**84**	**28**	**1**	**<1**	**21**	**6**	**<1**	**-**	**1,182**	**96**	**52**	**77**