THE TUNA FISHERY IN THE EASTERN PACIFIC OCEAN IN 2022

This report provides a summary of the catches and effort in 2022 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 2023; therefore, some of the data for 2021 and 2022 are incomplete, and all data for 2020, 2021 and 2022 should be considered preliminary. Any changes in the fishery statistics provided in this report for the years prior to 2020 are due to data updates reported by CPCs.

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.)
MLS	Striped marlin (*Kajikia audax*)
PBF	Pacific bluefin tuna (*Thunnus orientalis*)
SFA	Indo-Pacific sailfish (*Istiophorus platypterus)*
SKJ	Skipjack tuna (*Katsuwonus pelamis*)
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

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[1] Used to group known gear types

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
MHL	Marshall 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

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 2022. 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. In addition to the tunas, this document covers the billfishes (swordfish, marlins, shortbill spearfish, and sailfish).

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. Information on these other species such as carangids (yellowtail, rainbow runner, and jack mackerel), dorado, elasmobranchs (sharks, rays, and skates), among others, is provided in Document SAC-14-11, *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). The results of the pilot study will offer guidance in the development of a long-term sampling program in the region.

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 2021 and 2022, and 2019-2021 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

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

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 2021, 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 1993-2022 are shown in Tables A-2a-b.

The catches of tropical tunas during 1993-2022, by flag, are shown in Tables A-3a-e, and the purse-seine catches and landings of tunas during 2021-2022 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 1993-2022 are shown in Table A-1. The 2022 EPO catch of 292 thousand t is 20% higher than the average of 243 thousand t for the previous 5-year period (2017-2021). In the WCPO, the catches of yellowfin reached a record high of 771 thousand t in 2021.

The annual retained catches of yellowfin in the EPO, by gear, during 1993-2022 are shown in Table A-2a. Over the most recent 15-year period (2007-2021), the annual retained purse-seine and pole-and-line catches have fluctuated around an average of 223 thousand t (range: 171 to 253 thousand t). The preliminary estimate of the retained catch in 2022, 292 thousand t, is 15% higher than that of 2021, and 27% higher than the 2017-2021 average. On average, about 0.3% (range: 0.1 to 1.0%) of the total purse-seine catch of yellowfin was discarded at sea during 2007-2021 (Table A-2a).

During 1993-2005, annual longline catches in the EPO averaged about 21 thousand t (range: 12 to 30 thousand t), or about 7% 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 2006-2021. Catches by other fisheries (recreational, gillnet, troll, artisanal, *etc.*), whether incidental or targeted, are shown in Table A-2a, under “Other gears” (OTR); during 2006-2021 they averaged about 2 thousand t.

2.2. Skipjack tuna

The total annual catches of skipjack in the Pacific Ocean during 1993-2022 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 1.1 million t to an all-time high of 2 million t in 2019. In the EPO, the greatest catches occurred between 2003 and 2022, ranging from 153 to 351 thousand t, the record catch in 2019.

The annual retained catches of skipjack in the EPO, by gear, during 1993-2022 are shown in Table A-2a. During 2007-2021 the annual retained purse-seine catch averaged 281 thousand t (range: 147 to 347 thousand t). The preliminary estimate of the retained catch in 2022, 296 thousand t, is 6% greater than the 15-year average for 2007-2021.

Discards of skipjack at sea decreased each year during the period, from 3% in 2007 to a low of less than 1% in 2018, averaging about 1.3% 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 1993-2022 are shown in Table A-1. Overall, the catches in both the EPO and WCPO have increased, but with considerable fluctuations. In the WCPO starting in 1993 the bigeye has been fluctuating between 107 thousand t to 163 thousand t reaching a high of 183 thousand t in 2004. After 2004, the bigeye has fluctuated between 130 and 171 thousand t. In the EPO, the average catch during 1993-2022 was 104 thousand t, with a low of 64 thousand t in 2022 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 1993-2022 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. From 1994 to 1999, the average annual retained purse-seine catch of bigeye in the EPO was 44 thousand t, and than in 2000 was over 95 thousand t. Since the high in 2000, it has fluctuated between 49 and 84 thousand t; the preliminary estimate for 2022 is 47 thousand t.

During 2000-2022 the percentage of the purse-seine catch of bigeye discarded at sea has steadily decreased, from 5% in 2000 to less than 1% from 2017 to the current year, averaging about 1.5%.

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 51%, to 43 thousand t, and the preliminary estimate for 2022 is less than 17 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 1993-2022, by gear, are shown in Table A-2a. Since 2007, the purse-seine vessels accounted for over 89% of the annual catch. The 1993-2021 average EPO retained catch is 3.8 thousand t (range: 600 t to 9.9 thousand t); the preliminary estimate for 2022 is 3.4 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 1993-2022, 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 albacore, black skipjack, bonito, frigate and bullet tunas, contribute to the overall harvest. The estimated annual retained and discarded catches of these species during 1993-2022 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

2022 was 15 thousand t, greater than the 2007-2021 average of 14 thousand t (range: 8 to 23 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 24 thousand t, possibly due to increased abundance of swordfish, increased effort directed toward the species along with improved fishing efficiency, 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 2007-2021 were about 3.0 thousand and 1.8 thousand t, respectively. Smaller amounts of other billfishes are taken by longline.

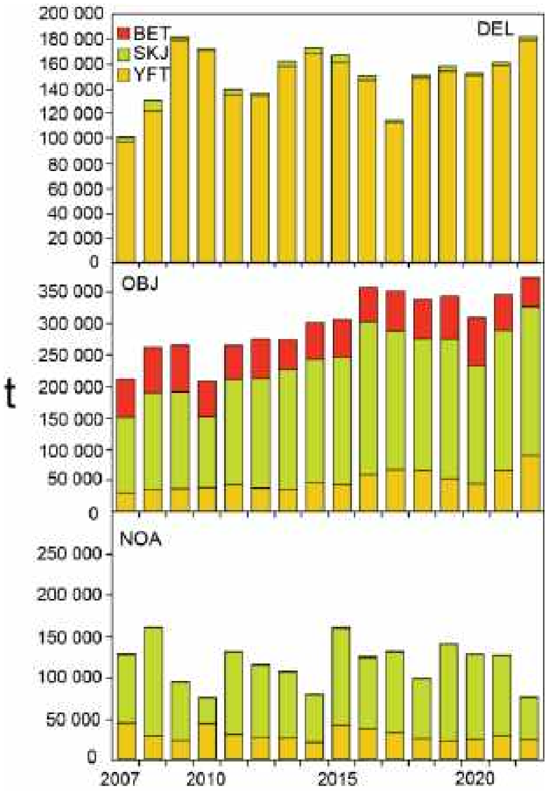

FIGURE 1. Purse-seine catches of tunas, by species and set type, 2007-2022

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 2007-2021 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.

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 2007-2022, 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

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[3] The catch data for 2007-2022 incorporate previously unavailable data, and are thus different from the corresponding data presented in previous publications.

[4] ≤363 t carrying capacity.

predominant in the floating-object fishery, and now account for an estimated 97% 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.

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 2017-2021 are shown in Figures A-1a, A-2a, and A-3a, respectively, and preliminary estimates for 2022 are shown in Figures A-1b, A-2b, and A-3b.

Yellowfin: The majority of catches in 2022 were taken in sets associated with dolphins in two principal areas: north of 5°N from 105°W to 140°W, and inshore north of 5°S from 100°W to the coast. Greater amounts of yellowfin were taken in dolphin and floating-objects sets in both areas when compared to the previous 5 years. (Figure A-1b).

Skipjack catches in 2022 occurred primarily in floating object sets between 5°N and 20°S and west of 100°W. The proportion of skipjack catch in this area from floating object sets increased over the previous 5 years. The amount of skipjack caught in 2022 in unassociated sets on the western edge of the EPO was much less than in the previous 5 years. (Figure A-2b).

Bigeye are not often caught north of about 7°N in the EPO. Almost all of the 2022 catches were taken in sets on FADs between the 10°N and 15°S and west of 90°W (Figure A-3b).

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 2017-2021 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 and Mexico. 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-14-04). In this report, data on the size composition of the catches during 2017-2022 are presented (Figures A-6 to A-8), with two sets of length-frequency histograms for each species: the first shows the data for 2022 by stratum (gear type, set type, and area), and the second the combined data for each year of the 2017-2022 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 937 wells with fish caught during 2022, 824 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 three quarters of the year, with smaller amounts taken in the OBJ fisheries throughout the year. Large yellowfin (100-140 cm) were caught primarily in the DEL-I and DEL-S fishery in the first quarter, in the DEL-N fishery in the second and third quarters and in the NOA-S fishery in the first quarter. Smaller yellowfin (<70 cm) were taken in the OBJ fisheries in all four quarters.

The estimated size compositions of the yellowfin caught by all fisheries combined during 2017-2022 are shown in Figure A-6b. The average weight of yellowfin in 2022, 6.5 kg, was much lower than the 2020 average of 10.5 kg, and lower than the average for other years (7.2-7.9 kg). The size distribution shifted toward the smaller end of the range when compared to previous years, indicating smaller sized yellowfin in 2022.

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 937 wells with fish caught, 602 contained skipjack. The estimated size compositions of the fish caught during 2022 are shown in Figure A-7a. Most of the skipjack catch was taken in the OBJ-N, OBJ-E and OBJ-S fisheries in all four quarters, and in the NOA-S fishery in the first and second quarters. The largest skipjack (60-70 cm) were caught in the OBJ-E fishery in the third and fourth quarters. The smallest (<50 cm) were caught primarily in the OBJ-N, OBJ-E and OBJ-S fisheries in all four quarters, and in the NOA-S fishery in the second quarter.

The estimated size compositions of skipjack caught by all fisheries combined during 2017-2022 are shown in Figure A-7b. The majority of the skipjack in 2022 was in the 40-50 cm range.

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 937 wells with fish caught, 160 contained bigeye. The estimated size compositions of the fish caught during 2022 are shown in Figure A-8a. Most of the bigeye catch was taken in the OBJ-N fishery in the second and third quarters, and in the OBJ-S fishery throughout the year. Lesser amounts were caught in the OBJ-E fishery in the second quarter.

The estimated size compositions of bigeye caught by all fisheries combined during 2017-2022 are shown in Figure A-8b. The average weight of bigeye in 2022 (4.0 kg) was considerably less than any of the previous five years (4.7-5.2 kg). The majority of bigeye caught in 2022 was in the 40-70 cm range, with less of the larger bigeye >100 cm than in previous years.

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. The 2021 purse-seine fishing season continued the trend of starting earlier than any previous year: in 2021, bluefin were first caught in early January, and the fishery was closed in late January, 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 Observer Program (PNAAPD) submitted the length-composition data for purse-seine catches during 2016-2021 (Figure A-9). This data is provided every other year, so the figure will be updated in 2024.

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 2016-2020 are shown in Figures A-10 and A-11. The average annual weight during that period ranged from 36.8 to 61.0 kg for yellowfin, and from 61.7 kg to 66.2 kg for bigeye.

Size composition data for 2021 was not available due to difficulties resulting from the COVID-19 pandemic, which impacted the collection and analysis of 2021 YFT and BET size data.

5.3. Catches of tunas, by flag and gear

The annual retained catches of tunas in the EPO during 1993-2022, by flag and gear, are shown in Tables A-3a-e. The purse-seine catches of tunas in 2021 and 2022, by flag and species, are summarized in Table A-4a. Of the nearly 650 thousand t of tunas caught in 2022, 40% were caught by Ecuadorian vessels, and 22% by Mexican vessels. Other countries with significant catches included Panama (15%), Venezuela (7%), Colombia (6%), United States (4%) and Nicaragua (3%). The purse-seine landings of tunas in 2021 and 2022, by species and country of landing, are summarized in Table A-4b. Of the more than 639 thousand t of tunas landed in the EPO in 2022, 64% were landed in Ecuadorian ports, and 23% in Mexican ports. Other countries with landings of tunas in the EPO included Colombia (5%), Peru (1%) and the United States (1%).

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 2022 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 2021 and preliminary 2022 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 2022, the fleet was dominated by Ecuadorian and Mexican vessels, with about 31% and 24%, respectively, of the total well volume; they were followed by the Panama (11%), United States (11%), Venezuela (9%), Colombia (6%), European Union (Spain) (3%), Nicaragua (3%) and El Savador (2%).[5]

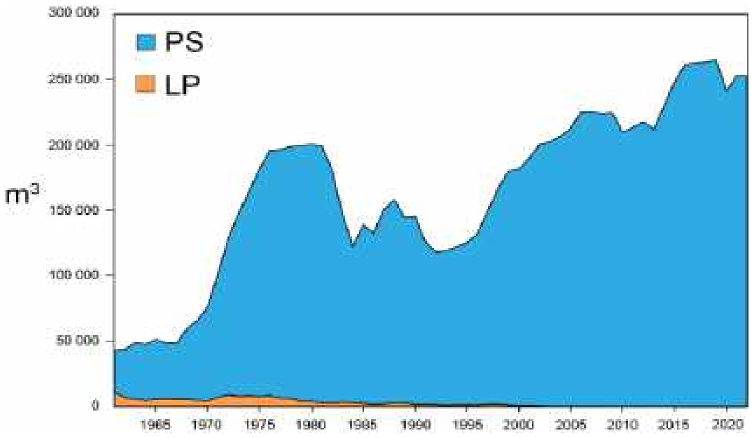

FIGURE 2. Carrying capacity, in cubic meters of well volume, of the purse-seine and pole-and-line fleets in the EPO, 1961-2022

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

The cumulative capacity at sea during 2022 is compared to those of the previous five years in Figure 3.

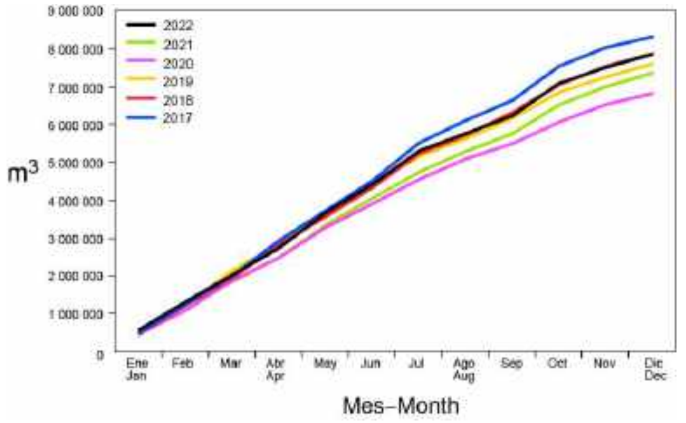

FIGURE 3. Cumulative capacity of the purse-seine and pole-and-line fleet at sea, by month, 2017-2022

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 2012-2021, and the 2022 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 2012-2021 and 2022 were slightly lower 144 thousand m^3 (59% of total capacity) and about 150 thousand m^3 (59% of total capacity), respectively.

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 2022, or ever.

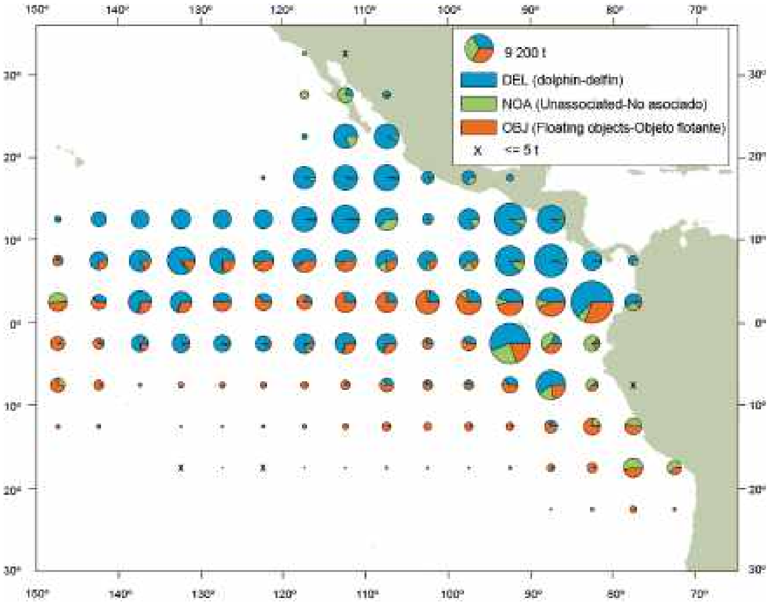

FIGURE A-1a. Average annual distributions of the purse-seine catches of yellowfin, by set type, 2017-2021. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.

FIGURA A-1a. Distribución media anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2017-2021. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

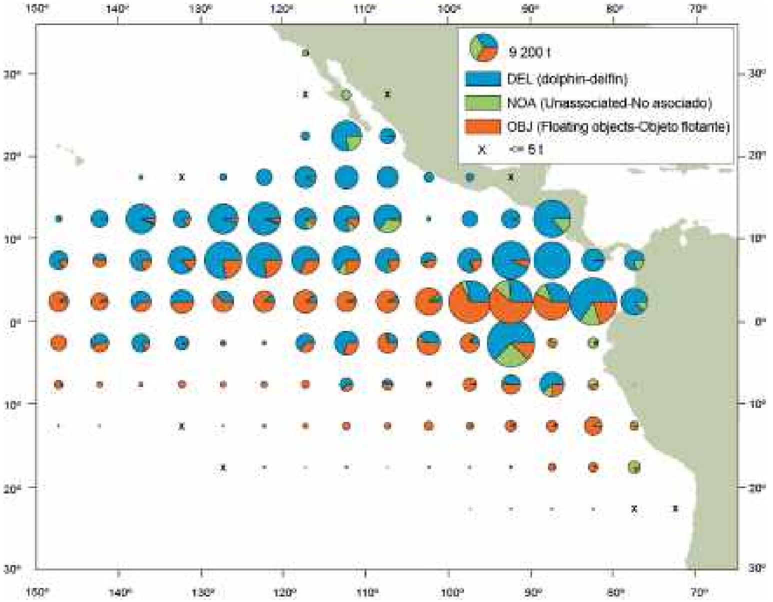

FIGURE A-1b. Annual distributions of the purse-seine catches of yellowfin, by set type, 2022. The sizes of the circles are proportional to the amounts of yellowfin caught in those 5° by 5° areas.

FIGURA A-1b. Distribución anual de las capturas cerqueras de aleta amarilla, por tipo de lance, 2022. El tamaño de cada círculo es proporcional a la cantidad de aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

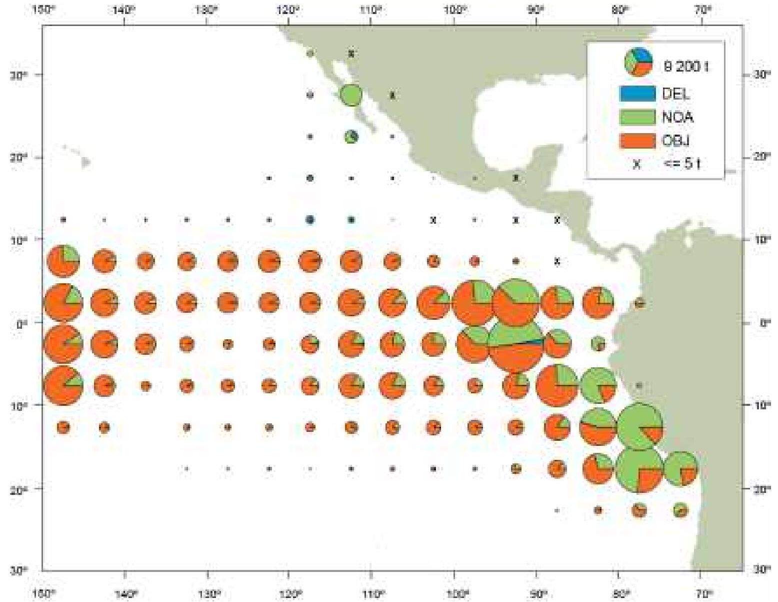

FIGURE A-2a. Average annual distributions of the purse-seine catches of skipjack, by set type, 2017-2021. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.

FIGURA A-2a. Distribución media anual de las capturas cerqueras de barrilete, por tipo de lance, 2017-2021. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

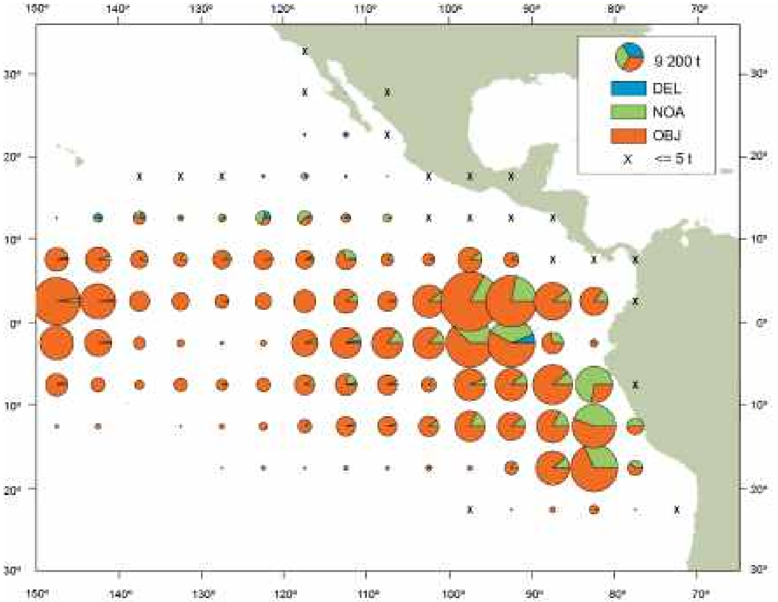

FIGURE A-2b. Annual distributions of the purse-seine catches of skipjack, by set type, 2022. The sizes of the circles are proportional to the amounts of skipjack caught in those 5° by 5° areas.

FIGURA A-2b. Distribución anual de las capturas cerqueras de barrilete, por tipo de lance, 2022. El tamaño de cada círculo es proporcional a la cantidad de barrilete capturado en la cuadrícula de 5° x 5° correspondiente.

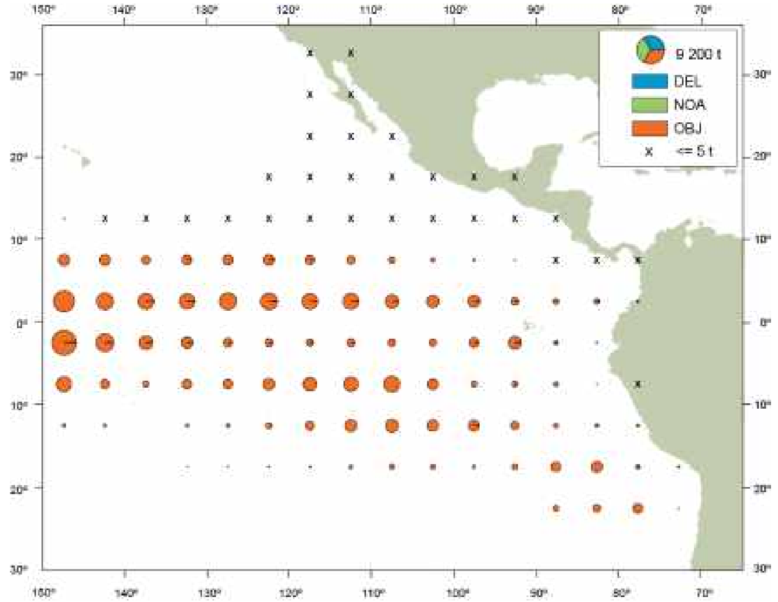

FIGURE A-3a. Average annual distributions of the purse-seine catches of bigeye, by set type, 2017-2021. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.

FIGURA A-3a. Distribución media anual de las capturas cerqueras de patudo, por tipo de lance, 2017-2021. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

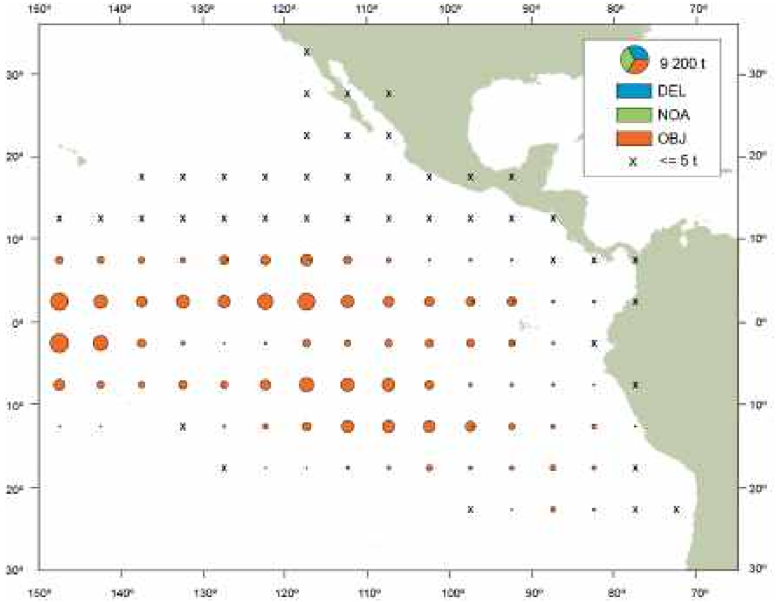

FIGURE A-3b. Annual distributions of the purse-seine catches of bigeye, by set type, 2022. The sizes of the circles are proportional to the amounts of bigeye caught in those 5° by 5° areas.

FIGURA A-3b. Distribución anual de las capturas cerqueras de patudo, por tipo de lance, 2022. El tamaño de cada círculo es proporcional a la cantidad de patudo capturado en la cuadrícula de 5° x 5° correspondiente.

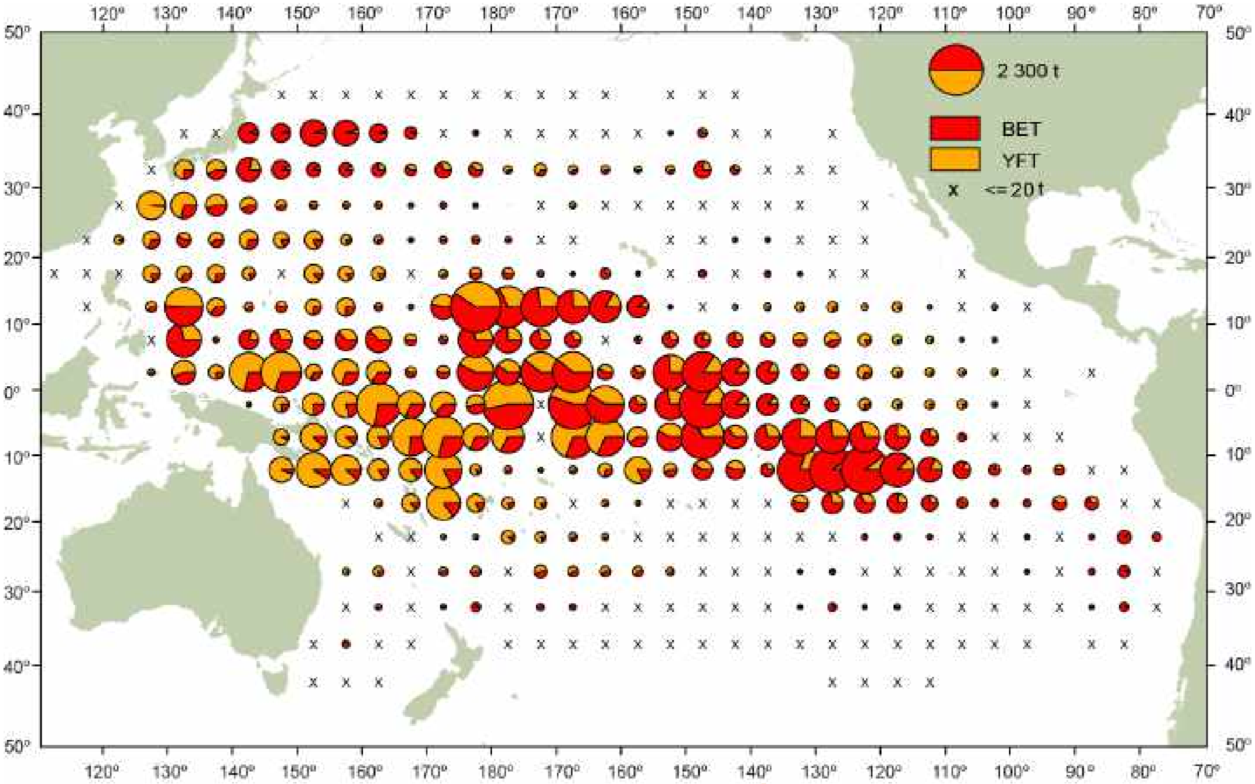

FIGURE A-4. Distributions of the average annual catches of bigeye and yellowfin tunas in the Pacific Ocean, in metric tons, by Chinese, Japanese, Korean, and Chinese Taipei longline vessels, 2017-2021. The sizes of the circles are proportional to the amounts of bigeye and yellowfin caught in those 5° 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, 2017-2021. El tamaño de cada círculo es proporcional a la cantidad de patudo y aleta amarilla capturado en la cuadrícula de 5° x 5° correspondiente.

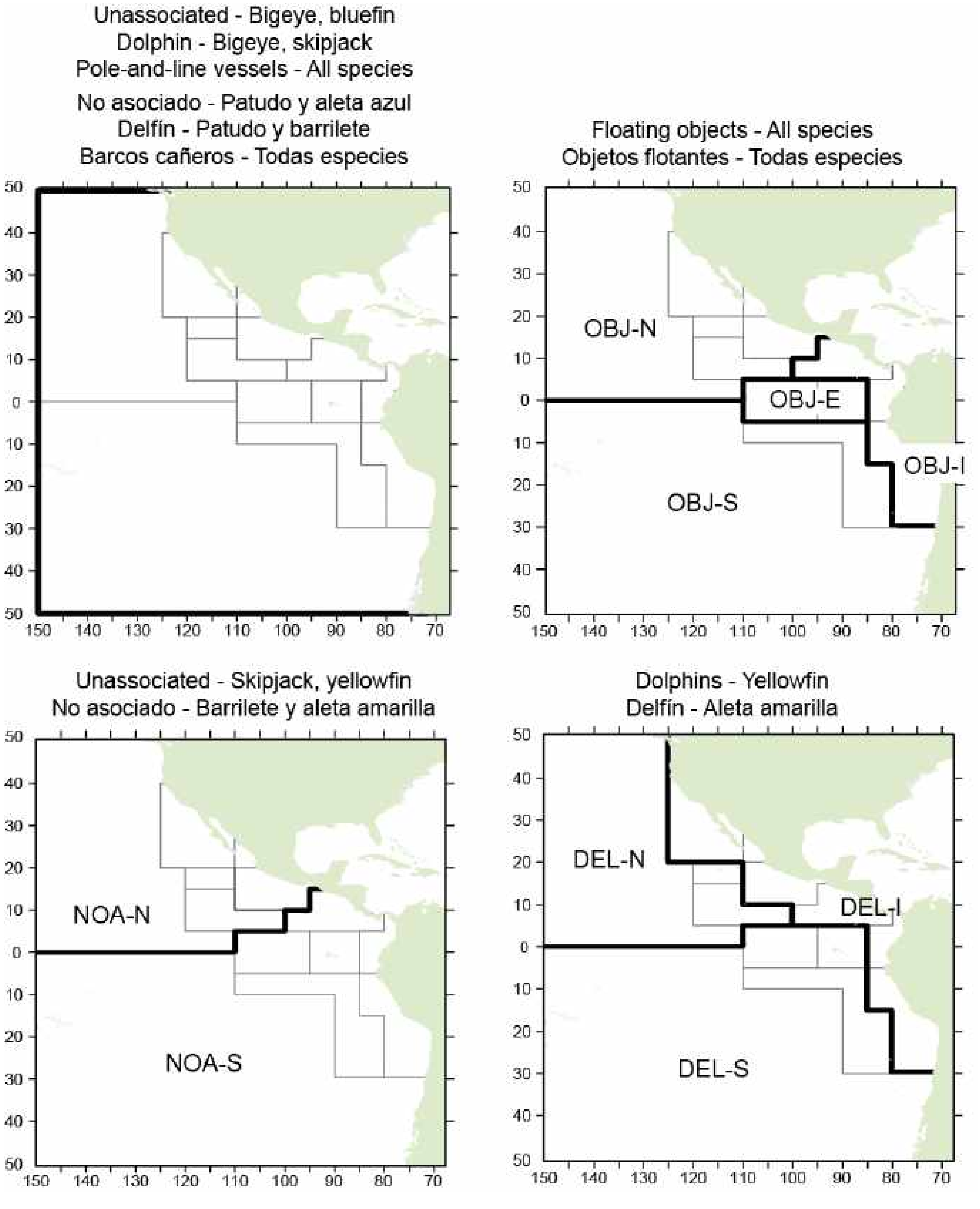

FIGURE A-5. The purse-seine fisheries defined by the IATTC staff for analyses of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries.

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.

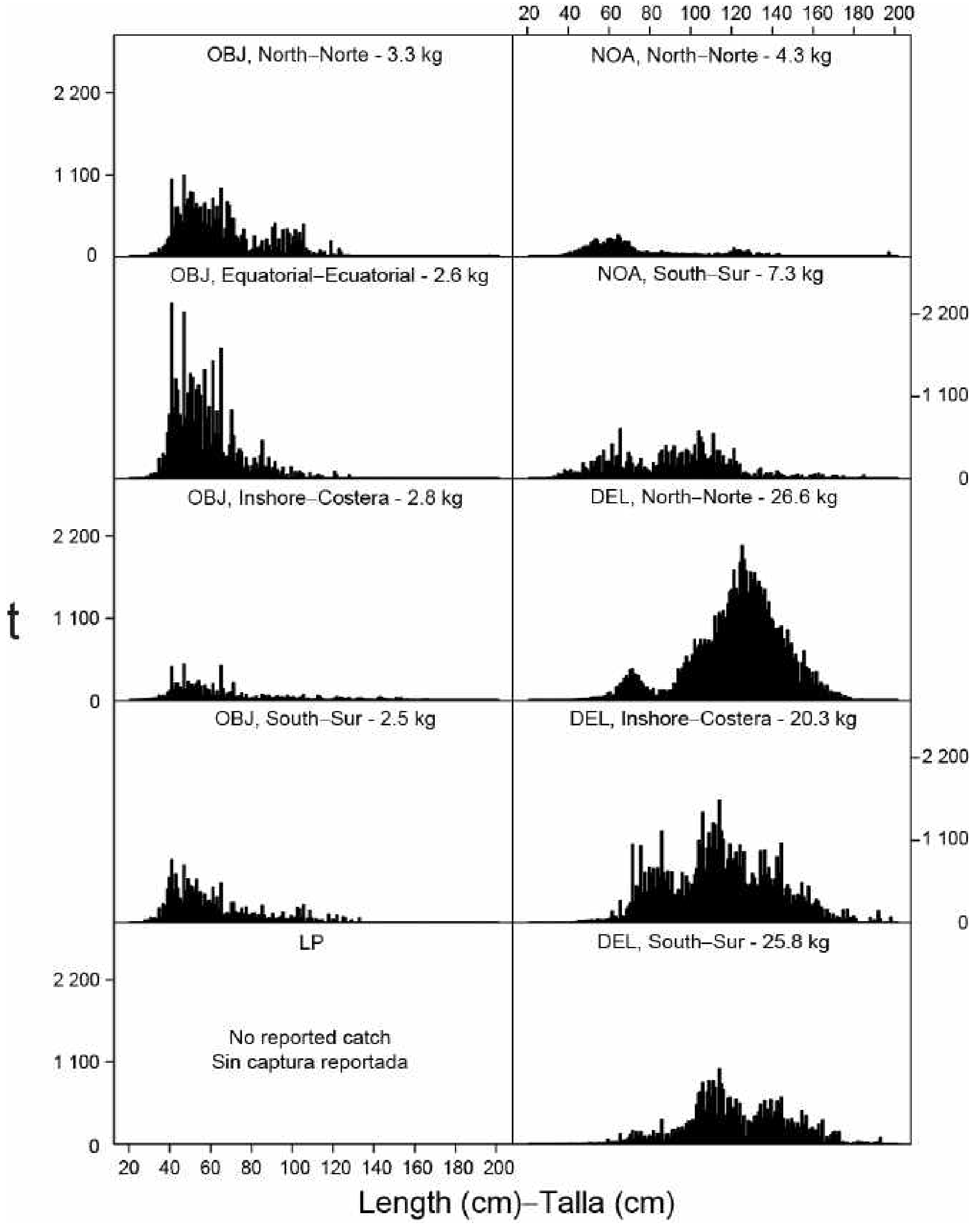

FIGURE A-6a. Estimated size compositions of the yellowfin caught in the EPO during 2022 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.
FIGURA A-6a. Composición por tallas estimada del aleta amarilla capturado en el OPO durante 2022 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

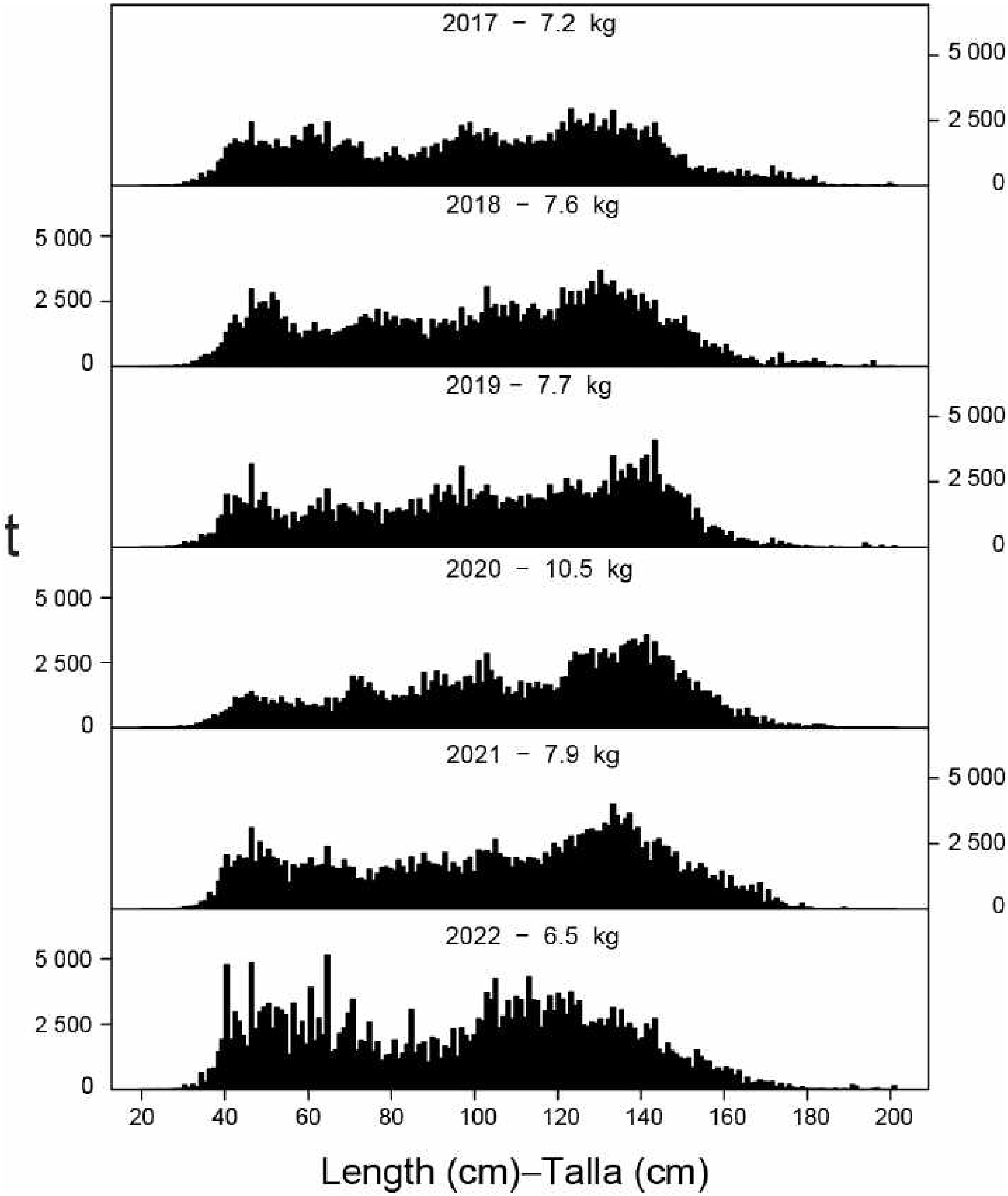

FIGURE A-6b. Estimated size compositions of the yellowfin caught by purse-seine and pole-and-line vessels in the EPO during 2017-2022. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-6b. Composición por tallas estimada del aleta amarilla capturado por buques cerqueros y cañeros en el OPO durante 2017-2022. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

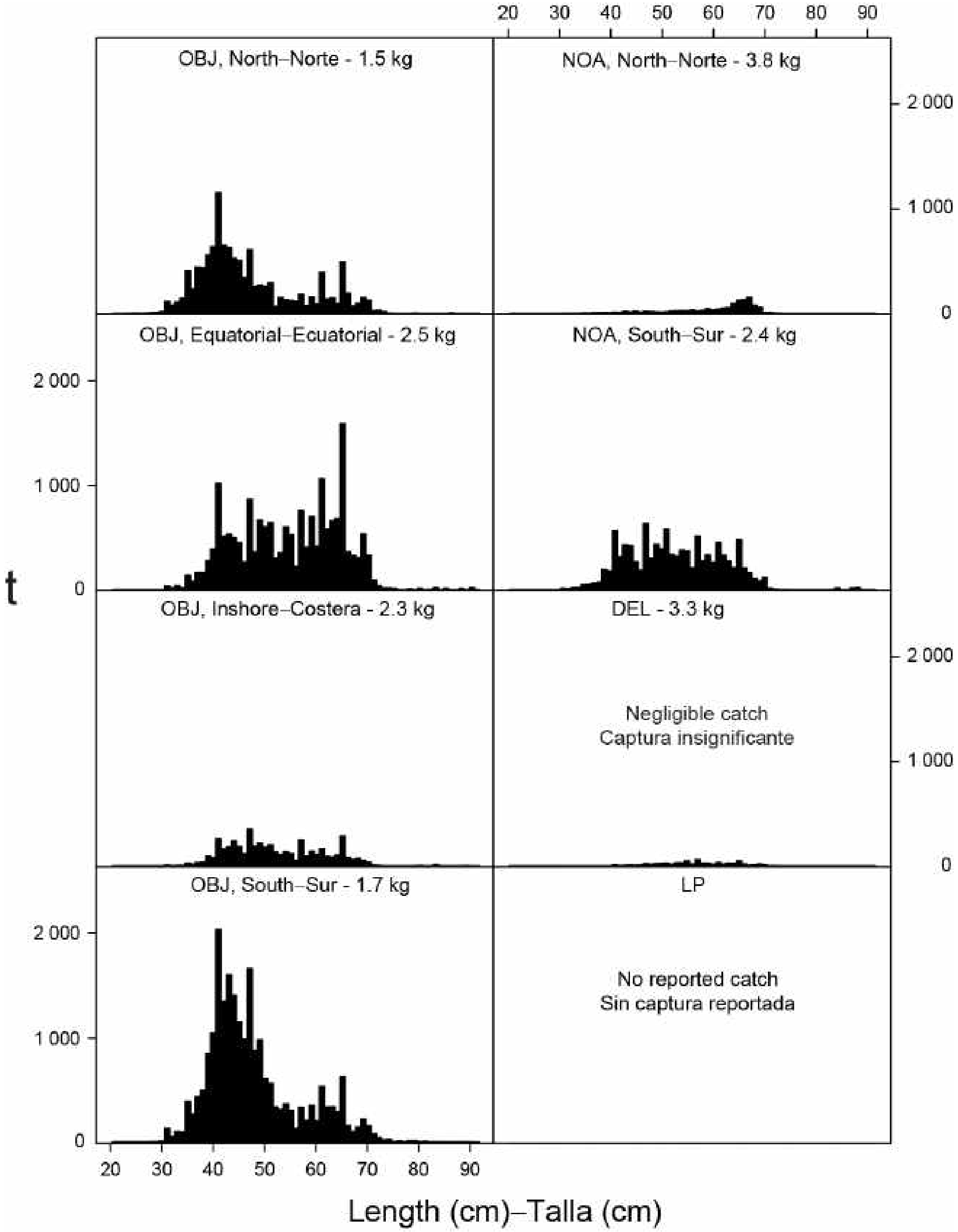

FIGURE A-7a. Estimated size compositions of the skipjack caught in the EPO during 2022 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight of the fish in the samples.
FIGURA A-7a. Composición por tallas estimada del barrilete capturado en el OPO durante 2022 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

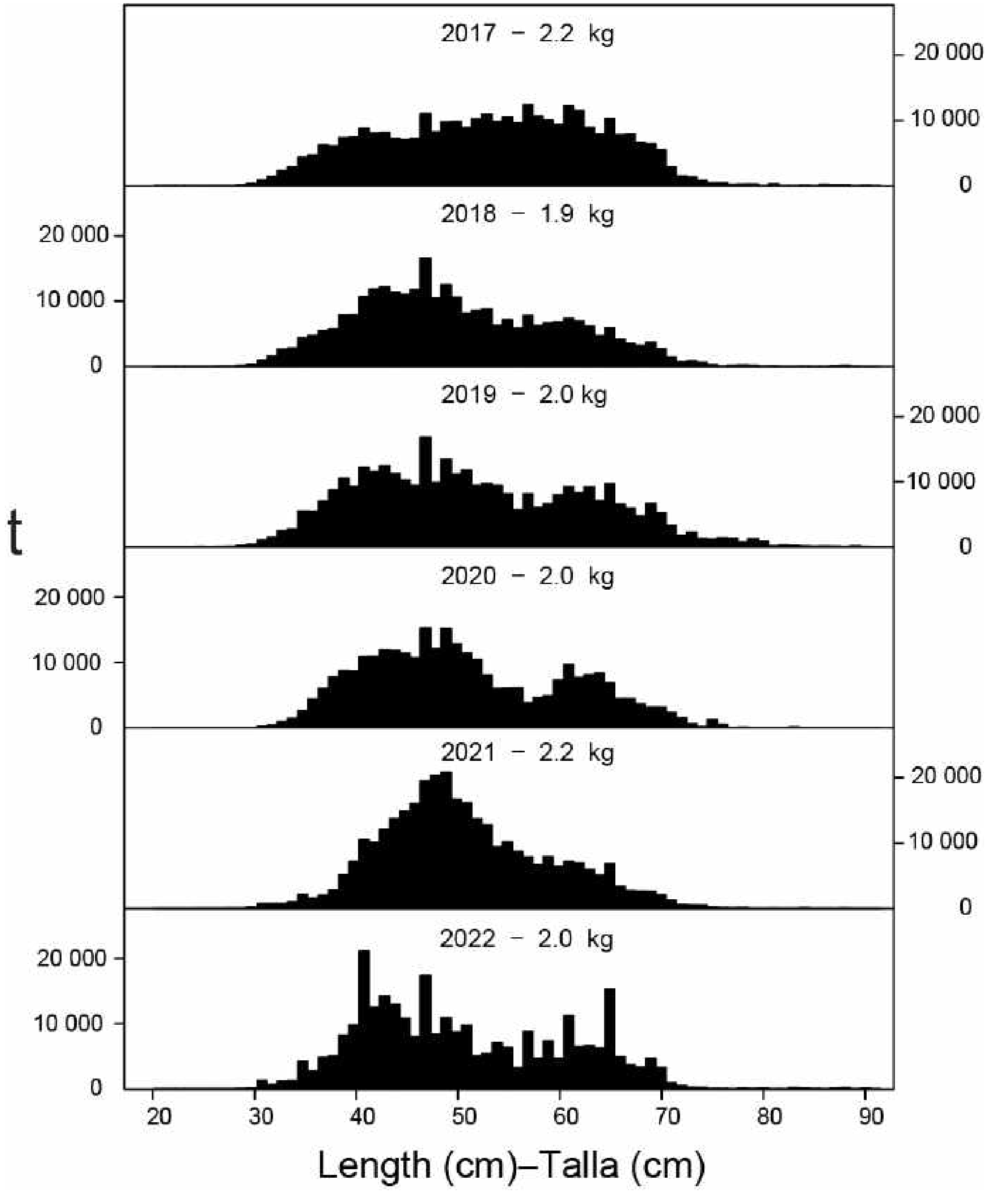

FIGURE A-7b. Estimated size compositions of the skipjack caught by purse-seine and pole-and-line vessels in the EPO during 2017-2022. The value at the top of each panel is the average weight of the fish in the samples.

FIGURA A-7b. Composición por tallas estimada del barrilete capturado por buques cerqueros y cañeros en el OPO durante 2017-2022. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

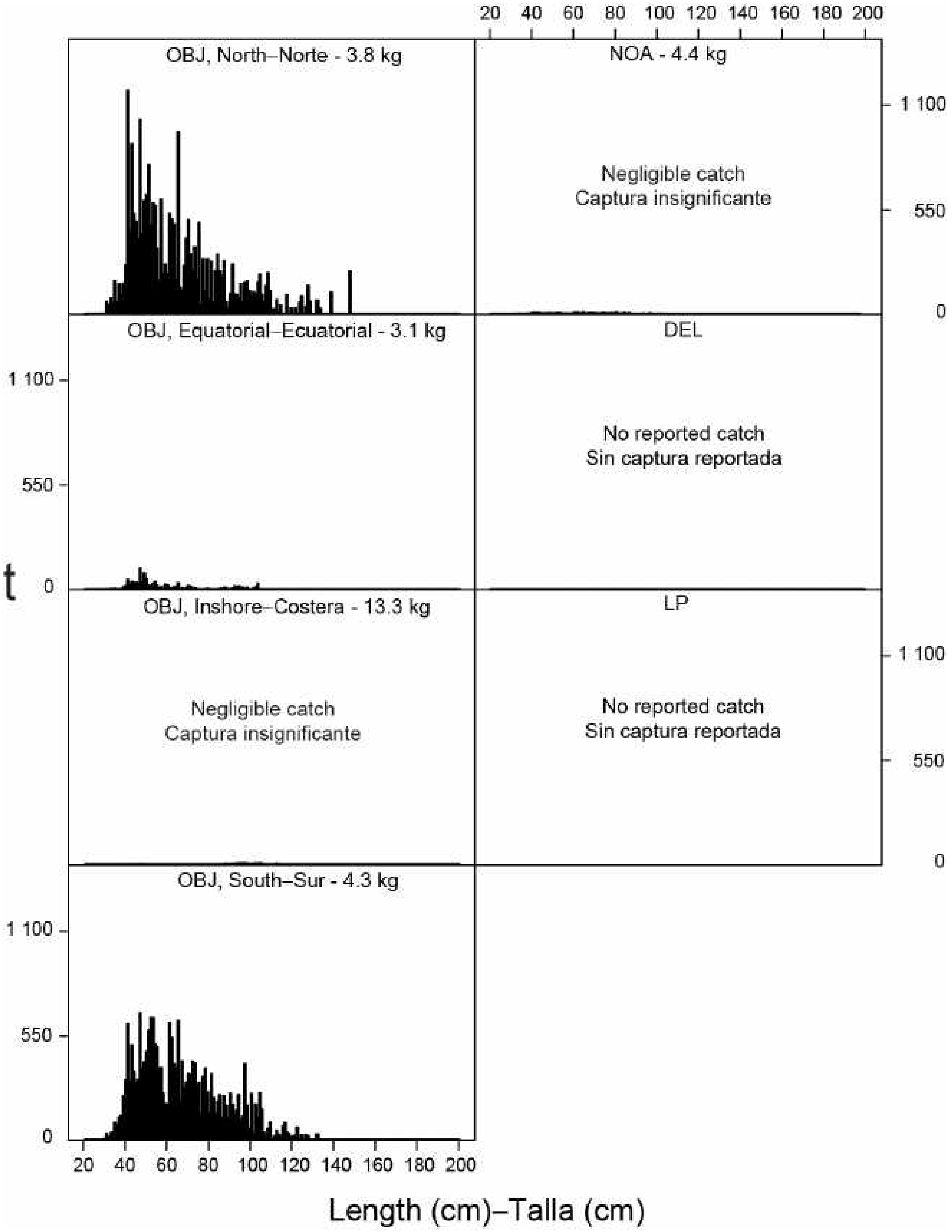

FIGURE A-8a. Estimated size compositions of the bigeye caught in the EPO during 2022 for each fishery designated in Figure A-5. The value at the top of each panel is the average weight.

FIGURA A-8a. Composición por tallas estimada del patudo capturado en el OPO durante 2022 en cada pesquería ilustrada en la Figura A-5. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

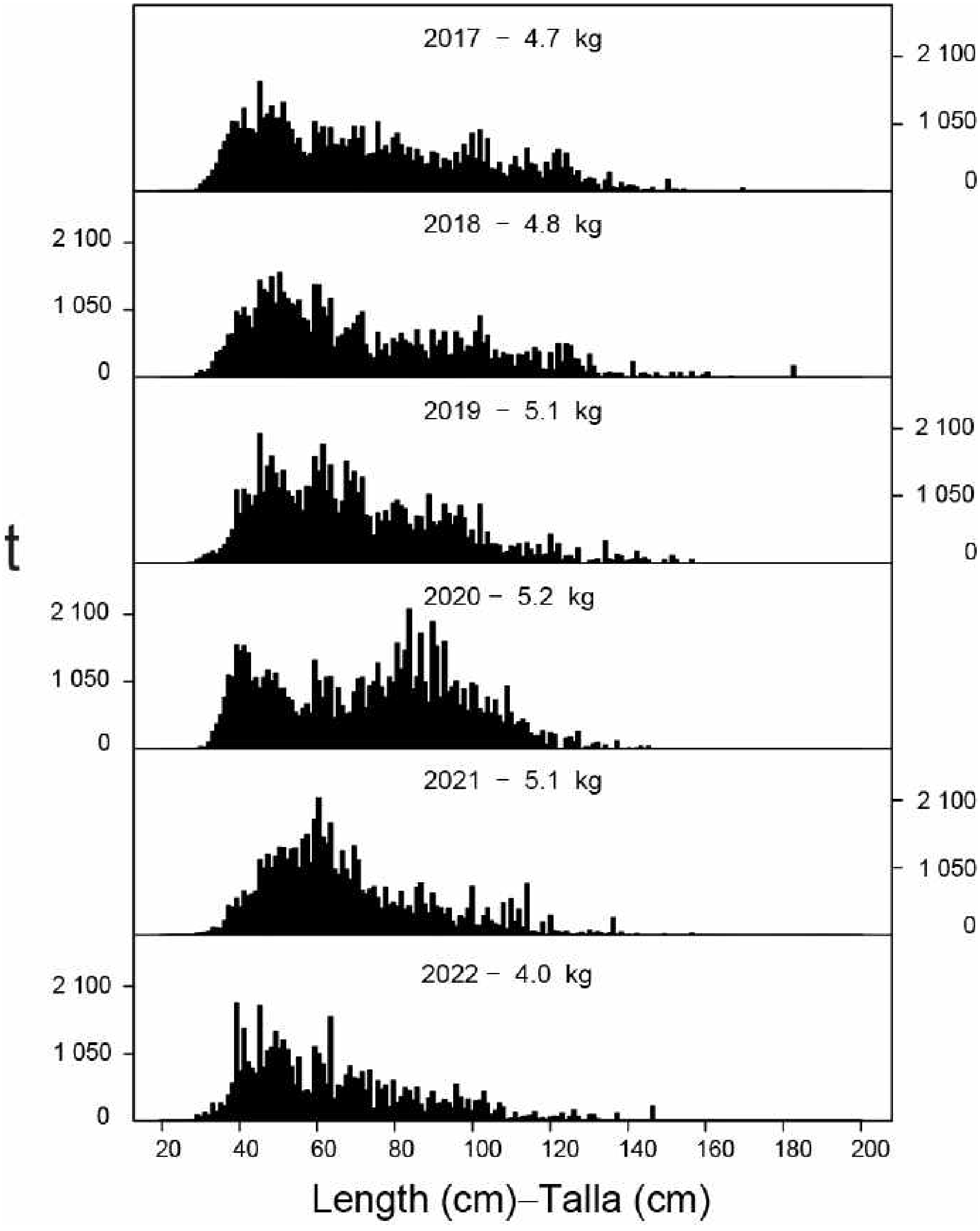

FIGURE A-8b. Estimated size compositions of the bigeye caught by purse-seine vessels in the EPO during 2017-2022. The value at the top of each panel is the average weight.

FIGURA A-8b. Composición por tallas estimada del patudo capturado por buques cerqueros en el OPO durante 2017-2022. El valor en cada recuadro representa el peso promedio del pescado en las muestras.

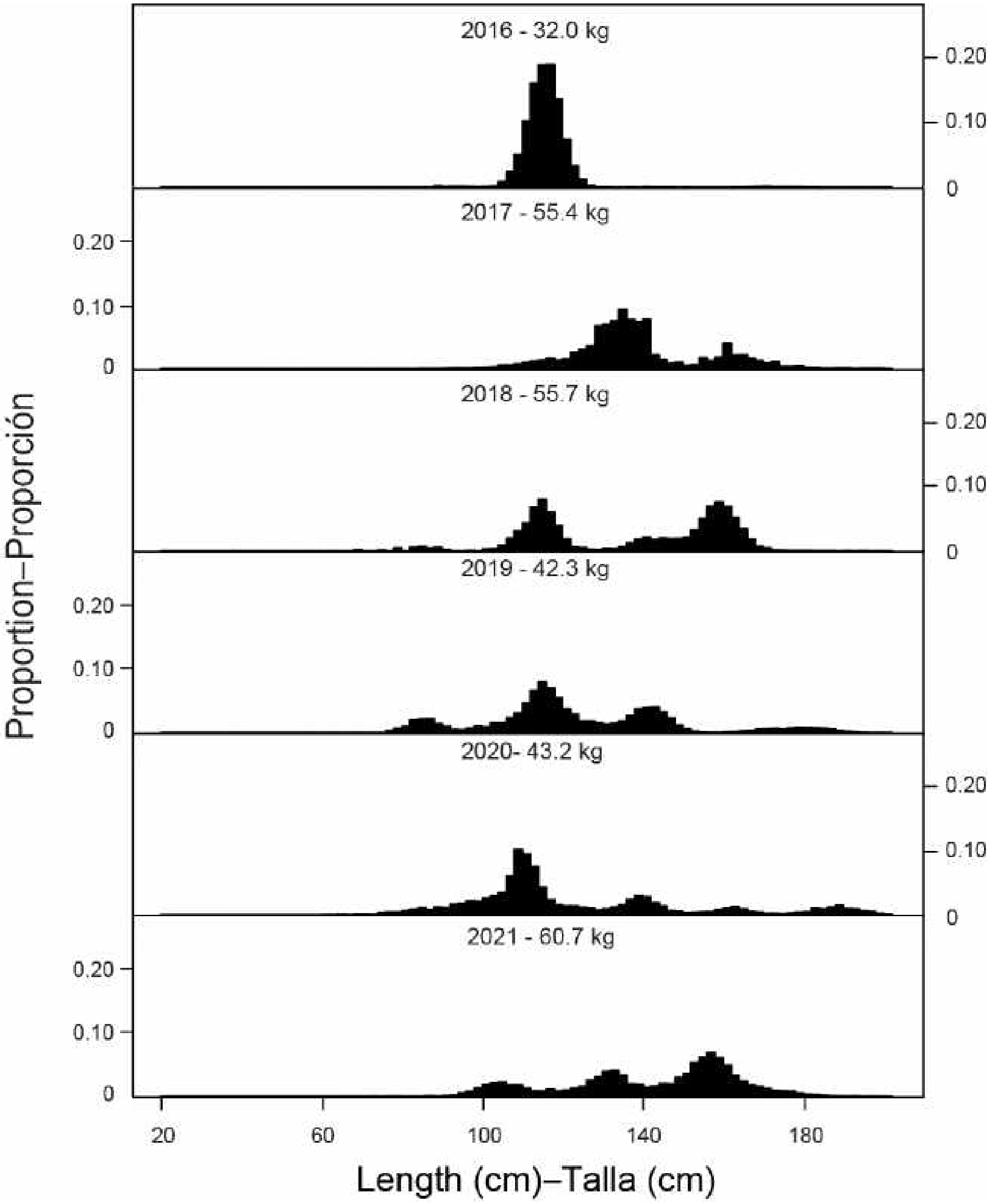

FIGURE A-9. Estimated length compositions of purse-seine catches of Pacific bluefin tuna, 2016-2021. The length distribution has been standardized as a proportion of the total number of measured tuna in each length interval. The value at the top of each panel is the average weight.
Source: Mexico's National Observer Program (PNAAPD).

FIGURA A-9. Composición por talla estimada de las capturas cerqueras de atún aleta azul del Pacífico, 2016-2021. 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: Programa Nacional de Observadores de México (PNAAPD).

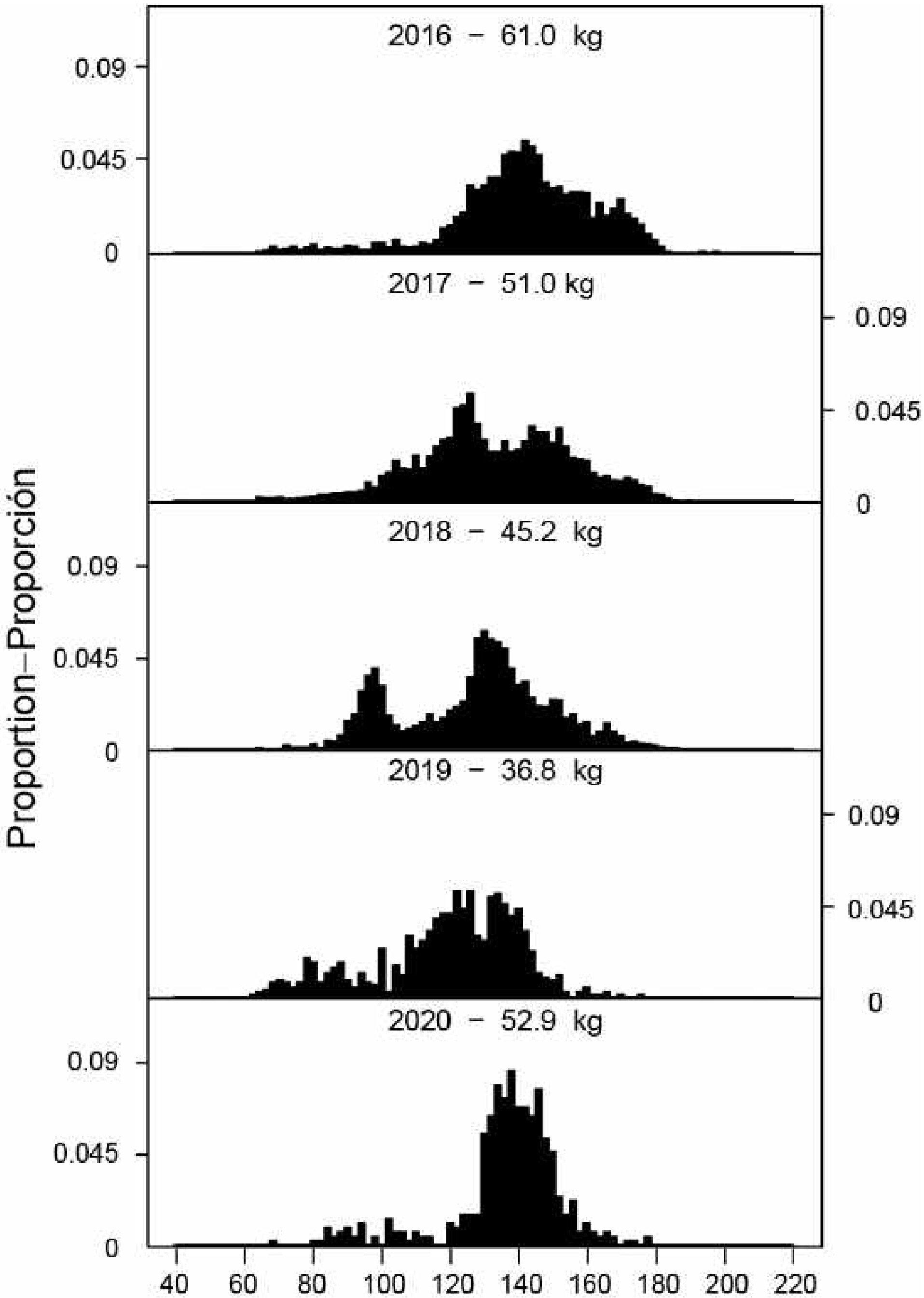

FIGURE A-10. Estimated size compositions of the catches of yellowfin by the Japanese longline fleet in the EPO, 2016-2020. The size distribution has been standardized as a proportion of the total number of measured tuna in each size range. The value at the top of each panel is the average weight. Source: 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, 2016-2020. 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.

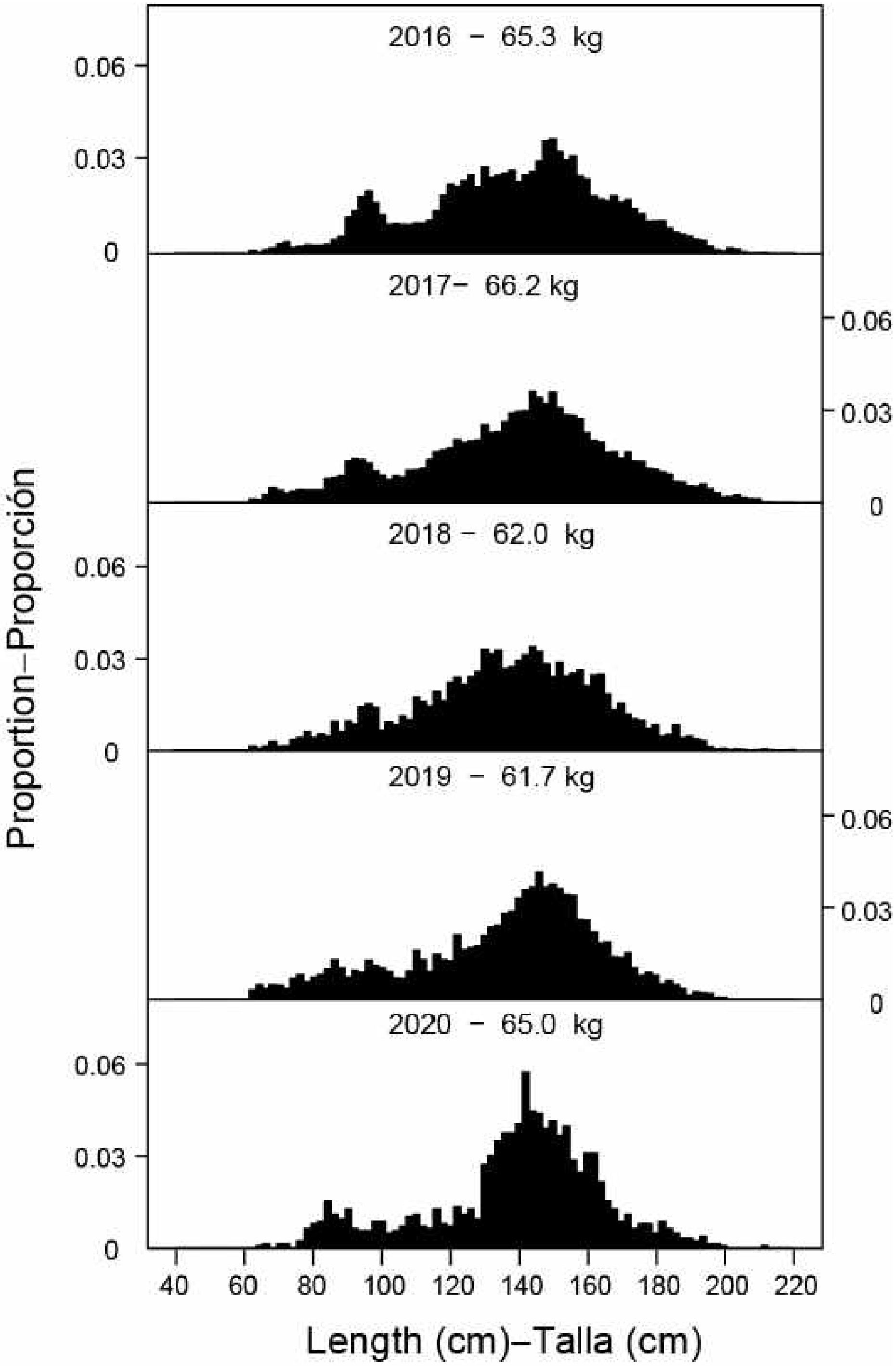

FIGURE A-11. Estimated size compositions of the catches of bigeye by the Japanese longline fleet in the EPO, 2016-2020. The size distribution has been standardized as a proportion of the total number of measured tuna in each size range. The value at the top of each panel is the average weight. Source: Fisheries Agency of Japan

FIGURA A-11. Composición por tallas estimada de las capturas de patudo por la flota palangrera japonesa en el OPO, 2016-2020. 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 1993-2022 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 1993-2022 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**
1993	256,199	418,101	674,300	100,434	864,455	964,889	82,843	113,424	196,267	439,476	1,395,980	1,835,456
1994	248,071	449,221	697,292	84,661	939,508	1,024,169	109,331	124,623	233,954	442,063	1,513,352	1,955,415
1995	244,639	442,815	687,454	150,661	977,478	1,128,139	108,210	110,376	218,586	503,510	1,530,669	2,034,179
1996	266,928	425,705	692,633	132,335	1,003,205	1,135,540	114,706	107,153	221,859	513,969	1,536,063	2,050,032
1997	277,575	481,125	758,700	188,285	942,932	1,131,217	122,274	133,740	256,014	588,134	1,557,797	2,145,931
1998	280,606	536,853	817,459	165,489	1,247,087	1,412,576	93,954	152,607	246,561	540,049	1,936,547	2,476,596
1999	304,638	475,159	779,797	291,249	1,072,899	1,364,148	93,078	163,186	256,264	688,965	1,711,244	2,400,209
2000	286,863	506,965	793,828	230,479	1,198,149	1,428,628	148,557	149,248	297,805	665,899	1,854,362	2,520,261
2001	425,008	505,659	930,667	157,676	1,104,553	1,262,229	130,546	135,601	266,147	713,230	1,745,813	2,459,043
2002	443,458	491,890	935,348	167,048	1,256,174	1,423,222	132,806	158,936	291,742	743,312	1,907,000	2,650,312
2003	415,933	565,533	981,466	300,470	1,247,718	1,548,188	115,175	143,931	259,106	831,578	1,957,182	2,788,760
2004	296,847	598,099	894,946	217,249	1,357,330	1,574,579	110,722	182,945	293,667	624,818	2,138,374	2,763,192
2005	286,492	553,254	839,746	283,453	1,418,129	1,701,582	110,514	155,709	266,223	680,459	2,127,092	2,807,551
2006	180,519	539,773	720,292	309,090	1,479,386	1,788,476	117,328	165,069	282,397	606,937	2,184,228	2,791,165
2007	182,141	567,047	749,188	216,324	1,663,349	1,879,673	94,260	165,153	259,413	492,725	2,395,549	2,888,274
2008	197,328	644,427	841,755	307,699	1,649,075	1,956,774	103,350	171,318	274,668	608,377	2,464,820	3,073,197
2009	250,413	558,446	808,859	239,408	1,761,338	2,000,746	109,255	169,168	278,423	599,076	2,488,952	3,088,028
2010	261,871	566,205	828,076	153,092	1,680,363	1,833,455	95,408	139,927	235,335	510,371	2,386,495	2,896,866
2011	216,720	531,230	747,950	283,509	1,536,806	1,820,315	89,460	168,273	257,733	589,689	2,236,309	2,825,998
2012	213,310	625,687	838,997	273,519	1,731,944	2,005,463	102,687	167,341	270,028	589,516	2,524,972	3,114,488
2013	231,170	578,552	809,722	284,043	1,831,396	2,115,439	86,029	154,882	240,911	601,242	2,564,830	3,166,072
2014	246,789	618,063	864,852	265,490	1,985,132	2,250,622	96,045	169,029	265,074	608,324	2,772,224	3,380,548
2015	260,265	589,285	849,550	334,050	1,788,514	2,122,564	104,635	145,722	250,357	698,950	2,523,521	3,222,471
2016	255,446	660,584	916,030	345,142	1,788,767	2,133,909	92,835	156,799	249,634	693,423	2,606,150	3,299,573
2017	224,777	712,722	937,499	327,610	1,610,032	1,937,642	102,856	130,583	233,439	655,243	2,453,337	3,108,580
2018	253,281	701,448	954,729	291,338	1,842,737	2,134,075	94,480	152,335	246,815	639,099	2,696,520	3,335,619
2019	242,402	694,182	936,584	350,991	2,037,943	2,388,934	97,482	130,421	227,903	690,875	2,862,546	3,553,421
2020	231,416	731,203	962,619	298,406	1,719,535	2,017,941	105,255	147,428	252,683	635,077	2,598,166	3,233,243
2021	263,201	771,472	1,034,673	328,583	1,625,302	1,953,885	79,867	142,712	222,579	671,651	2,539,486	3,211,137
2022	292,158	*	292,158	297,511	*	297,511	63,661	*	63,661	653,330	*	653,330

TABLE A-2a. Estimated catches, in metric tons, of tunas and bonitos in the EPO, by fishing gear, 1993-2022. 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 2021-2022 are preliminary.

TABLA A-2a. Capturas estimadas, en toneladas métricas, de atunes y bonitos en el OPO, por arte de pesca, 1993-2022. 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 2021-2022 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.[§]**				
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	10,637	3,567	260,265	328,907	3,699	C	189	1,255	334,050	62,913	177	-	41,524	21	104,635
2016	242,118	404	-	9,807	3,118	255,446	337,561	4,086	-	214	3,281	345,142	56,731	541	-	35,541	22	92,835
2017	210,980	412	C	10,643	2,742	224,777	324,759	1,765	C	185	901	327,610	66,973	201	-	35,649	33	102,856
2018	238,981	231	C	12,579	1,490	253,281	288,821	865	C	1,222	430	291,338	64,523	145	-	29,789	23	94,480
2019	228,313	578	C	12,081	1,430	242,402	347,405	2,851	C	262	473	350,991	69,223	117	-	28,124	18	97,482
2020	218,747	148	C	11,748	773	231,416	295,961	1,787	C	267	391	298,406	78,784	106	-	26,321	44	105,255
2021	253,415	246	-	9,458	82	263,201	326,524	1,824	-	224	11	328,583	58,170	69	-	21,623	5	79,867
2022	291,826	332	-	*	*	292,158	296,453	1,058	-	*	*	297,511	46,690	50	-	16,921	*	63,661

[§] 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. §				
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	-	-	15	405	3,588	-	-	C	28,939	17,142	46,081	3,763	356	-	1	111	4,231
2016	3,025	-	-	31	697	3,753	2	-	-	26,777	14,567	41,346	6,606	792	-	-	178	7,576
2017	4,109	-	-	22	482	4,613	-	-	-	26,592	9,517	36,109	5,079	306	C	-	54	5,439
2018	2,852	-	-	31	551	3,434	8	-	-	25,477	11,138	36,623	3,002	732	C	-	120	3,854
2019	2,475	-	-	36	490	3,001	-	-	-	19,891	11,897	31,788	5,199	499	C	-	132	5,830
2020	3,383	19	-	88	744	4,234	-	-	-	19,077	10,327	29,404	4,573	684	-	-	359	5,616
2021	3,069	-	-	116	1,219	4,404	-	-	-	31,432	6,945	38,377	4,701	472	-	-	3	5,285
2022	3,392	7	-	*	*	3,399	2	-	-	*	*	2	6,467	592	-	-	*	7,059

§ 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.[§]				
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	-	81,306	23,733	755,232
2016	3,806	15	-	-	1	3,822	129	212	-	-	294	635	649,978	6,050	-	72,485	22,157	750,655
2017	3,438	54	-	-	-	3,492	234	303	-	-	366	903	615,572	3,041	-	73,091	14,094	705,798
2018	2,409	58	-	-	-	2,467	75	448	-	3	213	739	600,671	2,479	-	69,101	13,965	686,216
2019	7,255	27	-	-	-	7,282	83	276	-	4	65	428	659,953	4,348	-	60,398	14,505	739,204
2020	3,169	6	-	-	506	3,681	211	480	-	3	-	694	604,828	3,229	-	57,504	13,144	678,705
2021	6,899	75	-	-	-	6,974	1,253	441	-	1	-	1,695	654,031	3,127	-	62,963	8,265	728,386
2022	3,242	9	-	-	-	3,251	2,293	699	-	*	-	2,992	650,365	2,747	-	16,921	*	670,033

[§] 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, 1993-2022. Purse-seine (PS) vessel data are for Class-6 vessels only. The data for 2021-2022 are preliminary.

TABLA A-2b. Capturas estimadas, en toneladas métricas, de peces picudos en el OPO, por arte de pesca, 1993-2022. En el caso de los buques de cerco (PS), los datos son de buques de Clase 6 únicamente. Los datos de 2021-2022 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.**			
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	25,803	6,080	31,889	306	11	4,120	182	4,619	117	14	240	-	371	26	-	1,268	474	1,768
2016	4	-	24,371	7,512	31,887	247	6	3,678	175	4,106	62	3	80	-	145	19	-	1,562	4	1,585
2017	1	2	22,442	8,073	30,518	151	4	3,903	191	4,249	39	1	211	-	251	10	-	1,752	7	1,769
2018	2	-	24,569	7,039	31,610	167	1	4,094	174	4,436	23	-	297	-	320	10	1	1,820	5	1,836
2019	3	-	21,858	9,247	31,108	201	4	2,503	186	2,894	45	-	161	-	206	16	-	1,752	11	1,779
2020	2	-	22,486	5,684	28,172	131	1	2,789	194	3,115	45	-	611	-	656	10	-	1,857	9	1,876
2021	2	-	17,607	4,852	22,461	117	1	1,614	*	1,732	38	-	281	-	319	12	-	1,336	2	1,350
2022	3	-	*	*	3	169	3	*	*	172	38	1	*	-	39	16	1	*	*	17

§ 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.**			
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	705	4	729	492	35	34,036	6,762	41,325
2016	1	-	416	-	417	49	9	457	19	534	112	9	732	1	854	494	27	31,296	7,710	39,527
2017	-	-	245	-	245	22	2	527	15	566	164	12	258	16	450	387	21	29,338	8,302	38,050
2018	-	-	235	-	235	13	2	467	17	499	123	6	203	12	344	338	10	31,684	7,247	39,280
2019	-	-	809	-	809	17	1	858	5	881	121	5	416	51	593	403	11	28,358	9,499	38,270
2020	1	-	647	-	648	18	1	493	3	515	77	3	564	7	651	284	5	29,448	5,897	35,633
2021	-	-	130	-	130	10	1	595	*	606	70	6	77	9	162	249	8	21,641	4,863	26,760
2022	1	-	*	-	1	8	2	*	*	10	62	4	*	*	66	297	11	*	*	308

§ 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
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	17,177	-	46,102	C	105,426	7,114	17,826	1,782	C	6,515	22,558	-	3,814	228,313
2020	16,641	-	39,897	C	102,137	5,423	22,585	561	C	3,728	24,475	-	3,300	218,747
2021	14,613	-	50,420	C	107,945	7,429	30,095	C	C	4,595	33,293	-	5,025	253,415
2022	15,874	-	59,669	C	119,478	8,945	39,148	*	C	4,412	38,081	-	6,219	291,826

[1] Includes—Incluye: BLZ, BOL, CHN, EU(CYP), GTM, HND, LBR, NZL, RUS, UNK, VCT

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 2020-2021 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 2020-2021 son preliminares.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS+LL	OTR[2]
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	121	530	139	10,637	256,364	3,567
2016	2,398	1,010	825	1,839	1,124	29	688	1,222	253	166	253	9,807	251,925	3,118
2017	2,907	837	1,252	1,463	1,176	10	612	1,263	536	406	182	10,643	221,623	2,742
2018	5,386	1,190	1,101	1,412	1,189	*	231	1,212	427	293	137	12,578	251,559	1,490
2019	3,372	1,490	1,015	1,809	1,725	*	314	1,556	260	344	195	12,081	240,394	1,430
2020	3,392	1,719	853	1,466	2,110	*	94	1,185	411	242	277	11,749	230,496	773
2021	2,299	*	1,933	1,092	1,641	*	1,037	895	216	215	131	9,459	262,874	82
2022	*	*	*	*	*	*	*	*	*	*	*	*	291,826	*

[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 2021-2022 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 2021-2022 son preliminares.

	PS														LL+ OTR[2]
	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C+OTR[1]	Total	
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	1,444
2016	20,665	-	190,577	C	13,286	1,971	32,844	6,449	C	40,036	9,067	-	22,666	337,561	3,495
2017	19,284	-	190,139	C	21,238	6,959	37,419	6,257	C	24,989	7,288	-	11,186	324,759	1,086
2018	15,365	-	177,456	C	17,014	7,759	36,504	4,119	C	11,869	6,679	-	12,056	288,821	1,652
2019	23,395	-	211,827	C	19,656	8,089	33,662	8,944	C	19,706	5,719	-	16,407	347,405	736
2020	15,569	-	189,750	C	7,322	9,049	39,058	2,618	C	14,119	4,578	-	13,898	295,961	658
2021	26,107	-	193,168	C	7,944	7,574	44,375	C	C	24,116	7,306	-	15,934	326,524	235
2022	20,349	-	169,788	C	11,526	7,741	48,031	*	C	17,616	6,466	-	14,936	296,453	*

[1] Includes—Incluye: BLZ, BOL, CHN, EU(CYP), GTM, HND, 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 2021 and 2022.

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 2021 y 2022 son preliminares.

	COL	CRI	ECU	EU(ESP)	MEX	NIC	PAN	PER	SLV	USA	VEN	VUT	C + OTR[1]	Total
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	4,171	-	38,757	C	962	2,630	10,868	-	C	3,304	996	-	7,536	69,223
2020	4,548	-	47,957	C	726	1,885	10,519	65	C	4,066	688	-	8,330	78,784
2021	3,742	-	31,084	C	1,107	1,700	6,473	-	C	5,078	275	-	8,711	58,170
2022	2,129	-	24,209	C	577	2,048	7,297	-	C	3,800	880	-	5,750	46,690

[1] Includes—Incluye: BLZ, BOL, CHN, EU(CYP), GTM, HND, LBR, NZL, UNK, VCT

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 2021-2022 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 2021-2022 son preliminares.

	CHN	CRI	FRA (PYF)	JPN	KOR	MEX	PAN	TWN	USA	VUT	C + OTR[1]	Total LL	Total PS + LL	OTR[2]
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	2,948	1,888	328	41,524	104,437	21
2016	7,052	3	477	10,467	7,692	-	313	6,006	2,090	762	679	35,541	92,272	22
2017	7,093	16	700	8,054	8,749	-	357	6,186	2,700	1,463	331	35,649	102,622	33
2018	6,060	14	897	6,125	6,675	-	415	5,125	2,410	1,841	227	29,789	94,312	23
2019	5,372	23	800	5,988	6,137	-	325	5,868	1,725	1,571	315	28,124	97,347	18
2020	4,048	35	745	5,440	7,633	-	164	5,414	1,466	1,077	299	26,321	105,105	44
2021	3,481	*	906	4,055	7,028	-	41	3,526	1,485	947	154	21,623	79,793	5
2022	2,922	*	*	3,325	5,402	-	*	4,971	*	157	144	16,921	63,611	*

[1] Includes—Incluye: BLZ, CHL, ECU, EU(ESP), EU(PRT), 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 2021 and 2022, 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 2021 y 2022, 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	%
2021	**Retained catches–Capturas retenidas**									
COL	14,613	26,107	3,742	-	-	22	-	-	44,484	6.8
ECU	50,420	193,168	31,084	-	-	1,614	42	673	277,001	42.3
MEX	107,945	7,944	1,107	3,026	-	3,030	6,812	63	129,927	19.9
NIC	7,428	7,574	1,700	-	-	-	-	-	16,702	2.6
PAN	30,095	44,375	6,473	-	-	20	-	486	81,449	12.4
USA	4,596	24,116	5,078	43	-	1	25	-	33,859	5.2
VEN	33,293	7,306	275	-	-	13	-	19	40,906	6.3
OTR[1]	5,025	15,934	8,711	-	-	1	20	12	29,703	4.5
Total	253,415	326,524	58,170	3,069	-	4,701	6,899	1,253	654,031	
2022	**Retained catches–Capturas retenidas**									
COL	15,874	20,349	2,129	-	-	51	-	31	38,434	5.9
ECU	59,669	169,787	24,209	-	2	1,975	55	2,034	257,731	39.6
MEX	119,479	11,526	576	3,194	-	4,263	3,187	21	142,246	21.9
NIC	8,945	7,741	2,048	-	-	32	-	31	18,797	2.9
PAN	39,148	48,031	7,297	-	-	130	-	107	94,713	14.6
USA	4,412	17,616	3,800	198	-	3	-	51	26,080	4.0
VEN	38,081	6,467	880	-	-	13	-	8	45,449	7.0
OTR[2]	6,218	14,936	5,751	-	-	-	-	10	26,915	4.1
Total	291,826	296,453	46,690	3,392	2	6,467	3,242	2,293	650,365	

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

[1] Incluye El Salvador, Perú 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 2021 and 2022, 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 2021 y 2022, 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	%
2021	**Landings-Descargas**									
COL	8,469	15,202	1,755	-	-	4	-	-	25,430	3.9
ECU	99,813	281,675	28,289	-	-	1,665	67	1,128	412,636	63.8
MEX	109,597	12,643	1,405	3,026	-	3,030	6,812	63	136,576	21.1
PER	1,460	6,724	441	-	-	5	20	4	8,654	1.3
USA	904	7,026	1,419	43	-	-	-	-	9,392	1.5
OTR[1]	35,786	13,653	4,690	-	-	1	-	51	54,181	8.4
Total	256,028	336,923	37,998	3,069	-	4,705	6,899	1,246	646,869	
2022	**Landings-Descargas**									
COL	13,457	14,381	1,255	-	-	27	-	-	29,120	4.6
ECU	111,877	264,782	26,310	-	2	2,187	55	2,208	407,421	63.8
MEX	119,555	15,609	587	3,194	-	4,266	3,187	34	146,432	22.9
PER	1,219	2,058	600	-	-	-	-	-	3,877	0.6
USA	841	2,154	797	198	-	-	-	-	3,990	0.6
OTR[2]	32,415	12,492	2,762	-	-	5	-	13	47,687	7.5
Total	279,364	311,476	32,311	3,392	2	6,485	3,242	2,255	638,527	

[1] Includes Costa Rica, El Salvador, European Union (Portugal), European Union (Spain), Guatemala, Kiribati, Marshall Islands, Panama, and Venezuela - This category is used to avoid revealing the operations of individual vessels or companies.

[1] Incluye Costa Rica, El Salvador, Guatemala, Islas Marshall, Kiribati, Panamá, Unión Europea (Portugal), Unión Europea (España) and Venezuela - Se usa esta categoría para no revelar información sobre las actividades de buques o empresas individuales.

[2] Includes Costa Rica, El Salvador, European Union (Spain), Guatemala, Marshall Islands, Panama and Unknown - This category is used to avoid revealing the operations of individual vessels or companies.

[2] Incluye Costa Rica, Desconocida, El Salvador, Guatemala, Islas Marshall, Panamá y Unión Europea (España) - 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, 1993-2021. The data for 2020 and 2021 are preliminary; 2022 data are not available.

TABLA A-5a. Capturas retenidas anuales de atún aleta azul del Pacífico, por arte de pesca y bandera, en toneladas, 1993-2021. Los datos de 2020 y 2021 son preliminares; no se dispone de datos de 2022.

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		
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	648	2,086	676	1	-	552	26	7,642	3,082	-	86	411	3,579	11,221
2016	5,095	54	691	2,514	1,024	5	-	454	0	9,837	2,709	-	316	413	3,438	13,275
2017	4,540	49	913	3,491	734	9	-	415	0	10,151	3,643	-	466	483	4,592	14,743
2018	4,050	9	700	1,447	523	12	-	381	3	7,125	2,482	-	12	582	3,076	10,201
2019	4,464	0	1,002	2,033	542	39	-	486	6	8,572	2,249	-	226	529	3,004	11,576
2020	3,960	1	1,416	2,496	567	38	-	1,149	1	9,628	3,266	-	116	834	4,216	13,844
2021	4,198	0	1,436	2,740	422	87	-	1,478	1	10,362	3,026	-	43	1,335	4,404	14,766

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[1] Source: International Scientific Committee, 22nd Plenary Meeting, PBFWG workshop report on Pacific Bluefin Tuna, July 2022—Fuente: Comité Científico Internacional, 22ª Reunión Plenaria, Taller PBFWG sobre Atún Aleta Azul del Pacífico, julio de 2022

TABLE A-5b. Reported catches of Pacific bluefin tuna in the EPO by recreational gear, in number of fish, 1993-2022.

TABLA A-5b. Capturas reportadas de atún aleta azul del Pacifico en el OPO por artes deportivas, en número de peces, 1993-2022.

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**	14,072
2004	3,391	**2019**	18,702
2005	5,757	**2020**	37,825
2006	7,473	**2021**	57,198
2007	1,028	**2022**	52,269

TABLE A-6. Annual retained catches of albacore in the EPO, by gear and area (north and south of the equator), in metric tons, 1993-2021. The data for 2020 and 2021 are preliminary; 2022 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, 1993-2021. Los datos de 2020 y 2021 son preliminares; no se dispone de datos de 2022.

ALB	North—Norte				South—Sur				Total
	LL	LTL[1]	OTR	Subtotal	LL	LTL	OTR	Subtotal	
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	2,067	15,986	934	18,987	26,873	0	221	27,094	46,081
2016	1,627	13,600	679	15,906	25,151	0	289	25,440	41,346
2017	2,580	8,927	402	11,909	24,012	2	186	24,200	36,109
2018	1,090	10,433	538	12,061	24,387	0	175	24,562	36,623
2019	1,427	10,167	1,517	13,111	18,464	1	212	18,677	31,788
2020	1,538	9,873	326	11,737	17,658	0	9	17,667	29,404
2021	1,382	6,608	317	8,307	30,049	2	19	30,070	38,377

[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 2021 and 2022 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 2021 y 2022 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**					
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	153,649	3,696	28
2020	0	9,773	9,773	150,263	1,705	63
2021	0	9,887	9,887	158,256	2,585	0
2022	0	10,614	10,614	178,366	2,887	0
OBJ	**Sets associated with floating objects Lances asociados a objetos flotantes**					
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	4,885	10,591	15,476	52,862	226,375	68,553
2020	3,363	8,788	12,151	44,461	191,399	78,208
2021	4,002	11,167	15,169	66,542	227,028	57,391
2022	4,293	13,406	17,699	90,128	241,420	46,487

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					
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	2,064	5,948	8,012	21,802	117,334	642
2020	1,883	4,575	6,458	24,023	102,857	513
2021	1,678	4,803	6,481	28,617	96,911	779
2022	1,226	3,459	4,685	23,332	52,146	203
ALL	Sets on all types of schools Lances sobre todos tipos de cardumen					
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	6,949	26,219	33,168	228,313	347,405	69,223
2020	5,246	23,136	28,382	218,747	295,961	78,784
2021	5,680	25,857	31,537	253,415	326,524	58,170
2022	5,519	27,479	32,998	291,826	296,453	46,690

TABLE A-8. Types of floating objects involved in sets by vessels of >363 t carrying capacity, 2007-2022. The 2022 data are preliminary.

TABLA A-8. Tipos de objetos flotantes sobre los que realizaron lances buques de >363 t de capacidad de acarreo, 2007-2022. Los datos de 2022 son preliminares.

OBJ	Flotsam Naturales		FADs Plantados		Unknown Desconocido		Total
	No.	%	No.	%	No.	%	
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	216	2.0	10,373	97.9	2	< 0.1	10,591
2020	166	1.9	8,622	98.1	0	0	8,788
2021	260	2.3	10,907	97.7	0	0	11,167
2022	414	3.1	12,987	96.9	5	< 0.1	13,406

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. 2022 data are not available.
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. No se dispone de datos de 2022.

LL	CHN		JPN		KOR		FRA(PYF)		TWN		USA		OTR[1]
	E	C	E	C	E	C	E	C	E	C	E	C	C
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	3,089	10,924
2016	66,405	25,756	30,910	13,242	23,235	9,457	13,677	3,954	20,941	11,432	11,313	2,408	6,236
2017	82,461	27,341	27,961	10,617	27,540	10,525	11,641	3,425	24,164	11,811	15,266	3,288	6,085
2018	83,023	27,024	24,608	8,686	19,443	8,474	13,258	4,300	31,735	9,985	13,607	2,916	7,713
2019	65,298	18,652	18,472	8,831	17,655	8,556	12,620	4,209	34,930	12,170	11,117	2,060	5,917
2020	56,607	15,620	17,987	7,780	23,284	10,427	14,253	3,906	43,643	11,778	9,384	2,098	5,892
2021	84,812	27,299	16,207	6,030	19,704	9,699	15,748	5,092	28,693	8,032	8,123	1,925	4,775

[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 2021 and 2022 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 2021 y 2022 son preliminares.

	PS		LP		Total	
	No.	Vol. (m^3)	No.	Vol. (m^3)	No.	Vol. (m^3)
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
2020	242	241,331	0	0	242	241,331
2021	236	253,323	0	0	236	253,323
2022	239	253,071	0	0	239	253,071

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 2021, 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 2021 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	34	34	24	4	10	106	82,234
EU(ESP)	PS	-	-	-	-	3	3	7,281
MEX	PS	5	3	20	23	-	51	61,072
NIC	PS	-	-	2	1	1	4	6,099
PAN	PS	-	2	5	7	5	19	27,390
PER	PS	-	4	-	-	-	4	2,475
SLV	PS	-	-	-	1	2	3	6,202
USA	PS	3	-	2	7	5	17	24,152
VEN	PS	-	-	6	8	1	15	21,558
Grand total—Total general	PS	44	45	66	54	27	236	
Well volume—Volumen de bodega (m^3)								
Grand total—Total general	PS	12,243	26,689	74,744	82,277	57,370		253,323

- : 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 2022, 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 2022, 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	1	2	7	3	-	13	14,590
ECU	PS	34	34	21	4	10	103	78,820
EU(ESP)	PS	-	-	-	-	3	3	7,281
MEX	PS	5	3	21	23	-	52	61,880
NIC	PS	-	-	3	1	1	5	7,316
PAN	PS	-	2	5	8	5	20	28,865
SLV	PS	-	-	-	1	2	3	6,202
USA	PS	10	-	2	8	5	25	26,559
VEN	PS	-	-	6	8	1	15	21,558
Grand total—Total general	PS	50	41	65	56	27	239	
Well volume—Volumen de bodega (m^3)								
Grand total—Total general	PS	12,831	23,970	73,729	85,367	57,174		253,071

- : 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 2012-2021 and in 2022, 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 2012-2021 y en 2022, por mes.

Month Mes	2012-2021			2022
	Min	Max	Ave.-Prom.	
1	86.9	129.6	103.8	130.4
2	150.7	192.3	174.3	185.7
3	147.9	189.7	166.8	178.8
4	151.2	200.8	168.5	178.1
5	146.5	196.9	169.7	186.9
6	155.0	198.6	174.0	187.4
7	156.7	200.4	171.8	176.9
8	107.6	148.7	121.2	115.9
9	102.2	142.2	120.1	116.7
10	141.7	188.9	170.7	173.0
11	93.9	140.8	122.6	104.7
12	45.9	90.4	62.9	70.4
Ave.-Prom.	123.8	168.3	143.9	150.4

B. YELLOWFIN TUNA

For the full version of the analyses herein, see documents SAC-11-05, SAC-11-07, SAC-11-INF-J, SAC-11-08, SAC-14-06 and SAC-14-04.

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 eastern Pacific Ocean (EPO) at 150ºW are relatively low, but have been increasing, mainly in sets on floating objects (Figure A-1a and A-1b, Tables A-1, A-2). Most 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. A recent review of all available information indicated that at least two stocks may be exploited by the EPO fisheries, roughly associated with epi and mesopelagic biogeochemical provinces (SAC-14-06). The boundaries between the stocks vary dynamically.

In 2023, the stock status indicators (SSIs, SAC-14-04) showed that the continuous increasing trend in the number of floating object sets, briefly interrupted during the COVID-19 pandemic in 2020-2021, has resumed and it is now at the highest levels since 2000, 10.6% above the *status quo*[6]*.* In contrast, the number of sets in the unassociated fishery in 2022 decreased to the lowest level since 2000, and the number of sets in the dolphin associated fishery had a slight increase in 2022, above the *status quo*. The closure-adjusted capacity is stable and below the *status quo*. The catch SSIs highlight the increasing importance of the purse-seine on floating objects fishery for yellowfin tuna. From 2021 to 2022 the catches increased by 38.9% in weight and 67.5% in numbers from the bias-adjusted catches in 2021. The catches are around the *status quo* for both unassociated and dolphin sets, with a slight increase in the catch in weight on dolphin sets in 2022. Port sampling for species composition was greatly affected as well, which caused a bias in the catch estimation (SAC-13-05). The 2020 yellowfin tuna estimated catches may be as much as 18% larger than what is shown in Figure B-1, while the 2021 may be 10% smaller, because some yellowfin tuna catches were most likely attributed to bigeye tuna, and vice-versa in 2020 and 2021(Figure B-3), respectively, due to lack of sampling on key ports as a result of the impact of the COVID-19 pandemic. The longline effort was about the same from 2019 to 2021 (Figure B-2), yet the relative CPUE and the average length increased in 2020 and decreased in 2021 (Figure B-3). The standardized average length obtained from data for the purse-seine fishery associated with dolphins decreased dramatically in 2022, to the second lowest level in the series, while the average length of the catch remained above the median for the series. The relative standardized CPUE was similar to the 2021 level, slightly lower than the median for the whole series.

In the long term, 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, and in the population in 2022 (Figure B-4). This coincided with a declining trend in the yellowfin longline CPUE index based on spatiotemporal modelling since 2005, which was at the lowest historic levels in 2017 – 2018 (Figure B-4). Long term trends in some of the other SSIs do not support the interpretation that increased fishing mortality is occurring because of an increase

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[6] Average for 2017-2019

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 spatiotemporal 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-object sets (Figure B-3), but it has been increasing slightly in recent years. The SSI based on spatiotemporal modelling of CPUE for the longline fishery does not coincide with the purse-seine one (Figure B-4), although both indices refer to large fish, with longline fish being the largest. 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 gear/set types. .

The last benchmark assessment for yellowfin tuna was conducted in 2020 and followed a risk assessment framework, which includes the development of hypotheses, 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). For yellowfin tuna, three overarching hypotheses centered on the degree of spatial mixing of the yellowfin tuna population in the EPO were considered (SAC-11-INF-J). Of those, the high-mixing hypothesis was assumed for the benchmark assessment, for practical reasons, with the purse-seine index assumed the most representative of the core of the exploited population (SAC-11-07). A total of 48 models composed the benchmark assessment for yellowfin tuna (SAC-11-07), which addressed uncertainty in changes in selectivity and catchability, growth, asymptotic selectivity, and density-dependence in the index catchability. All EPO catches were added to the models, which were fit to a standardized dolphin associated 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, to avoid mixing the signal from a possible southern population.

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 ($S_{\text{MSY\_d}}$); 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 $S_{\text{MSY\_d}}$ 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 the assessment is the spatial structure of the stock of yellowfin tuna in the EPO and research is under way (e.g., SAC-14-06) to be able to incorporate stock structure aspects in the upcoming 2024 benchmark assessment.

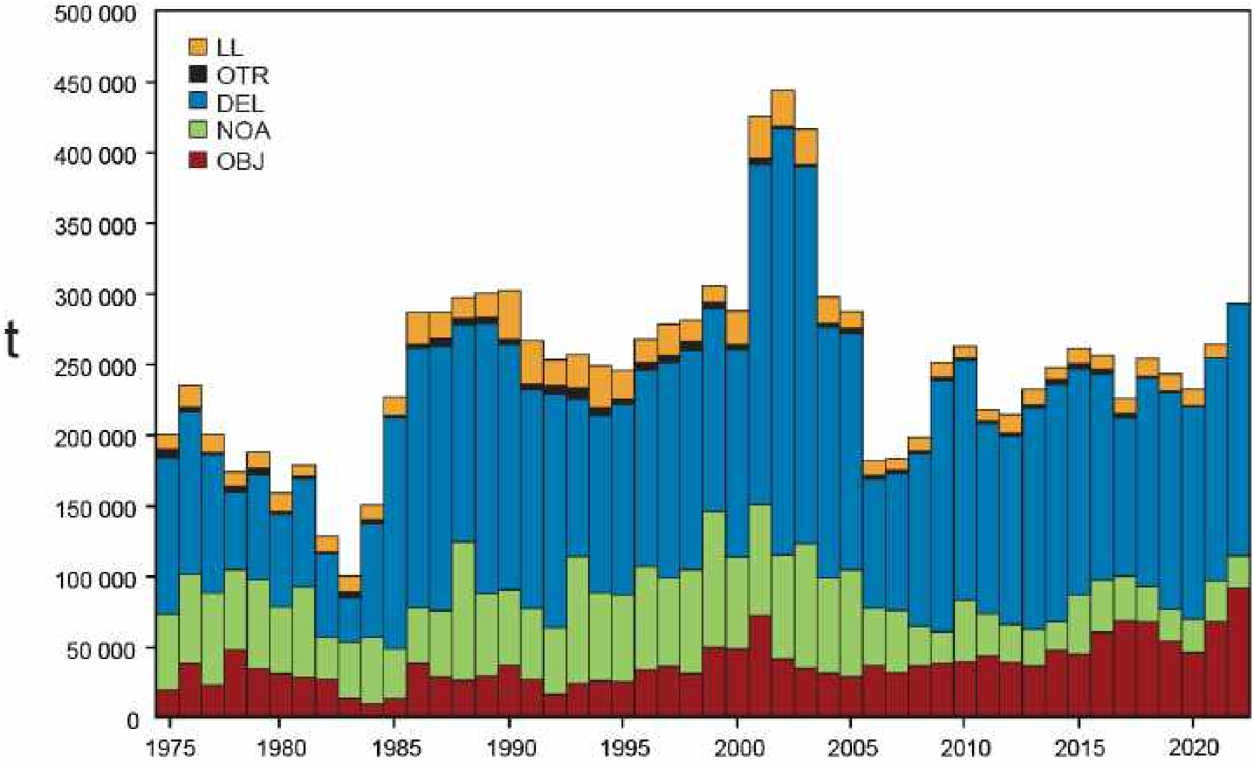

FIGURE B-1. Total catches (retained catches plus discards) for the purse-seine fisheries, by set type (DEL, NOA, OBJ), and retained catches for the longline (LL) and other (OTR) fisheries, of yellowfin tuna in the eastern Pacific Ocean, 1975-2021. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2020 and 2021 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, 1975-2021. Se ajustan las capturas de cerco a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de 2020 y 2021 son preliminares.

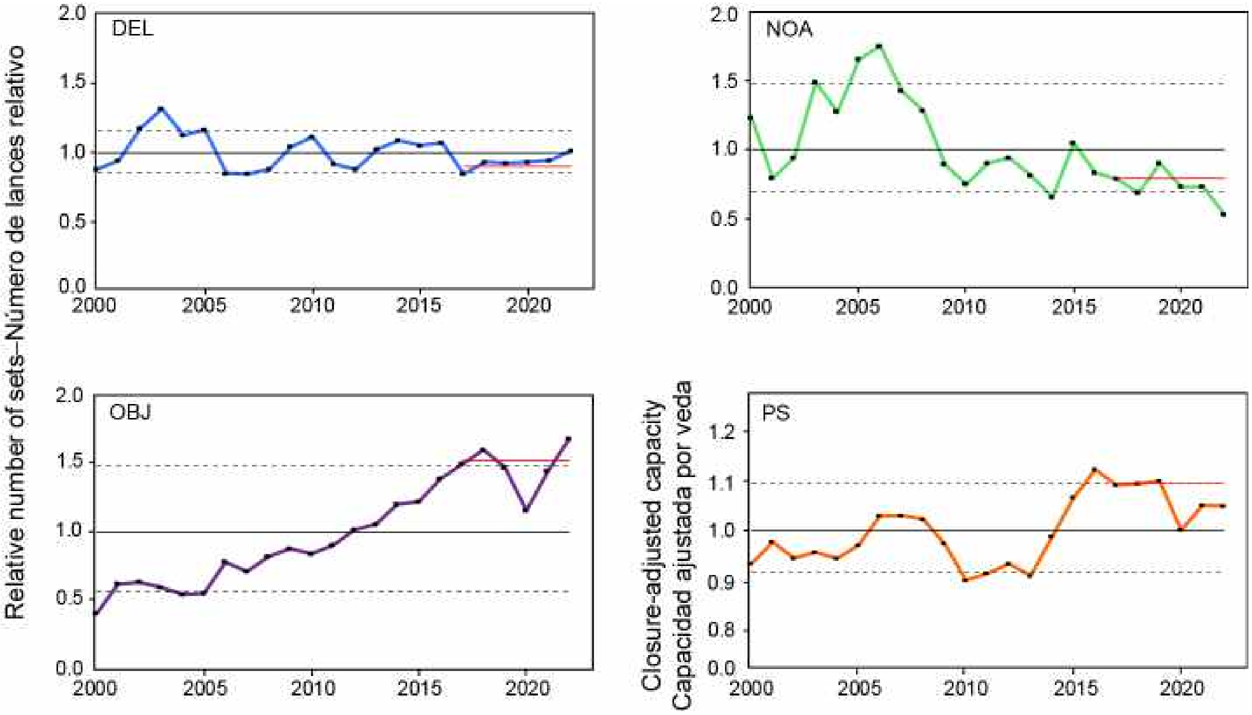

FIGURE B-2. Indicators of total effort in the EPO, based on purse-seine data closure-adjusted capacity, 2000-2021; annual total number of sets, by type, 1987-2021) and based on longline data for 2000-2020 (effort reported by all fleets, in total numbers of hooks; proportion of the effort corresponding to Japan). The dashed horizontal lines are the 10th and 90th percentiles, the solid horizontal line is the mean. The red dashed lines mark the *status quo* levels (average conditions in 2017-2019).

FIGURA B-2. Indicadores del esfuerzo total en el OPO, basados en datos de cerco (capacidad ajustada por veda, 2000-2021; número total anual de lances, por tipo, 1987-2021) y en datos de palangre de 2000-2020 (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 10 y 90%, y la línea horizontal sólida el promedio. Las líneas discontinuas rojas marcan los niveles de *statu quo* (condiciones promedio en 2017-2019).

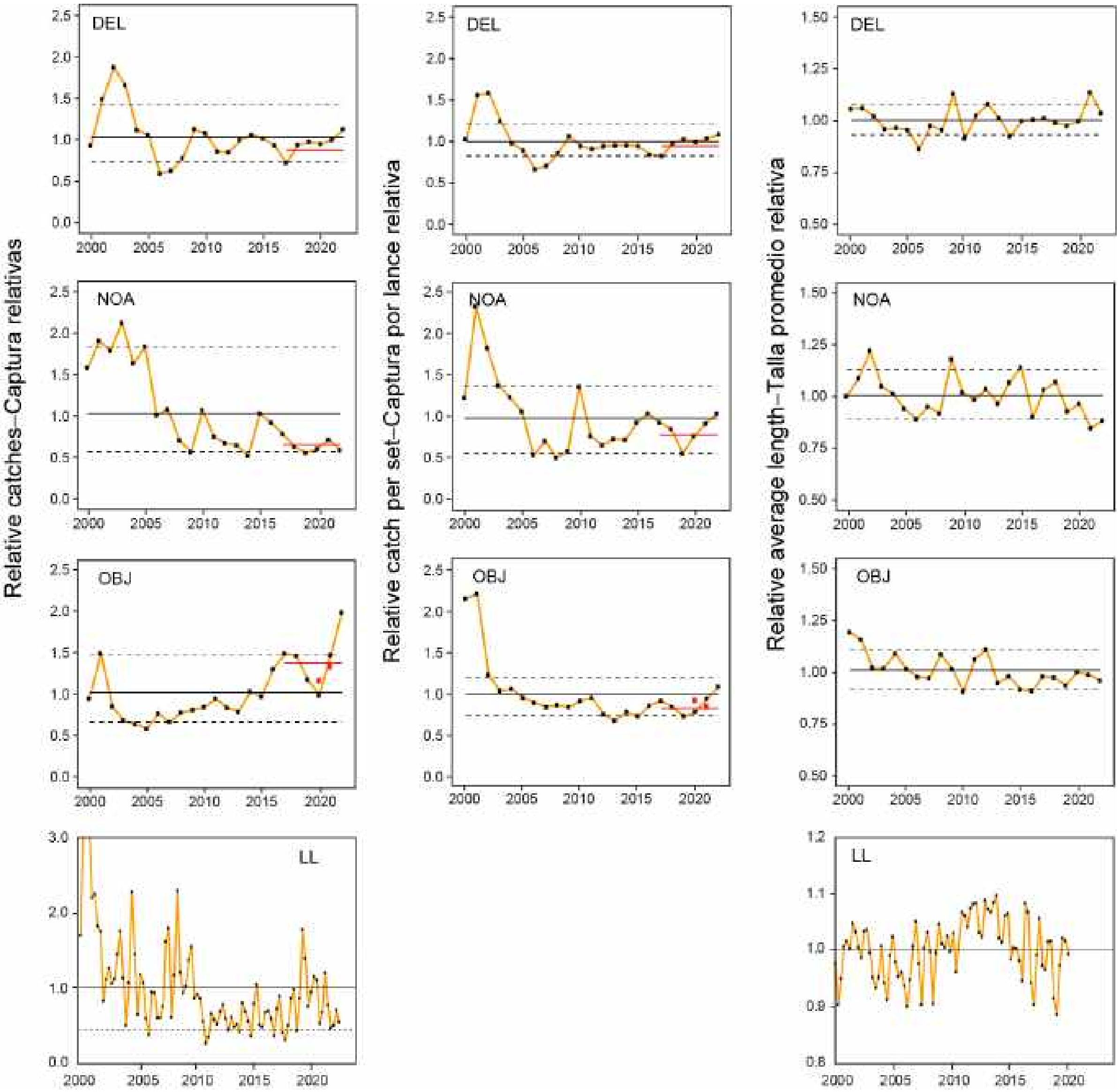

FIGURE B-3. Indicators (catch (t and numbers); CPUE (t/day fished); average length (cm)) for the yellowfin tuna stock in the eastern Pacific Ocean, from purse-seine fisheries; relative catch and relative average length, obtained from standardized length composition using spatiotemporal model, from longline fisheries. The lines represent the 10% and 90% percentiles (dashed lines) and the mean (solid line). The red dots are the bias-adjusted estimates for floating-object catches in the two COVID-19 years (see SAC-13-05). The red dashed lines mark the *status quo* reference levels (average conditions in 2017-2019).

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. Las líneas representan los percentiles de 10% y 90% (líneas de trazos) y el promedio (línea sólida). Los puntos rojos son las estimaciones ajustadas al sesgo de las capturas de objetos flotantes en los dos años de COVID-19 (ver SAC-13-05). Las líneas discontinuas rojas marcan los niveles de *statu quo* (condiciones promedio en 2017-2019).

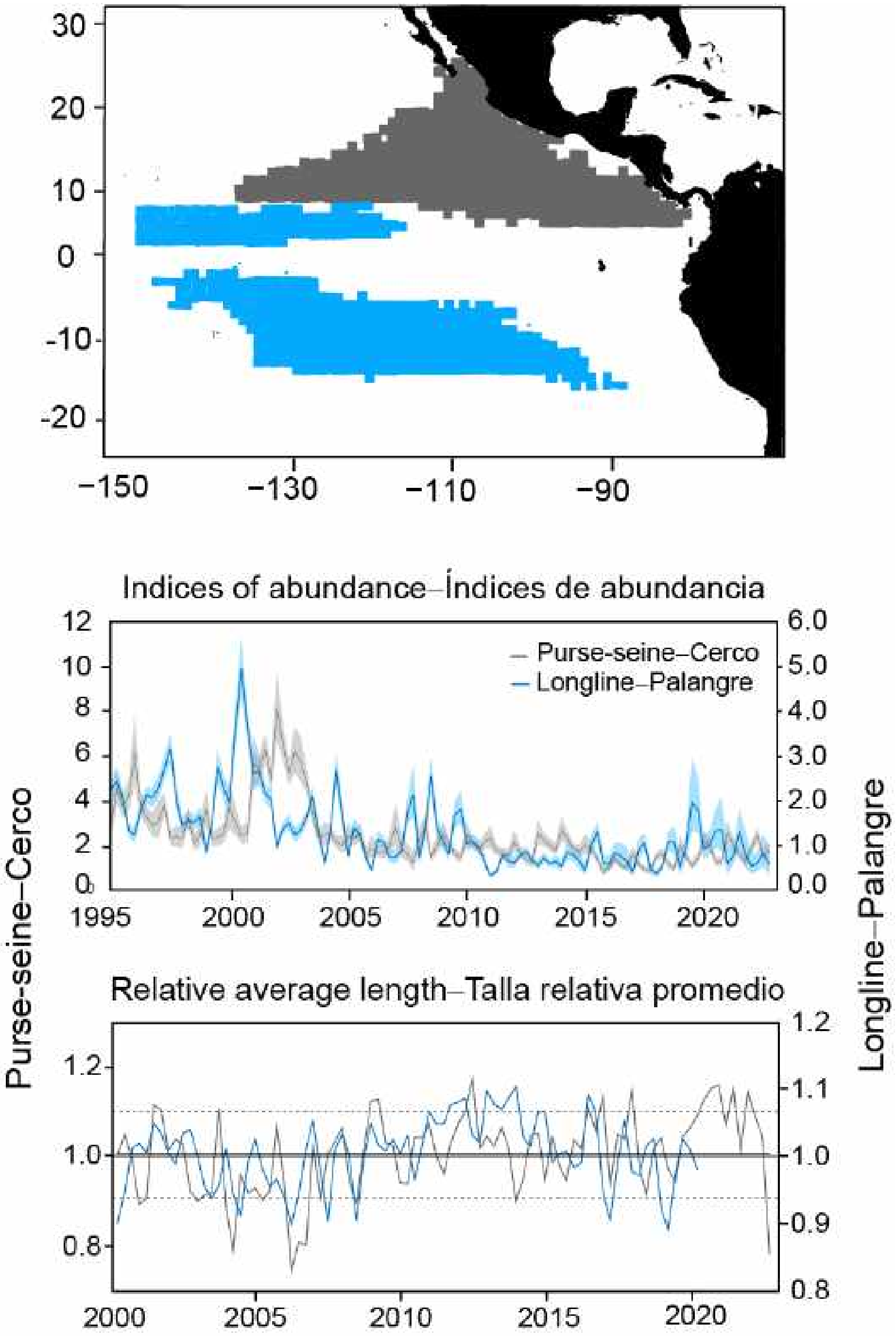

FIGURE B-4. Top: Spatial domain of the purse-seine and longline derived indices. Middle: Relative abundance indices derived from catch per unit of effort of purse-seine (1995-2022) and longline (1995-2020 3rd quarter[7]) fisheries standardized using spatiotemporal models. Bottom: Relative average size.

FIGURA B-4. Arriba: Dominio espacial de los índices derivados de cerco y palangre. Medio: Índices de abundancia relativa derivados de la captura por unidad de esfuerzo de las pesquerías de cerco (1995-2022) y de palangre (1995-2020 3er trimestre) estandarizados mediante modelos espaciotemporales. Abajo: Talla promedio relativa.

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[7]

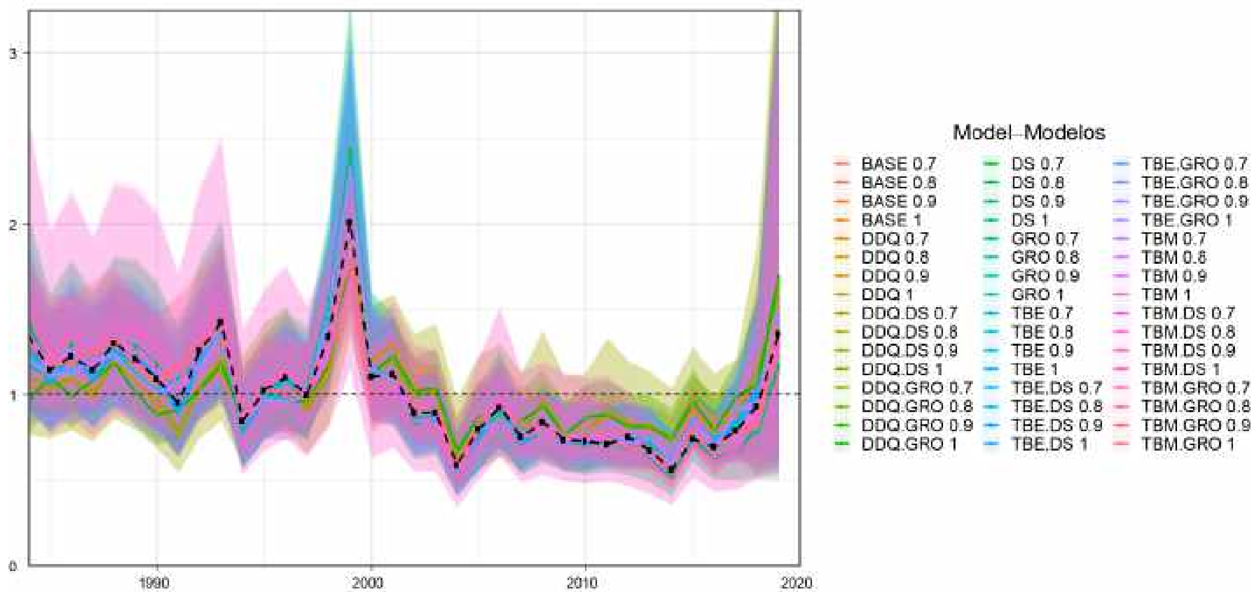

FIGURE B-5. Annual relative recruitment of yellowfin tuna to the fisheries of the EPO estimated by the 48 models and weighted average (black dashed line). The lines and dots indicate the maximum likelihood estimates of recruitment, and the shaded areas the approximate 95% confidence intervals around 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.

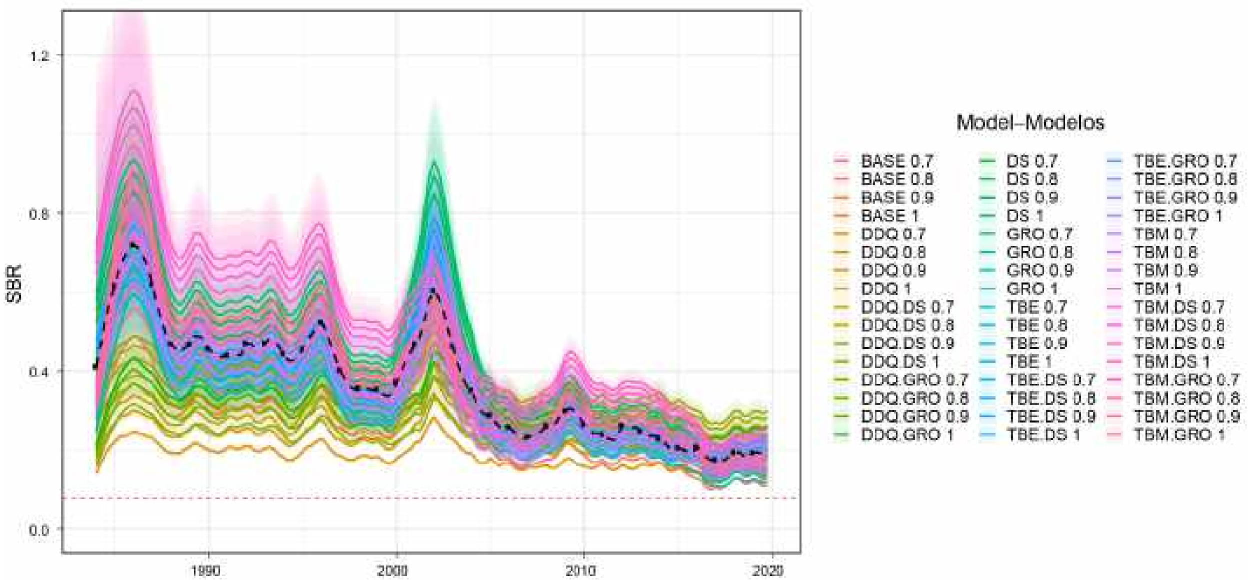

FIGURE B-6. Spawning biomass ratios (SBRs) for yellowfin tuna in the EPO, 1985-2019. The solid lines represent the maximum likelihood estimates and the shaded areas the approximate 95% confidence intervals around those estimates estimated by the 48 models and weighted average (black dashed line). The 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.

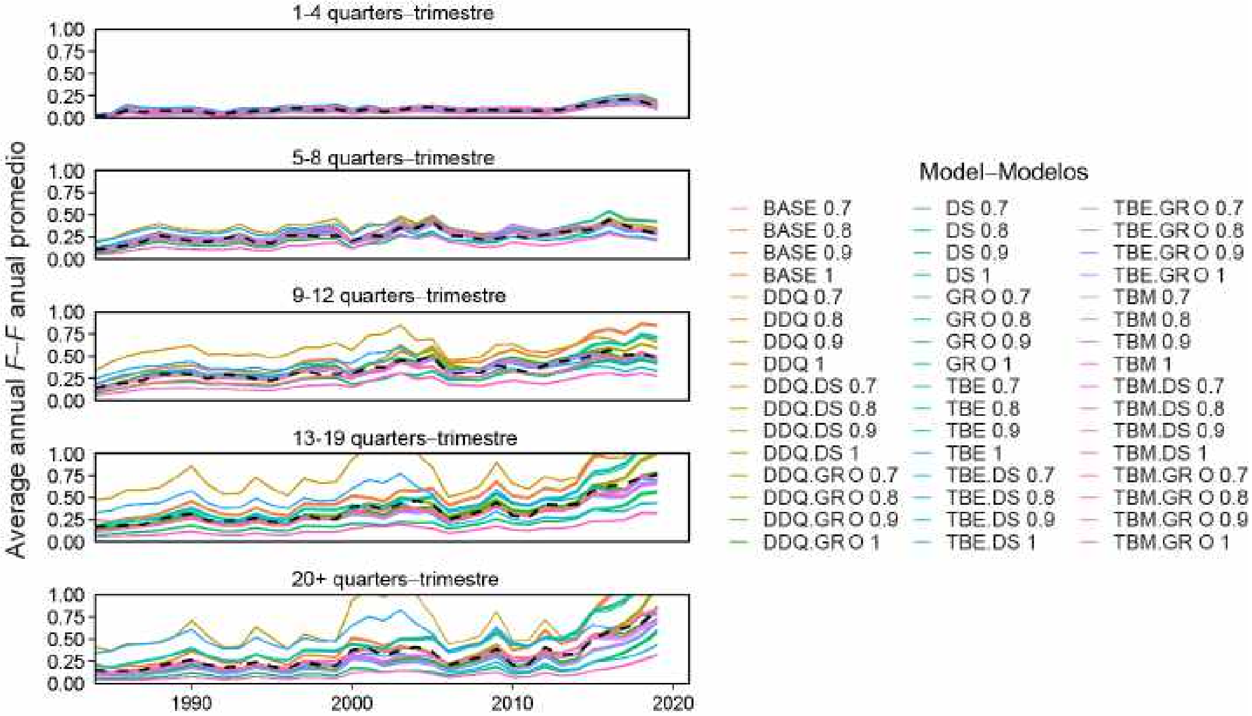

FIGURE B-7. Average annual fishing mortality (F) of yellowfin tuna in the EPO, by age group (in quarters), for all gears, estimated by the 48 models and weighted average. See model descriptions in Table B-1. The weighted average was computed using the weights assigned to each model in SAC-11-INF-J.

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.

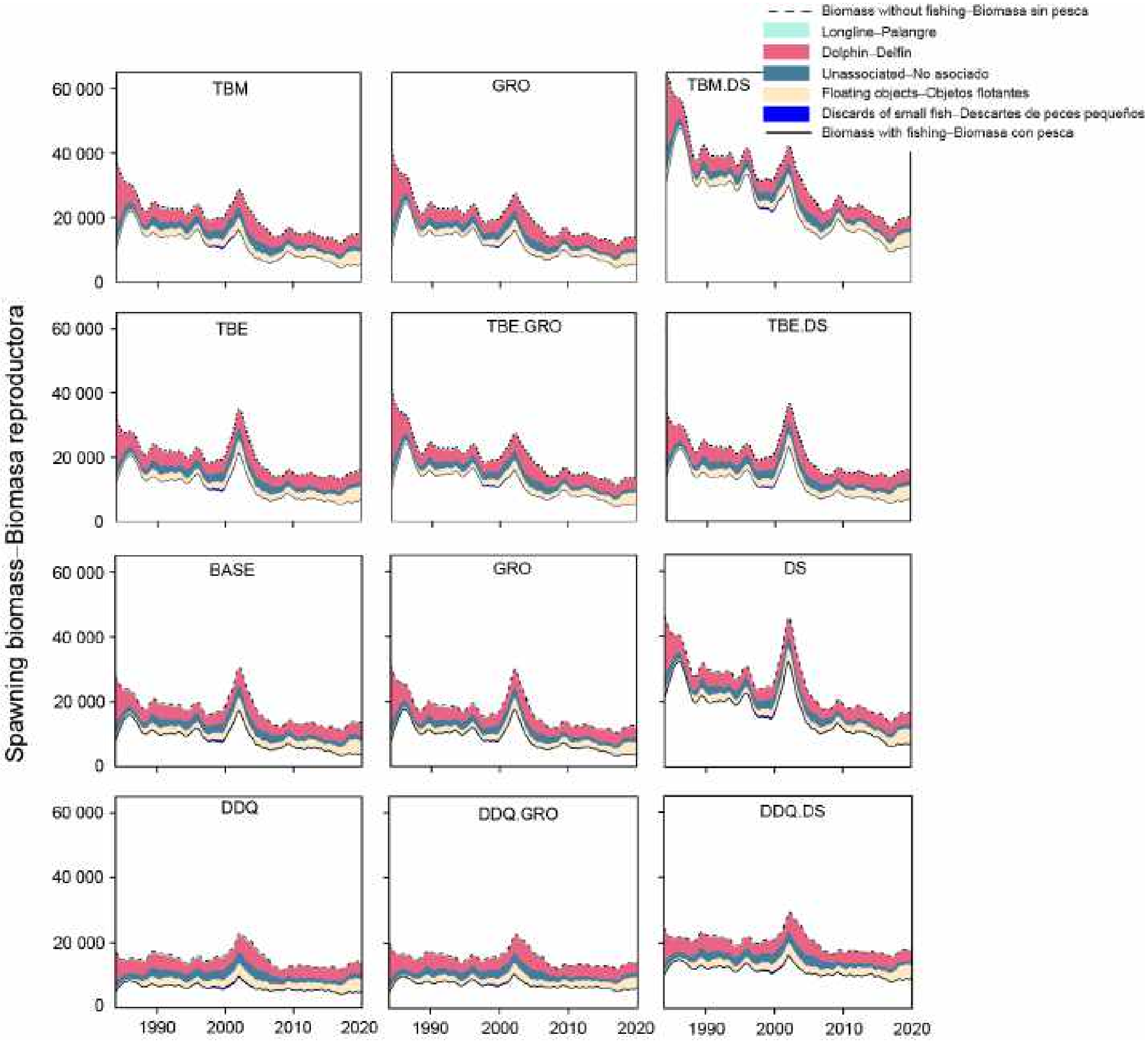

FIGURE B-8. Impact of fishing, 1985-2019: trajectory of the spawning biomass (a fecundity index, see text for details) of a simulated population of yellowfin tuna that was never exploited (dashed line) and that predicted by each model, with a steepness of 1.0 (solid line). The shaded areas between the 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.

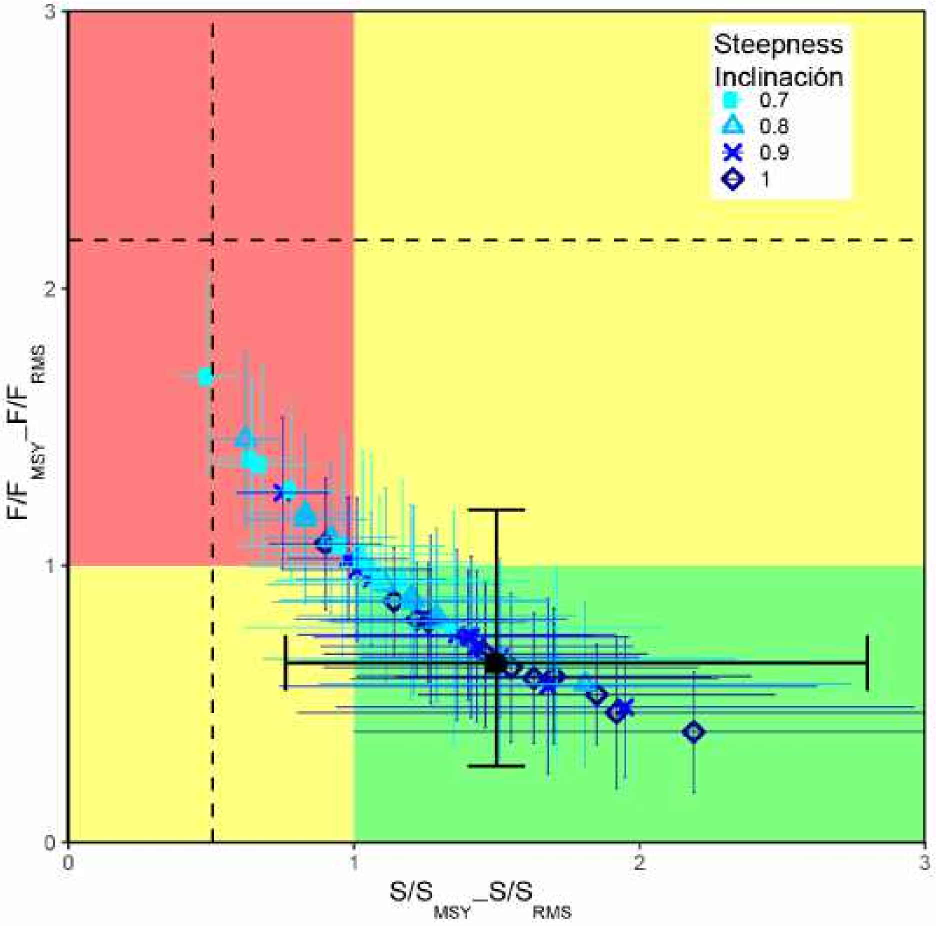

FIGURE B-9. Kobe (phase) plot of the time series of estimates of spawning stock size (*S*) and fishing mortality (*F*) of yellowfin tuna relative to their MSY reference points. The colored panels are separated by the target reference points (S_{MSY} and F_{MSY}). Limit reference points (dashed lines), 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%.

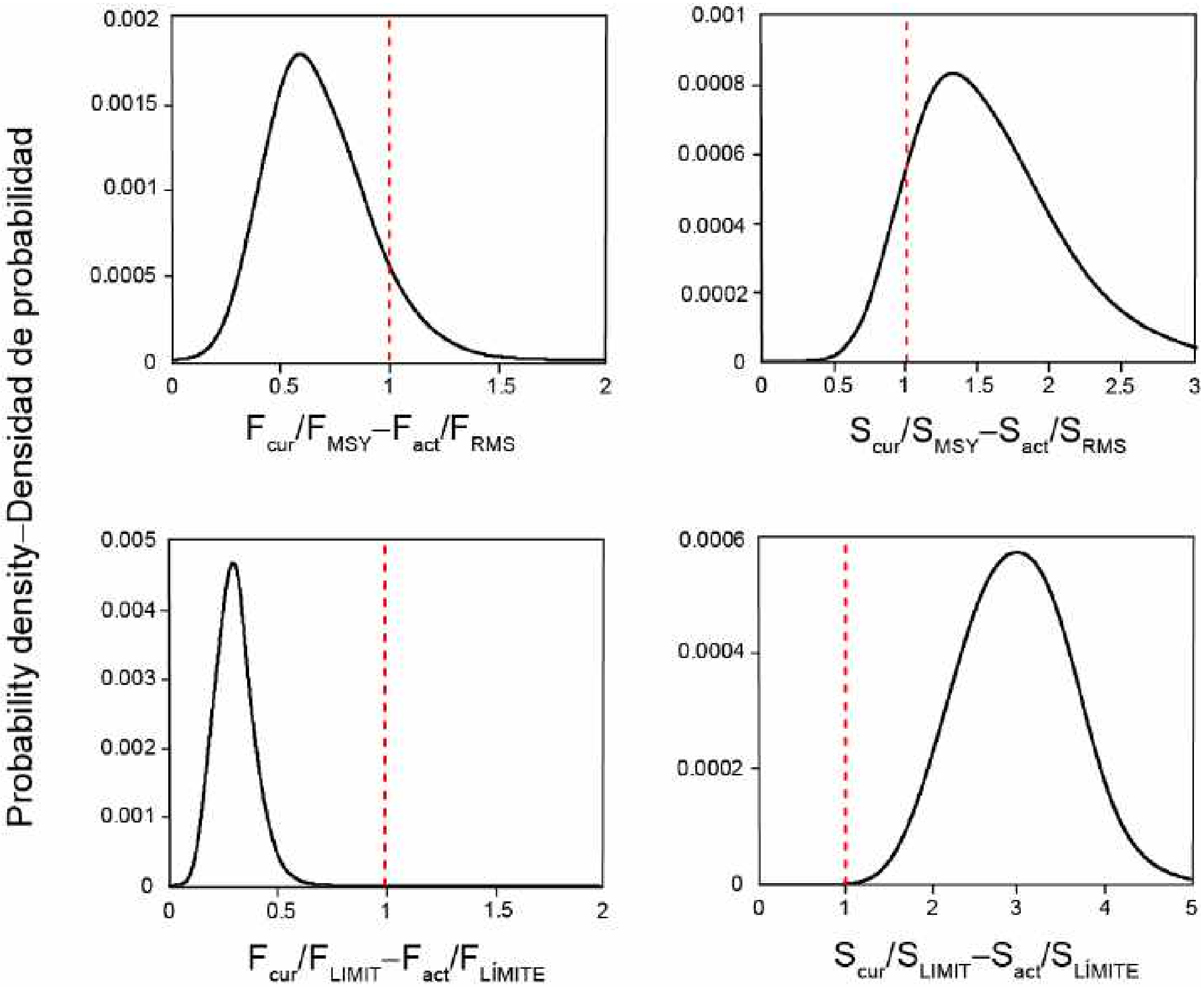

FIGURE B-10. Yellowfin probability density functions for F_{cur}/F_{MSY}, F_{cur}/F_{LIMIT} and S_{cur}/S_{LIMIT} broken down into different components for models developed to address: a) combined; b) issues with the index of abundance; c) misfit to the composition data for the fishery with asymptotic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

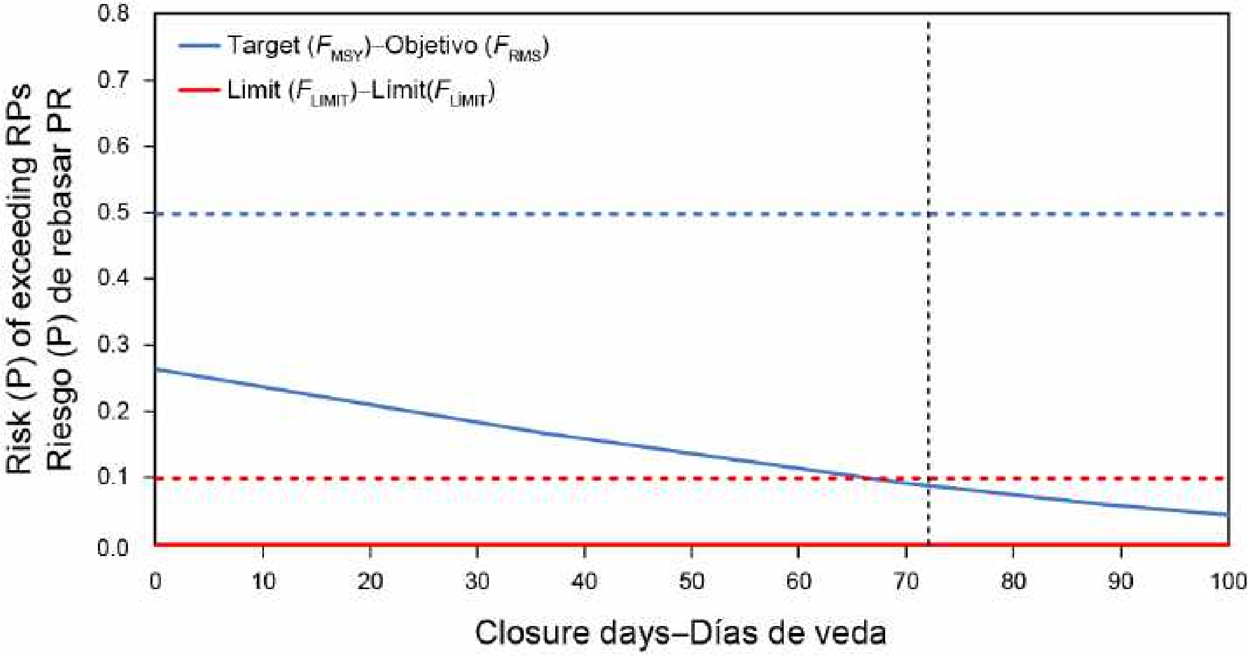

FIGURE B-11. Risk curves showing the probability of exceeding the target and limit reference points (RPs) for different durations of the temporal closure for yellowfin in the EPO.

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.

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).

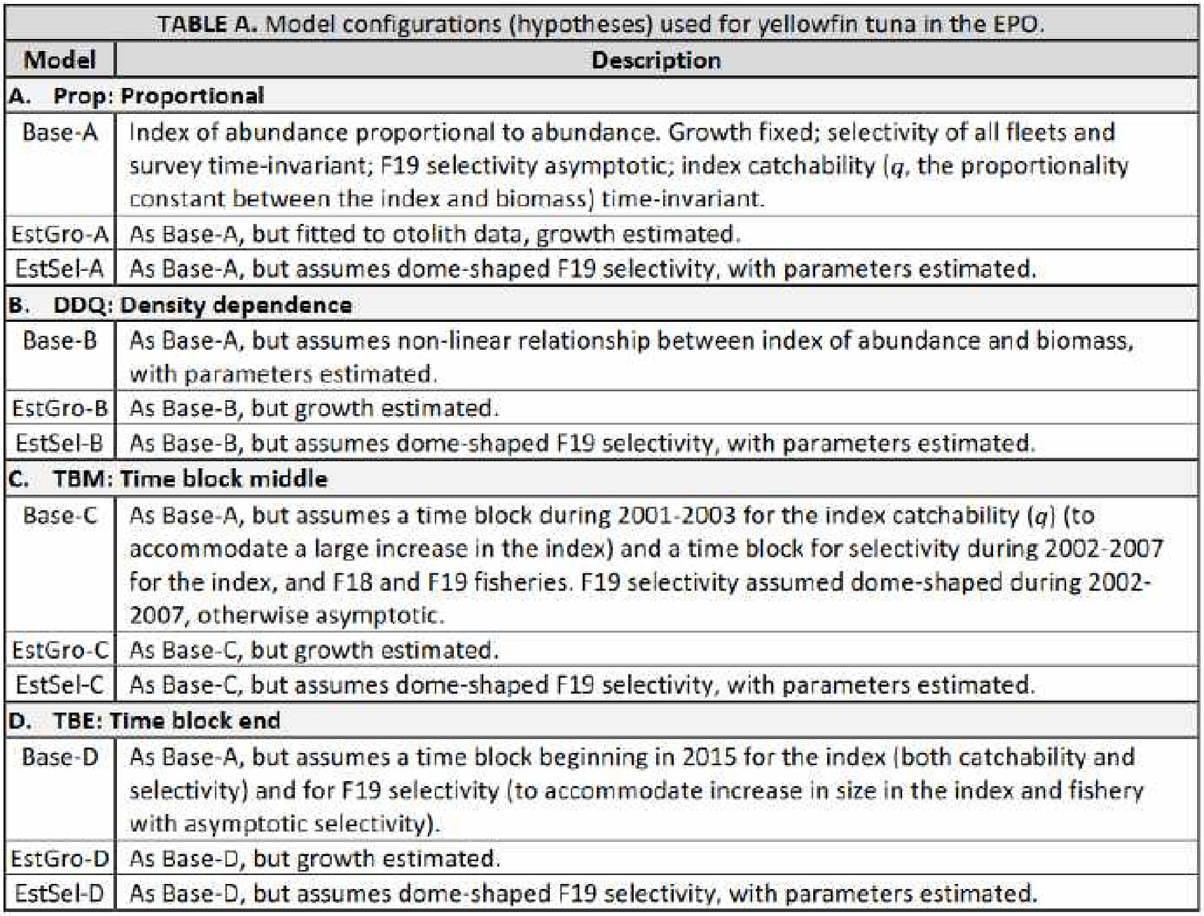

TABLE A. Model configurations (hypotheses) used for yellowfin tuna in the EPO.

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).

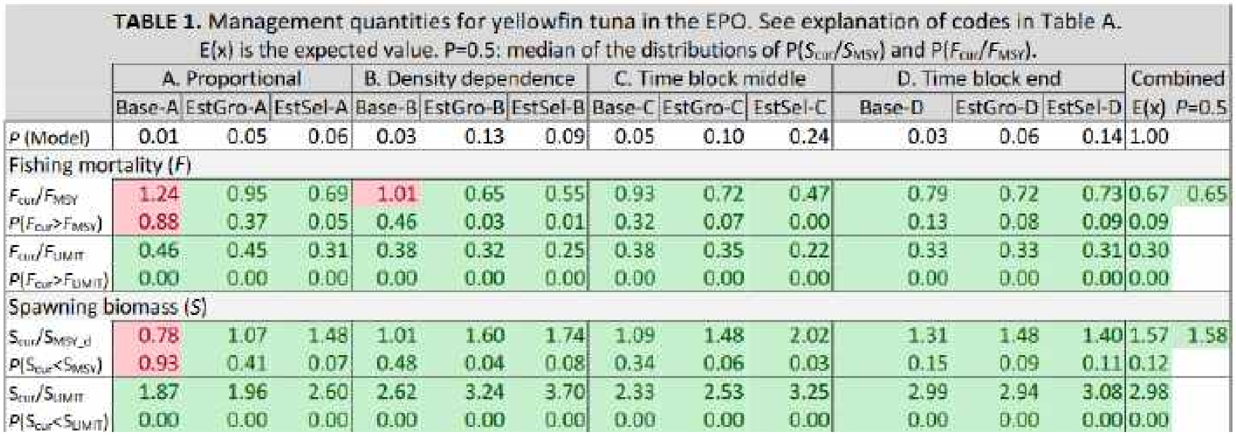

TABLE 1. Management quantities for yellowfin tuna in the EPO. See explanation of codes in Table A. E(x) is the expected value. P=0.5: median of the distributions of P(S_{cur}/S_{MSY}) and P(F_{cur}/F_{MSY}).

	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).

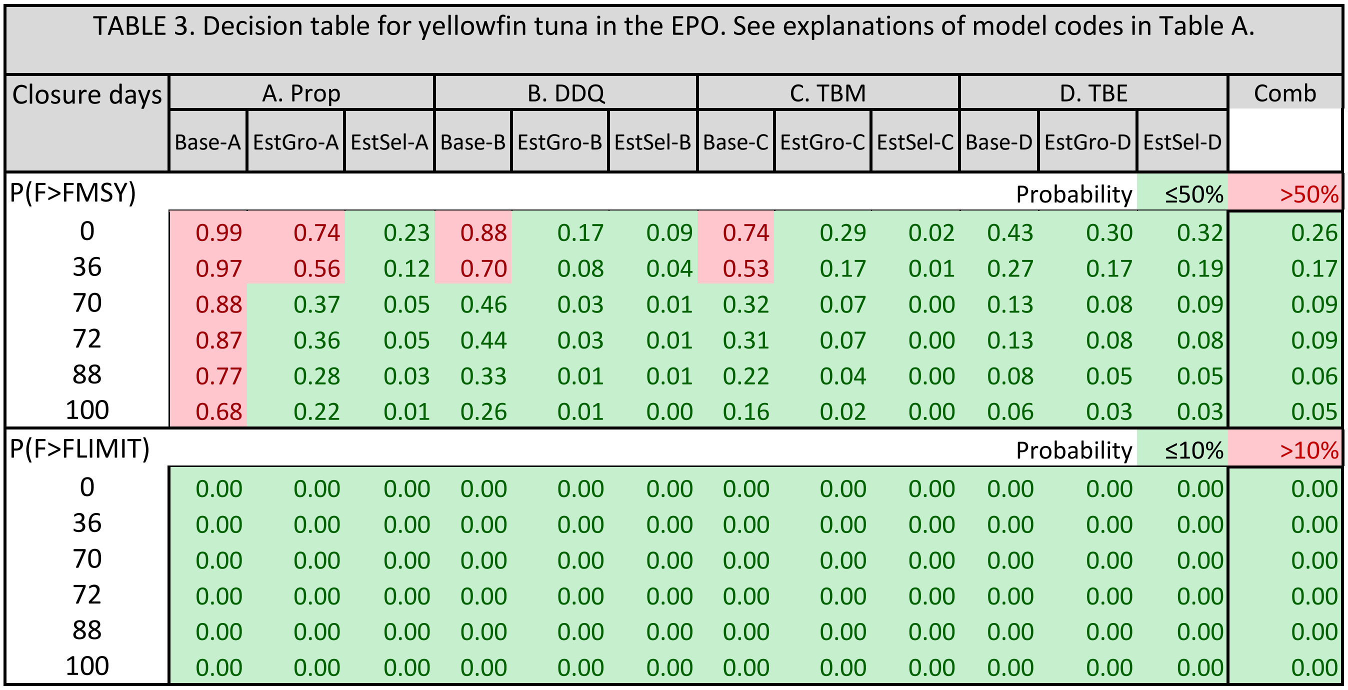

TABLE 3. Decision table for yellowfin tuna in the EPO. See explanations of model codes in Table A.

Closure days	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>FMSY)											Probability	≤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>FLIMIT)											Probability	≤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

C. SKIPJACK TUNA

Skipjack tuna are distributed in tropical waters across the Pacific Ocean. In the eastern Pacific Ocean (EPO), the majority of catch is taken by the purse seine fishery. Since 1990 the purse-seine fishery associated with floating objects has become the dominant fishery type (Figure C-1).

An integrated statistical age-structured catch-at-length stock assessment was developed for skipjack tuna in the eastern Pacific Ocean using Stock Synthesis. The assessment is similar to those conduced for bigeye and yellowfin tuna and is fit to indices of relative abundance and length-composition data. Although the assessment is termed *interim* by the staff, the staff considers it reliable for management advice. The term *interim* results from additional improvements being expected on the skipjack assessment under the ongoing workplan to develop a stock assessment for skipjack in the EPO that includes tagging data.

There is substantial uncertainty about several model assumptions and sensitivity analyses are conducted to determine if the management advice is robust to the uncertainty. In particular, there is uncertainty about why the large skipjack are not seen in the purse-seine fishery. This could be due to dome-shaped selectivity, high fishing mortality, high natural mortality for old fish, or a rapid decline in growth rates for older fish. Several data sources are available to fit the model, but there is uncertainty about their reliability. Sensitivity analyses are conducted to determine if the management advice is robust to the use of the different data sources. Relative indices of abundance include: a) a longline index, for which the sample size is low; b) catch-per-set indices for purse-seine sets, by set type (floating objects, free swimming schools), for which the relationship between catch-per-set and abundance is uncertain; and, c) an index based on echosounder buoy data, which has recently been developed. A reference model is developed based on the most plausible assumptions and sensitivity analyses are conducted by changing the assumptions of the reference model. The diagnostics indicate that a data conflict exists, and that this was reduced somewhat when the stock east of 120°W was assessed separately. However, the management results were robust to the inclusion or exclusion of the index of abundance and length-composition data sets. An independent review of the SKJ assessment was conducted in 2022 and the recommendations will be used to improve the assessment.

MSY-based quantities cannot be estimated because the tradeoff between growth and natural mortality, in combination with the assumption that recruitment is independent of stock size, implies fish should be caught at the youngest ages to maximize yield, implying that the optimal fishing mortality should be infinite. Therefore, a conservative proxy for the target biomass of SBR = 0.3 based on values for bigeye and yellowfin, and the fishing mortality corresponding to that biomass, are proposed as the target reference points (SAC-14-09; SAC-14 INF-O). The reference model estimated that the 2021 exploitation rate was slightly above *status quo* (average level of 2017-2019; Figure C-2) as did over half of the sensitivity models ranging from being only slightly above to being 0.1 higher (except one model that estimated high exploitation rates; Table C-1). The reference model and most of the sensitivity analyses estimate that the current biomass is above the target reference point and the fishing mortality is below the target fishing mortality (Figure C-3, Table C-1).

The model will continue to be improved towards the benchmark assessment in 2024, including incorporating the results of the analysis of recently collected tagging data and recommendations from the independent review.

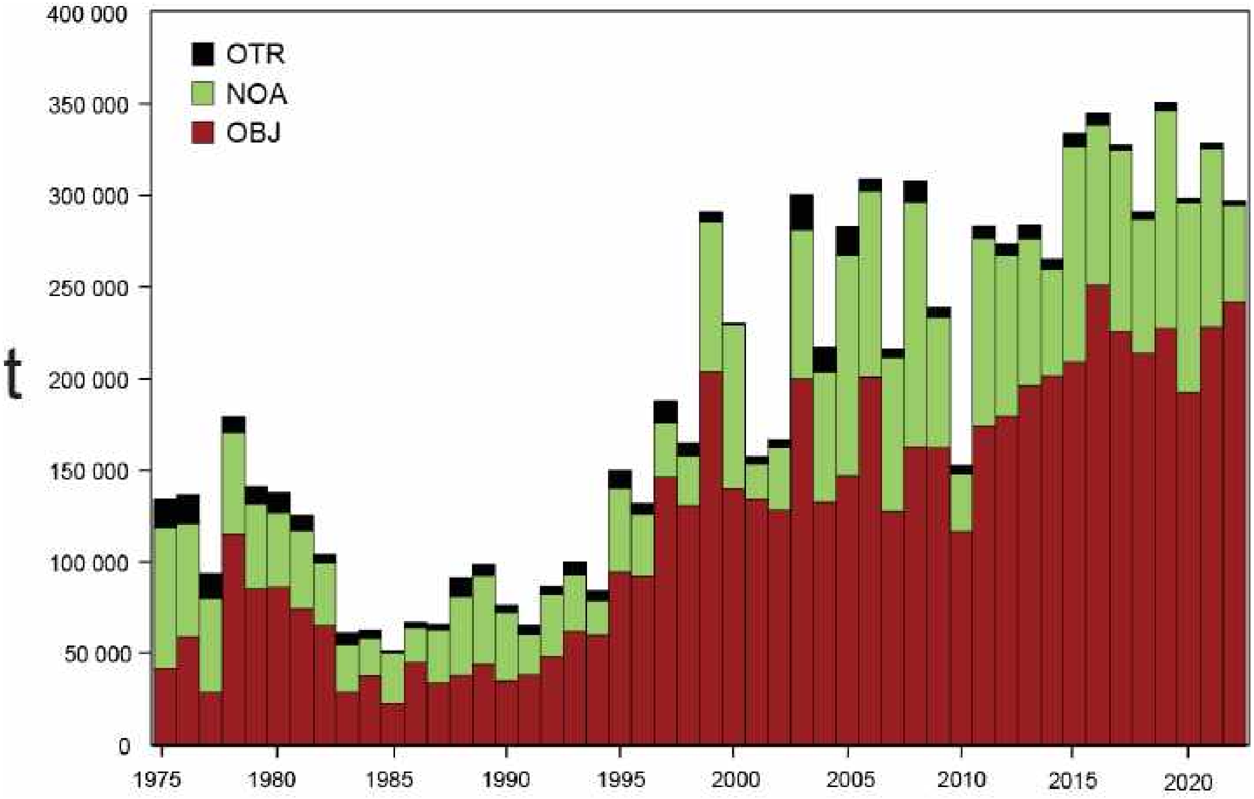

FIGURE C-1. Total catches (retained catches plus discards) for the purse-seine fisheries, by set type (NOA, OBJ) and retained catches for the other (OTR) fisheries, of skipjack tuna in the eastern Pacific Ocean, 1975-2021. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. The 2020 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, 1975-2021. 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 2020 son preliminares.

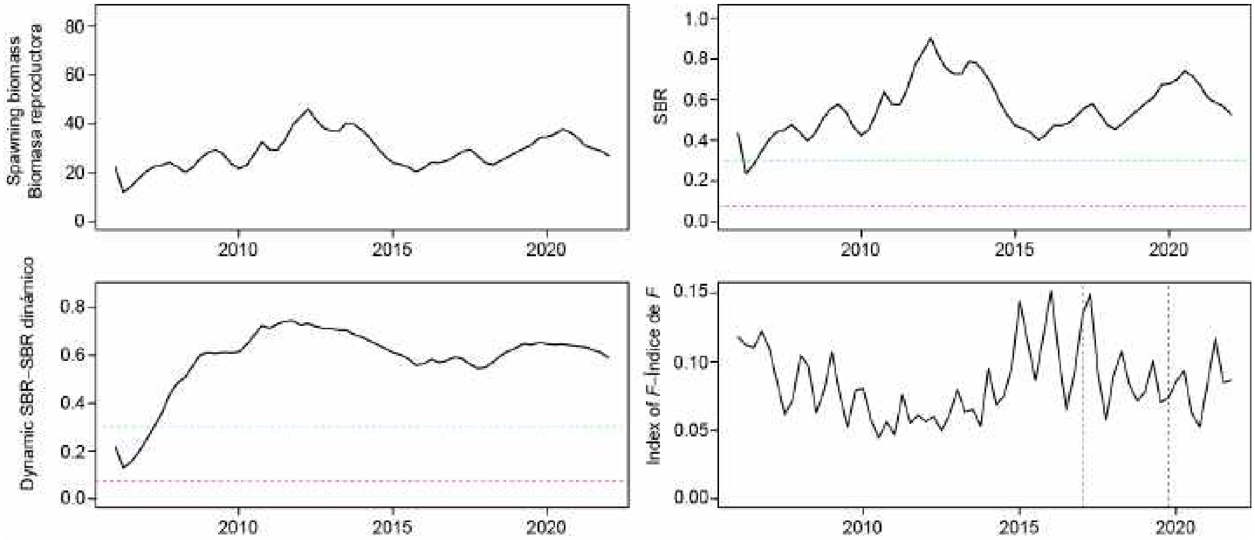

FIGURE C-2. Spawning biomass, spawning biomass ratio, dynamic spawning biomass ratio, and an index of quarterly exploitation rate for the reference model. The green dashed horizontal line is the target biomass reference point (SBR = 0.3) and the red horizontal dashed line is the limit biomass reference point (SBR = 0.077). The two vertical lines represent the *status quo* period (2017-2019).

FIGURA C-2. Biomasa reproductora, cociente de biomasa reproductora, cociente de biomasa reproductora dinámica y un índice de la tasa de explotación trimestral para el análisis de sensibilidad que supone que la edad de un pez de 37 cm es 3 trimestres. La línea horizontal verde discontinua es el punto de referencia objetivo de la biomasa (SBR = 0.3) y la línea horizontal roja discontinua es el punto de referencia límite de la biomasa (SBR = 0.077). Las dos líneas verticales representan el periodo de *statu quo* (2017-2019).

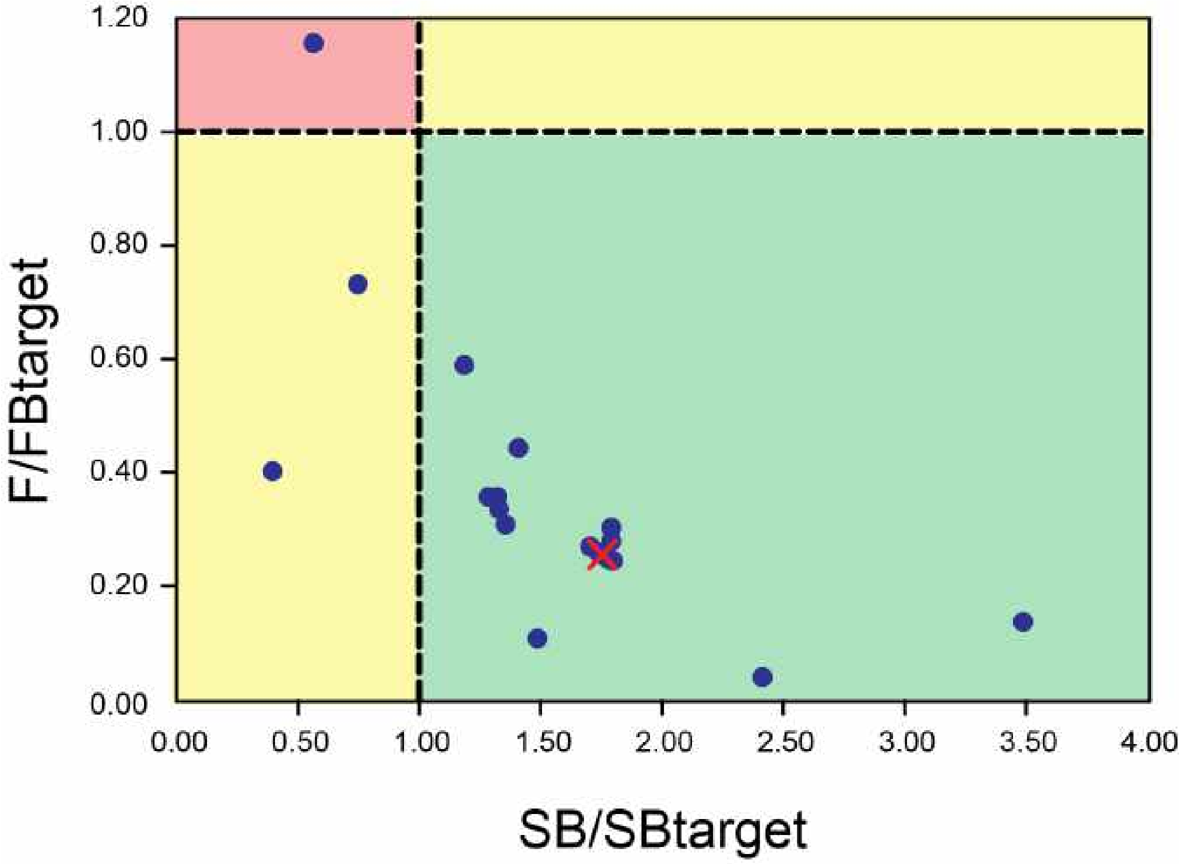

FIGURE C-3. Kobe plot showing the stock status estimates from all the models.

FIGURA C-3. Gráfica de Kobe que muestra las estimaciones de la condición de la población de todos los modelos.

TABLE C-1. Estimates of spawning biomass, spawning biomass ratio (SBR), dynamic spawning biomass ration (dSBR), average recruitment over the model time period (except the 4th quarter of 2021) as a ratio of the estimated virgin recruitment for all of the models, average exploitation rate in 2020 as a ratio of the *status quo*, average exploitation rate in 2021 as a ratio of the *status quo*, and current fishing mortality as a ratio of the fishing mortality corresponding to B_{target} = 0.3B0. R_{ave}/R_0 is a check to make sure the SBR based on B_0 is not biased due to the bias correction for recruitment residuals (this will affect the plots of SBR that are plotted with confidence intervals). The dSBR is adjusted by the ratio R_{ave}/R_0. The red highlighting and text indicate where SBR or dSBR are below the proxy target reference point (0.3) and when the *status quo* fishing mortality (average of 2017-2019) has been exceeded.
TABLA C-1. Estimaciones de biomasa reproductora, cociente de biomasa reproductora (SBR), cociente de biomasa reproductora dinámica (dSBR), reclutamiento promedio a lo largo del periodo del modelo (excepto el cuarto trimestre de 2021) como razón del reclutamiento virgen estimado para todos los modelos, tasa promedio de explotación en 2020 como razón del *statu quo*, tasa promedio de explotación en 2021 como razón del *statu quo*, y mortalidad por pesca actual como razón de la mortalidad por pesca correspondiente a B_{obj} = 0.3B0. R_{prom}/R_0 es una comprobación para asegurarse de que el SBR basado en B_0 no esté sesgado debido a la corrección del sesgo por los residuales de reclutamiento (esto afectará a las gráficas de SBR que se trazan con intervalos de confianza). El dSBR se ajusta por la razón R_{prom}/R_0. Las celdas y el texto en rojo indican los casos en que el SBR o dSBR están por debajo del punto de referencia objetivo sustituto (0.3) y cuando se ha rebasado la mortalidad por pesca del *statu quo* (promedio de 2017-2019).

Model code	**Model**	**SB**	**SBR**	**dSBR**	**R_{av}/R_0**	**F_{2020}/F_{sq}**	**F_{2021}/F_{sq}**	**F_{cur}/ Fb_{target}**
	Reference model	26871	0.53	0.59	0.98	0.80	1.01	0.25
a	L_{inf} = 73 cm	28475	0.54	0.60	0.99	0.81	1.02	0.24
b	L_{inf} = 83 cm	24899	0.51	0.57	0.98	0.79	1.00	0.27
c	L_{cv} = 0.05	27560	0.53	0.60	0.97	0.80	1.02	0.25
d	L_{cv} = 0.07	26086	0.52	0.58	0.99	0.79	1.01	0.26
e	Bias corrected catch for 2020-2021	27861	0.53	0.60	0.98	0.76	1.03	0.25
f	No echosounder index	70976	1.05	0.79	1.04	0.59	0.55	0.14
g	No longline index	23746	0.41	0.56	0.99	0.92	1.06	0.31
h	OBJ catch-per-set index	25339	0.54	0.58	0.98	0.81	0.95	0.28
i	NOA catch-per-set index	22421	0.54	0.55	0.98	0.76	0.90	0.30
j	NOA asymptotic selectivity	3688	0.17	0.18	0.98	0.93	1.00	1.16
k	OBJ asymptotic selectivity	14786	0.42	0.44	0.96	0.77	0.88	0.44
l	East of -120	7960	0.36	0.36	1.01	0.93	0.97	0.59
m1	Higher M for adults	55346	0.72	0.84	0.99	0.72	1.01	0.04
m2	No LL higher M for adults	20029	0.45	0.64	1.00	0.88	1.09	0.11
m3 no M	No LL not Dome	21993	0.40	0.54	0.99	0.92	1.07	0.36
m3 M	No LL not Dome higher M for adults	1772	0.12	0.14	0.97	1.05	1.59	0.40
n	Constant selectivity after 78 cm	26674	0.53	0.59	0.98	0.80	1.01	0.26
o1	L_{inf} = 70cm	28334	0.54	0.59	0.99	0.81	1.02	0.24
o2	No longline L_{inf} = 70cm	21296	0.40	0.52	0.99	0.92	1.06	0.33
o3	No longline L_{inf} = 70cm not dome	19489	0.39	0.50	0.99	0.92	1.07	0.36
o4	as h3 with F5 cons select after 70cm	6572	0.22	0.26	0.97	0.95	1.10	0.73

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 catch small bigeye have replaced longline fisheries as the dominant fishery type for EPO bigeye since 1996.

In 2023, stock status indicators (SSIs) were developed for bigeye using the data collected in the EPO as a whole (SAC-14-04). For the floating-object fishery, the main fishery catching bigeye since 1993, fishing effort has been continuously increasing (Figure B-2). This increase in fishing effort corresponds to decreased catch per set and decreased average length for the floating-object fishery during the same time (Figure D-2). In 2020 and 2021, COVID-19 became a global pandemic and had pronounced impacts on the floating-object fishery in the EPO. Specifically, fishing effort dramatically decreased (Figure B-2) while catch and catch per set for bigeye both notably increased in 2020 (Figure D-2). The staff recently found that the estimated bigeye catches in the floating-object fishery are overestimated for 2020 and 2021 by 12% and 18.2%, respectively (SAC-14 INF-D). This overestimation was caused by the impact of the COVID-19 pandemic on the operations of the port-sampling program for species and size compositions. In 2020 and 2021, the bias-adjusted bigeye catches in the floating-object fishery are slightly above and below the *status quo* level, respectively. In 2022, the number of floating-object sets reached a historical high level while the estimated bigeye catch in the floating-object fishery remained low due to the historical low catch per set value in 2022.

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 2012 (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 overall 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 bigeye and yellowfin, 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 addressing three issues with the assessment (SAC-11-INF-J). The first issue, which is an 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 issue 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 issue 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 with respect to 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.

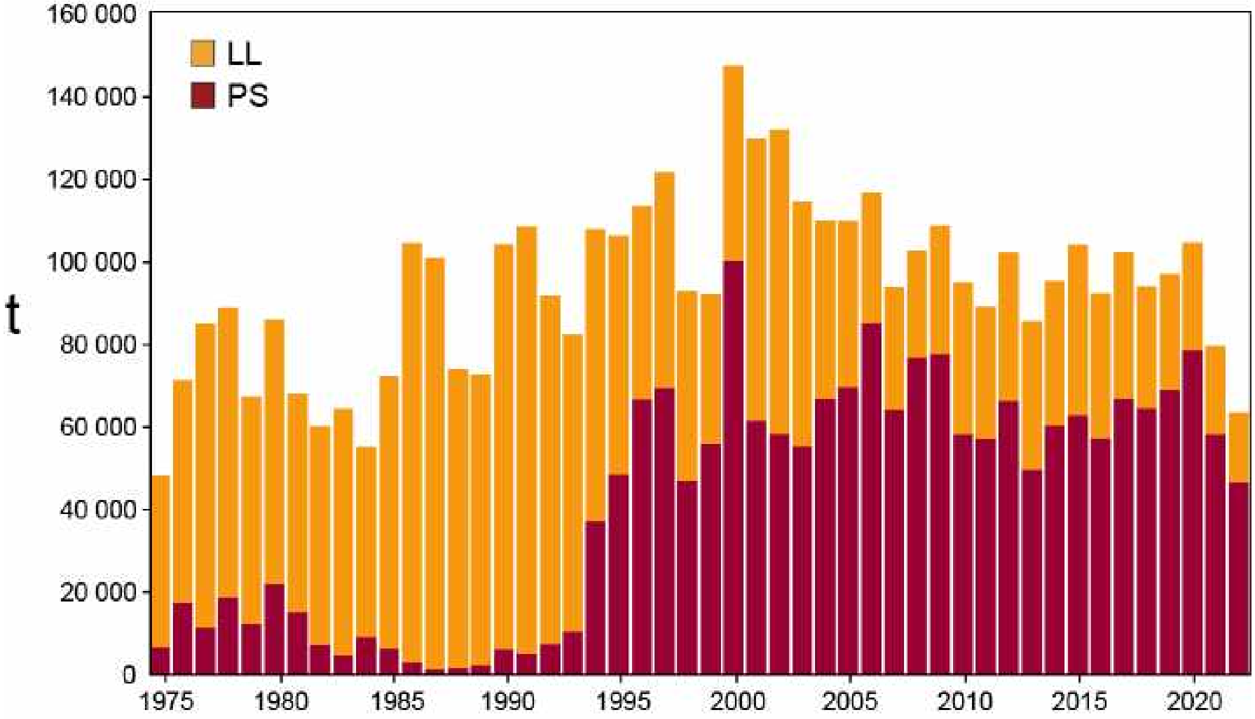

FIGURE D-1. Total catches (retained catches plus discards) by the purse-seine (PS) fisheries, and retained catches by the longline (LL) fisheries, of bigeye tuna in the eastern Pacific Ocean, 1975-2022. The purse-seine catches are adjusted to the species composition estimate obtained from sampling the catches. 2020 and 2021 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, 1975-2022. Se ajustan las capturas de cerco a la estimación de la composición por especie obtenida del muestreo de las capturas. Los datos de 2020 y 2021 son preliminares.

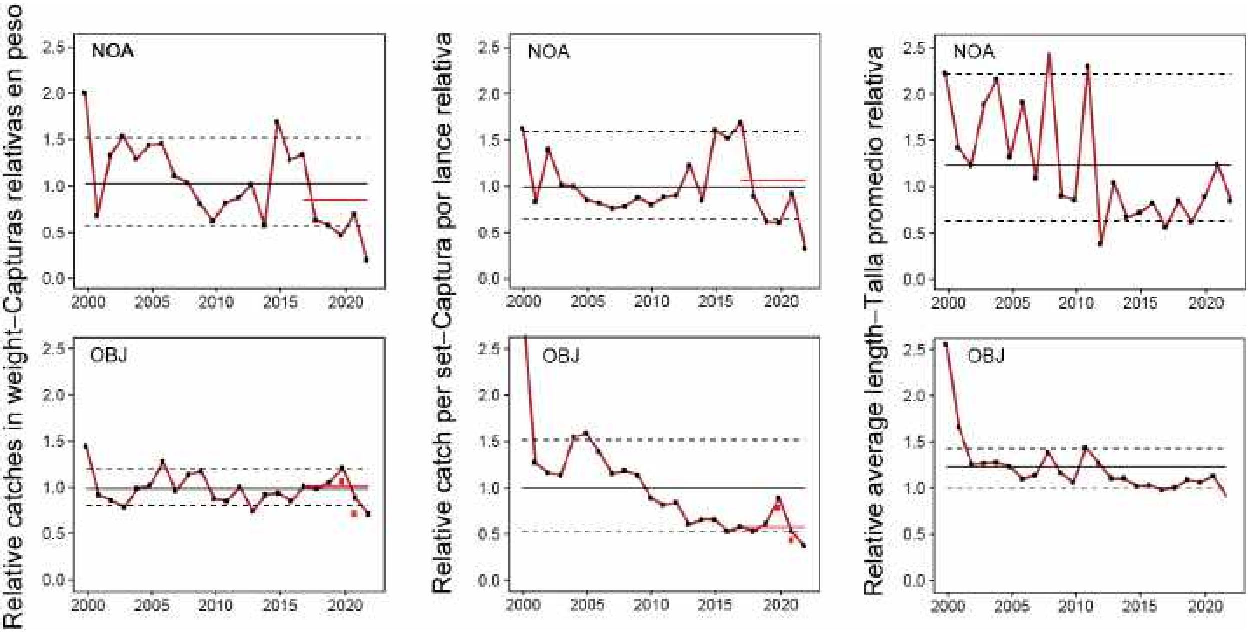

FIGURE D-2. Indicators of catch, catch per set, and average length for bigeye tuna in the EPO based on purse-seine data for 2000-2022. The dashed horizontal lines are the 10th and 90th percentiles, and the solid horizontal line is the median. The red dots are the bias-adjusted estimates for floating-object catches in the two COVID-19 years (see SAC-13-05). The red dashed lines mark the *status quo* reference levels (average conditions in 2017-2019).

FIGURA D-2. Indicadores de captura, captura por lance, y talla promedio para el atún patudo en el OPO basados en datos de cerco para 2000-2022. Las líneas horizontales discontinuas son los percentiles de 10% y 90%, y la línea horizontal sólida es la mediana. Los puntos rojos son las estimaciones ajustadas al sesgo de las capturas de objetos flotantes en los dos años de COVID-19 (ver SAC-13-05). Las líneas rojas discontinuas marcan los niveles de referencia de *statu quo* (condiciones promedio en 2017-2019).

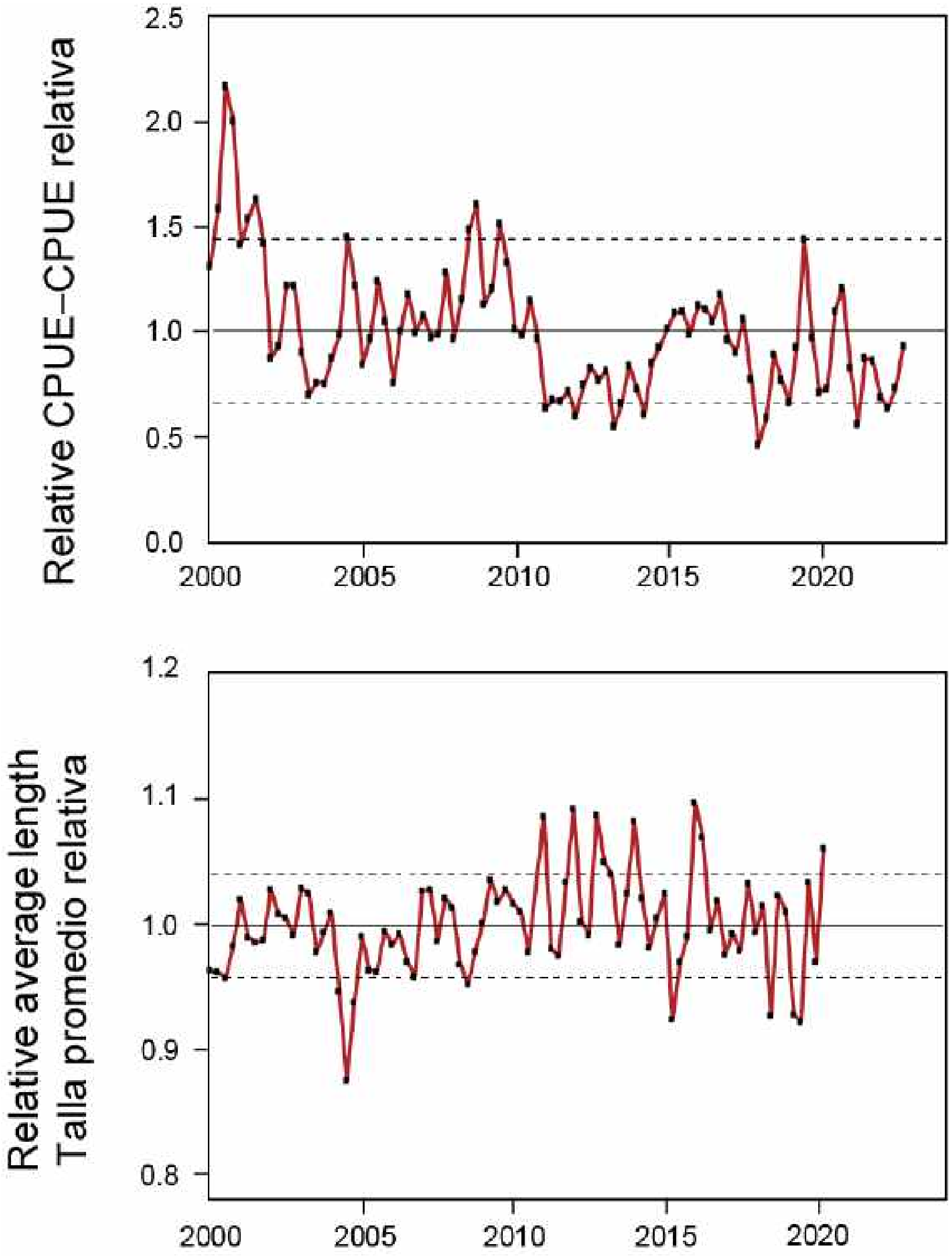

FIGURE D-3. Index of abundance and average length of bigeye in the EPO, based on Japanese longline data for 1975-2022. The dashed horizontal lines are the 10th and 90th percentiles, and the solid horizontal line is the median.

FIGURA D-3. Índice de abundancia y talla promedio del patudo en el OPO, basados en datos de palangre japoneses para 1975-2022. Las líneas horizontales de trazos representan los percentiles de 10 y 90%, y la línea horizontal sólida la mediana.

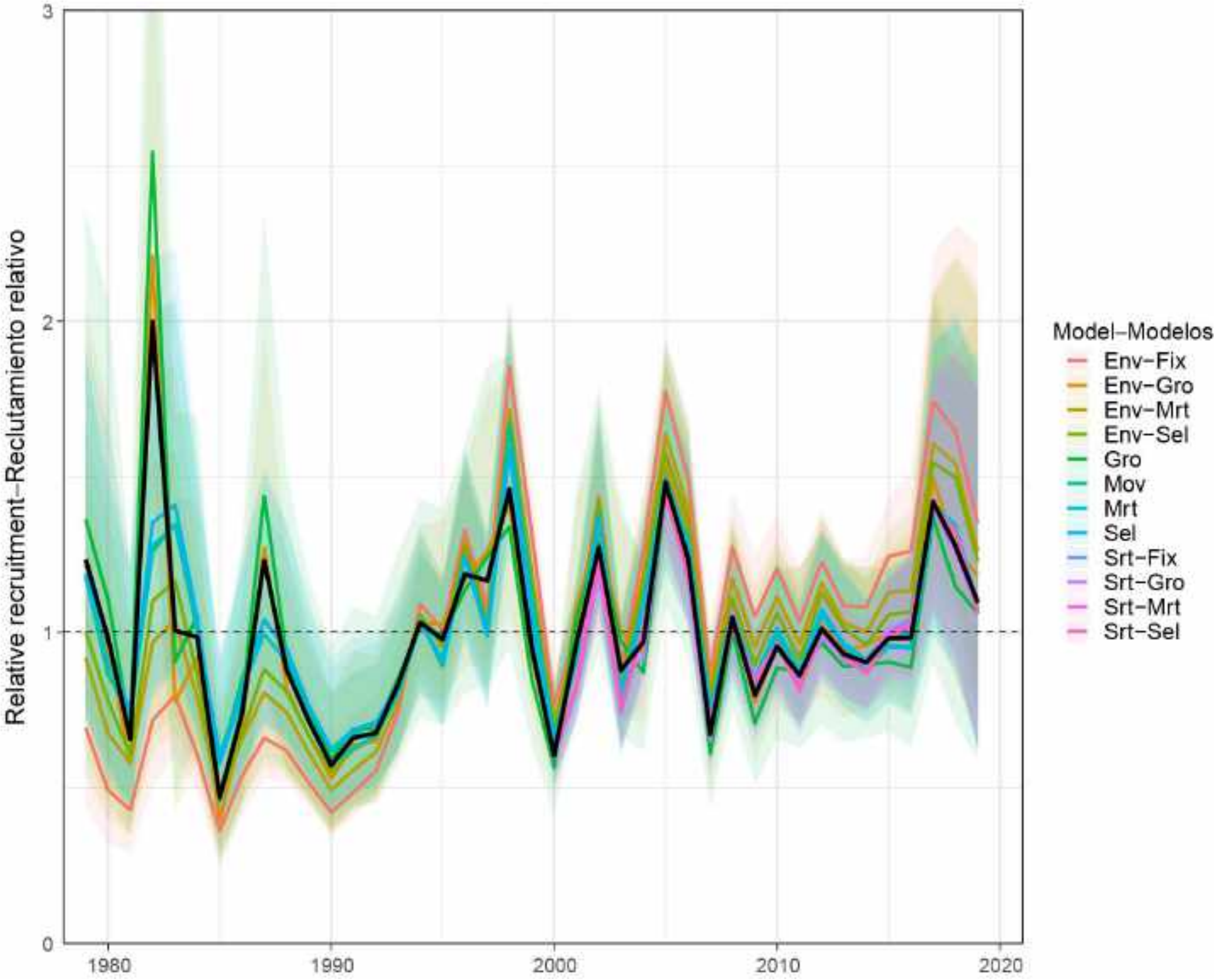

FIGURE D-4. Comparison of annual relative recruitment estimates for bigeye tuna in the eastern Pacific Ocean from the twelve reference models (only the estimates that correspond to steepness = 1.0 are shown). The shaded areas represent the 95% confidence intervals and the black line represents the combined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

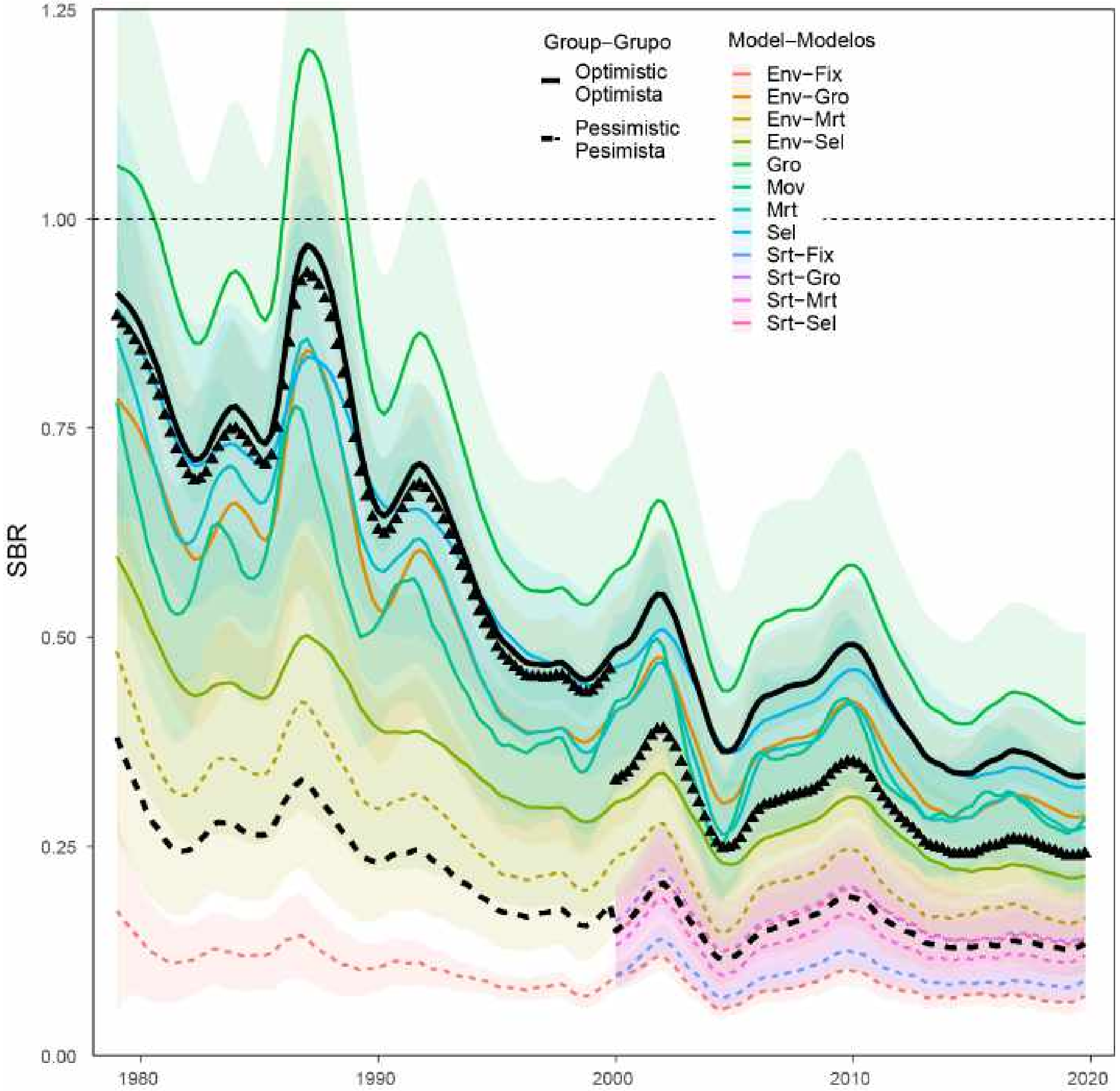

FIGURE D-5. Comparison of spawning biomass estimates for bigeye tuna in the eastern Pacific Ocean from the twelve reference models (only the estimates that correspond to steepness = 1.0 are shown). The shaded areas represent the 95% confidence intervals and the two black lines represent the combined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

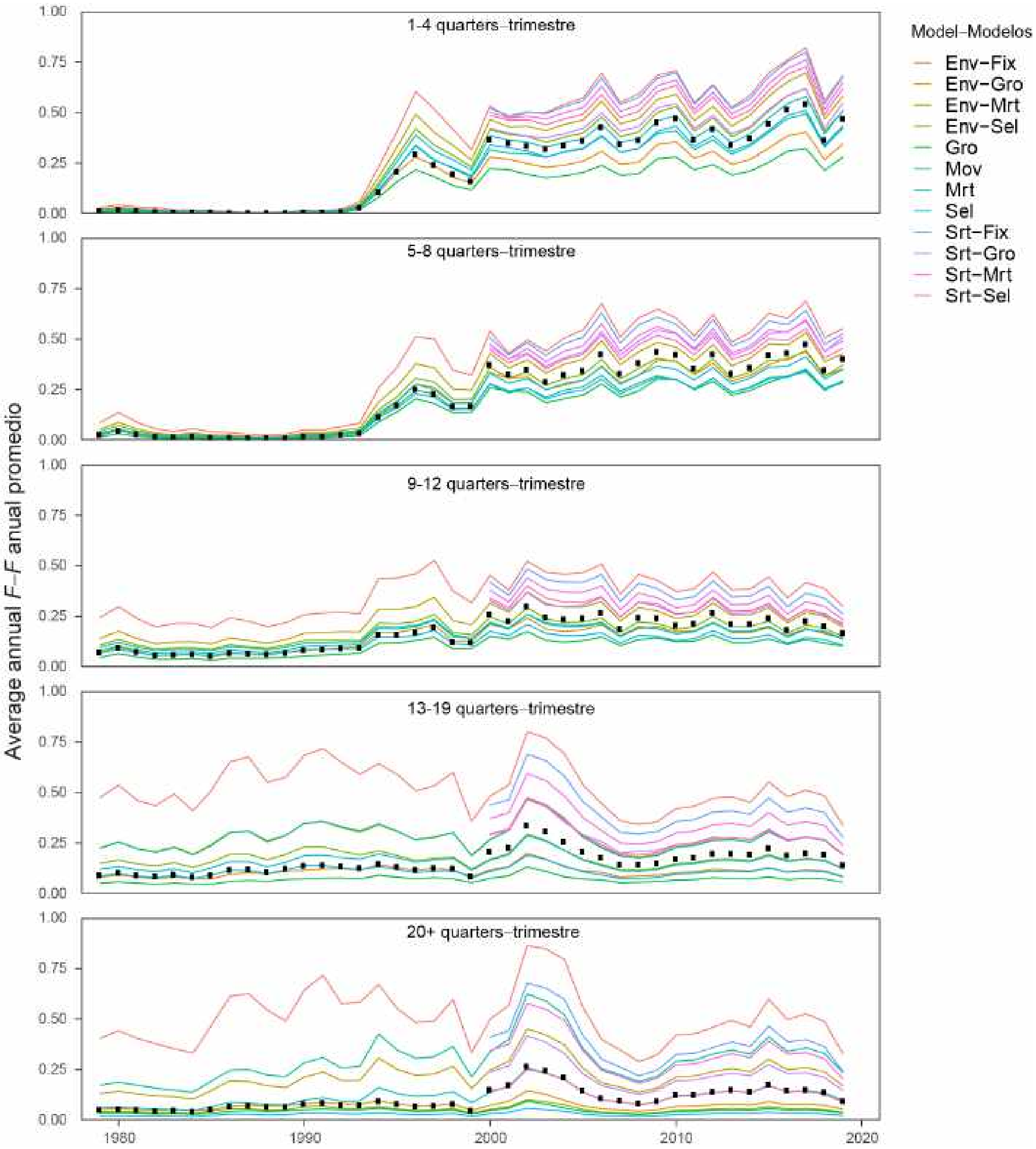

FIGURE D-6. Comparison of average annual fishing mortality, by age groups, of bigeye tuna in the eastern Pacific Ocean (only the estimates that correspond to steepness = 1.0 are shown). The black dots show the combined values across all models with a steepness of 1.0.

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.

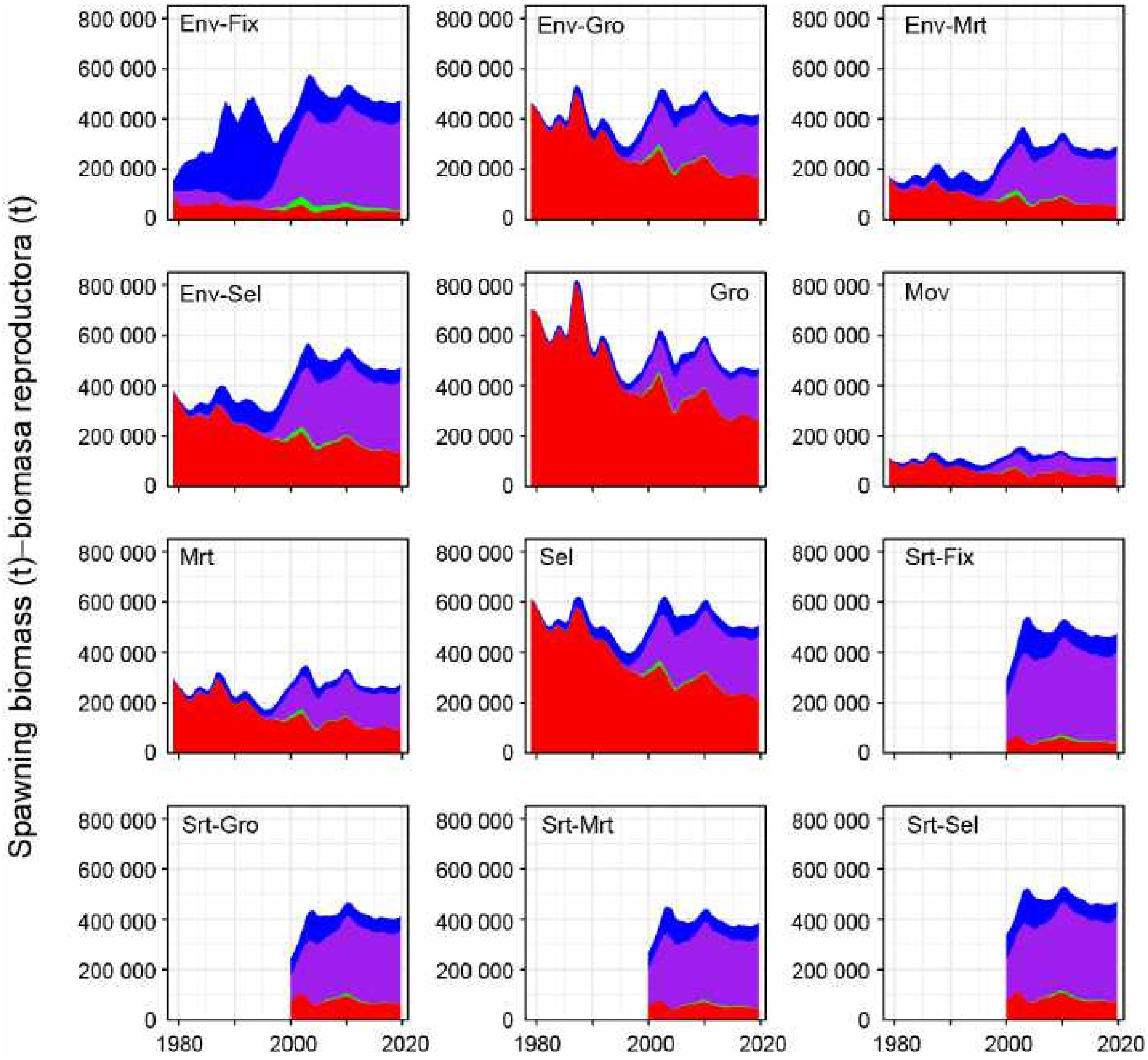

FIGURE D-7. Comparison of spawning biomass trajectory of a simulated population of bigeye tuna in the eastern Pacific Ocean that was never exploited (top line) and that predicted by the stock assessment model (bottom line). The shaded green, purple, and blue areas between the two lines show the portions 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.

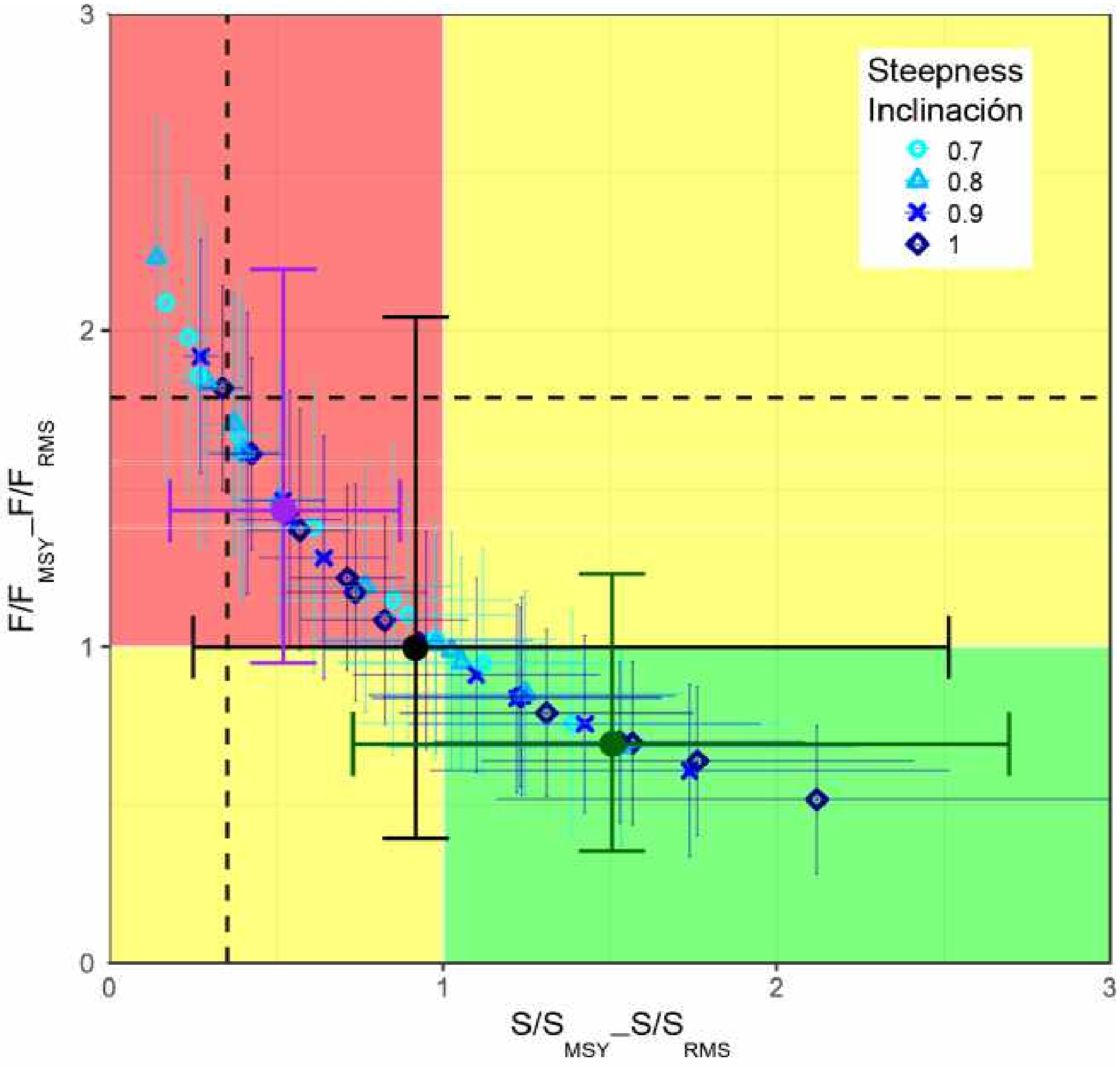

FIGURE D-8. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their MSY reference points (S_{MSY_d} and F_{MSY}) estimated by the 44 converged reference model runs (see Table 4). Each dot is based on the average *F* over the most recent three years. 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.

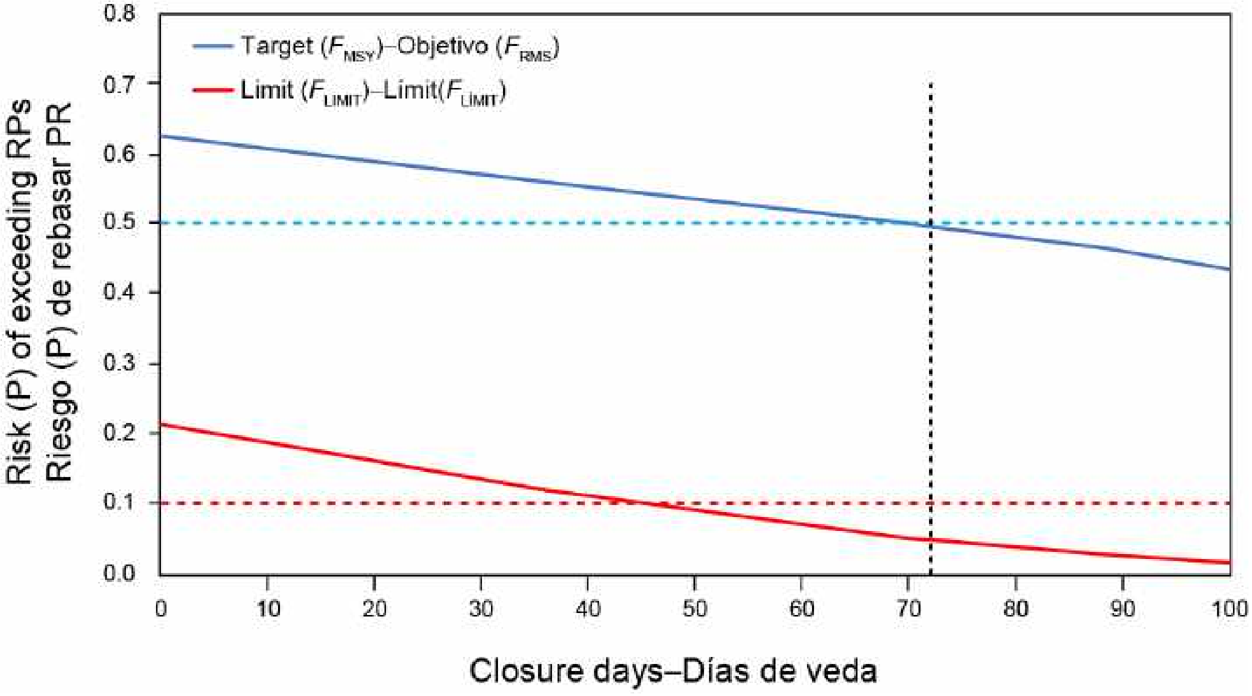

FIGURE D-9. Risk curves showing the probability of exceeding the target (blue) and limit (red) reference points for different durations of the temporal closure.

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.

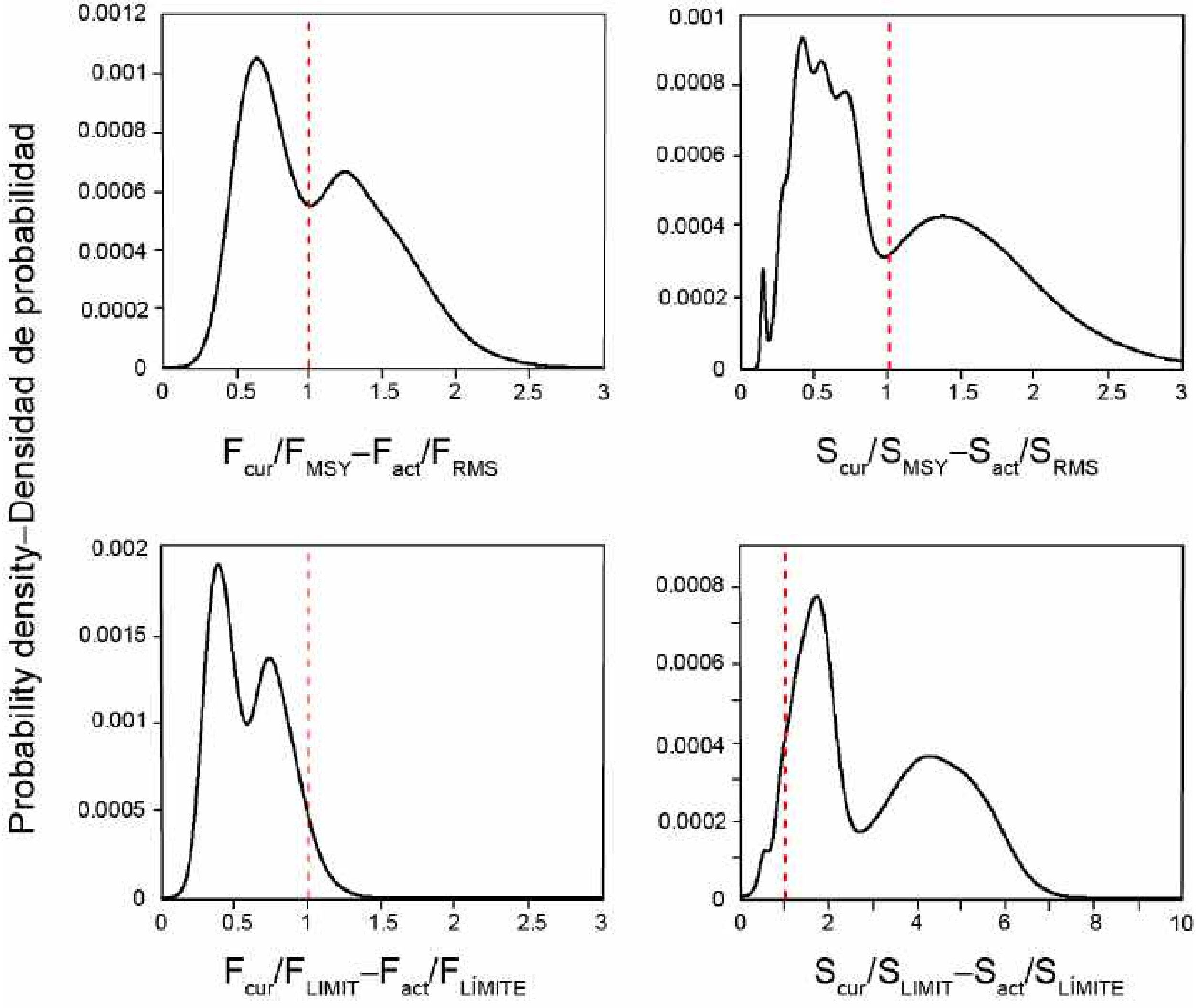

FIGURE D-10. Combined bigeye probability density function for F_{cur}/F_{MSY}, F_{cur}/F_{LIMIT}, S_{cur}/S_{MSY}, and S_{cur}/S_{LIMIT}.
FIGURA D-10. Función de densidad de probabilidad combinada para F_{act}/F_{RMS}, $F_{act}/F_{LÍMITE}$, S_{act}/S_{RMS}, y $S_{act}/S_{LÍMITE}$ de patudo.

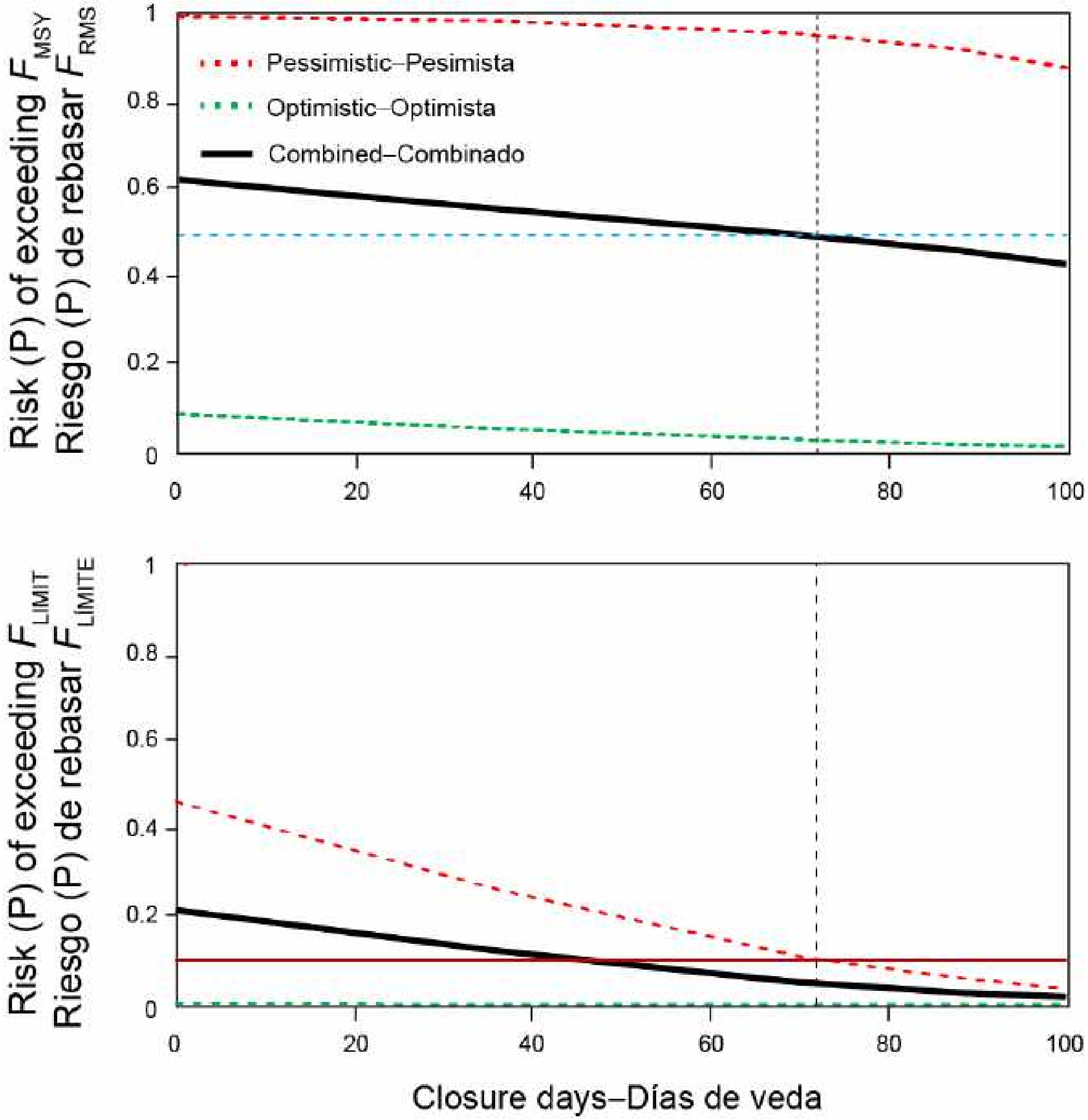

FIGURE D-11. Risk curves showing the probability of exceeding the target (top) and limit (bottom) reference points for bigeye with different durations of the temporal closure, combined by pessimistic and optimistic models resulting from the bimodal combined distribution.

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.

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	
***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

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 (1952-2018) 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.

A benchmark 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 2022. 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 1952-2020); (2) the SSB steadily declined from 1996 to 2010; (3) the SSB has increased since 2011 resulting in the 2020 SSB being back to the 1996 level; (4) total biomass after 2011 continued to increase with an increase in young fish, creating the 2nd highest biomass peak in the assessed history in 2020; (5) fishing mortality (F%SPR), which declined to a level producing about 1% of SPR in 2004-2009, returned to a level producing 30.7% of SPR in 2018-2020; and (6) SSB in 2020 was 10.2% of $SSB_{F=0}$, an increase from the 5.6% of $SSB_{F=0}$ estimated for 2018 in the 2020 assessment (2018 was the last year of the 2020 assessment). Based on the model diagnostics, the estimated biomass trend for the last 40 years is considered robust although SSB prior to the 1980s is uncertain due to data limitations. The SSB in 2020 was estimated to be around 65,464 t, which is a 30,000 t increase from 2018 according to the base-case model. An increase of young fish (0-2 years old) biomass was observed in 2016-2020, likely resulting from low fishing mortality on those fish and is expected to accelerate the recovery of SSB in the future even further. Historical recruitment estimates have fluctuated since 1952 without an apparent trend. A substantial decrease in estimated *F* is observed in ages 0-2 in 2018-2020 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 2020 SSB was 10.2% of the SSB in the absence of fishing ($10.2\%SSB_{F=0}$), and the recent (2018-2020) fishing mortality (*F*) corresponds to F30.7%SPR. Because the harvest strategy includes 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, but does not exceed 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.

Resolution C-18-02 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 by adopting an 1) 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 and 2) a second rebuilding target of $20\%SSB_{F=0}$ to be achieved within 10 years of reaching the initial rebuilding target or by 2034, whichever is earlier, with at least 60% probability. The IATTC has adopted resolutions to restrict the catch of bluefin tuna in the EPO (e.g. C-16-08, C-18-01, C-20-02, C-21-05). Resolution C-21-05 states that during 2021-2022, in the IATTC Convention Area, combined total commercial catches of Pacific bluefin tuna by all CPCs shall not exceed the catch limit of 7,295 metric tons. During 2023-2024, in the IATTC Convention Area, combined total commercial catches of Pacific bluefin tuna by all CPCs shall not exceed the catch limit of 7,990 metric tons. Resolution C-18-02 also requires that no later than the IATTC meeting in 2020, taking into account the outcomes of the Joint IATTC-WCPFC NC Working Group, the Commission shall consider and develop candidate reference points and harvest control rules. These candidate reference points and harvest control rules will be forwarded to the Joint IATTC-WCPFC NC Working Group and ISC for consideration and potential inclusion in a management strategy evaluation to be completed by the ISC. This task has still not been accomplished.

The 2020 SSB was above the initial rebuilding target but remains below the second rebuilding target adopted by the WCPFC and IATTC. However, stock recovery is occurring at a faster rate than anticipated by managers when the Harvest Strategy to foster rebuilding were implemented in 2014. Projections were conducted based on the base-case model under several harvest scenarios and time schedules as requested by the RFMOs, including the harvest strategy proposed at the Joint WCPFC NC-IATTC WG (JWG) meeting. Under all examined scenarios the second rebuilding target is reached, and the risk of SSB falling below the historical lowest SSB at least once in 10 years is negligible. Some scenarios had the future impact ratios between WPO and EPO specified by the RFMOs and were tuned to achieve the second rebuilding target with 60% probability, and result in larger catch increases.

The Chair of the ISC PBFWG requested that the JWG provide technical guidance on PBF MSE so that the PBFWG can provide the final results to JWG in 2025 for the selection of a Management Procedure (MP) for PBF. ISC requested the JWG to (i) refine operational management objectives so that they can be evaluated in MSE, (ii) reduce candidate MPs to a realistic level (preferably less than 10), and (iii) agree to 3-year management cycle to allow time to improve scientific research for PBF. At its 8th meeting in July 2023, the JWG revised and refined a set of candidate management objectives and performance indicators in the categories of safety, status, stability and yield and also did the same for a set of candidate reference points and harvest control rules (HCRs) for Pacific bluefin tuna. The JWG also approved an interim harvest strategy to be implemented once the second rebuilding is met and until a long-term harvest strategy is adopted based on the MSE process. Finally, the JWG also updated its “Work Plan for Development of a Long-term Harvest Strategy for PBF (including MSE).”

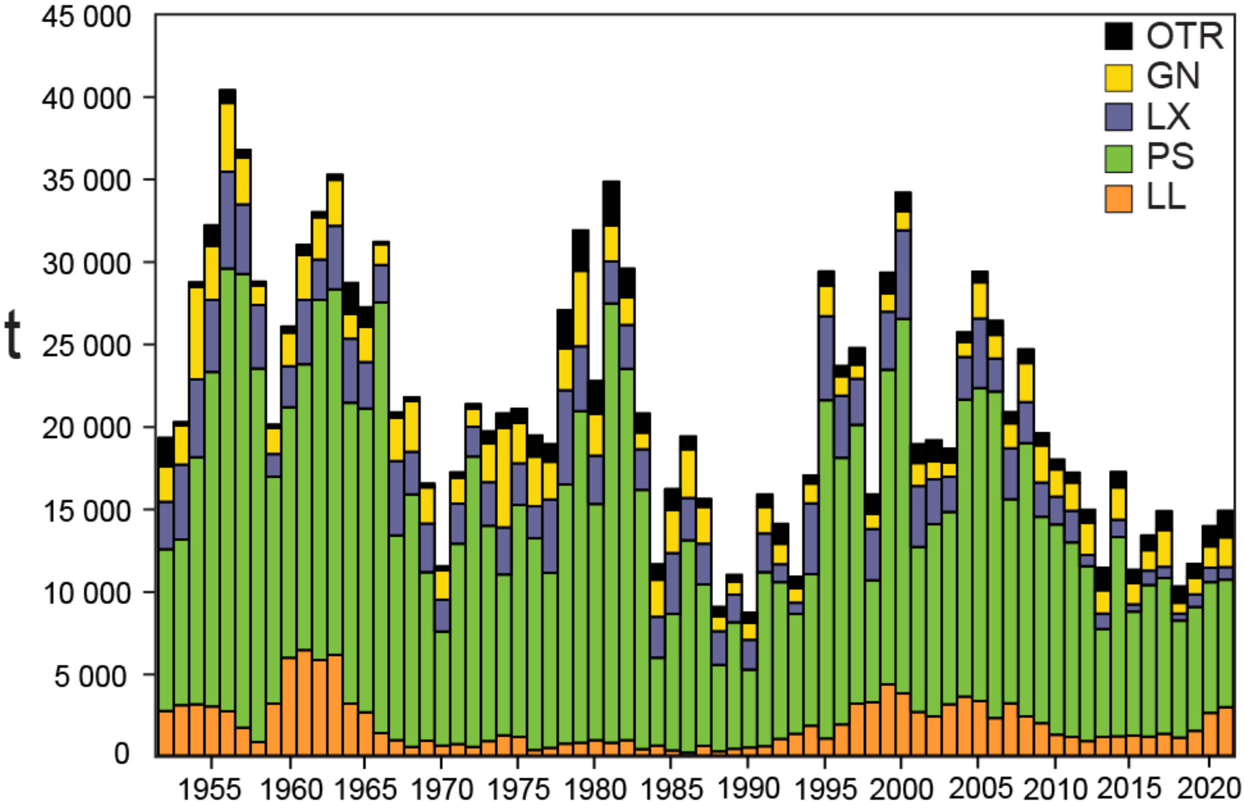

FIGURE E-1. Retained catches of Pacific bluefin tuna, by gear, 1952-2020. GN: gillnet; LL: longline; LX: hook and line; OTR: other; PS: purse seine.

FIGURA E-1. Capturas retenidas de atún aleta azul del Pacífico, por arte, 1952-2020. GN: red agallera; LL: palangre; LX: sedal y anzuelo; OTR: otras; PS: red de cerco.

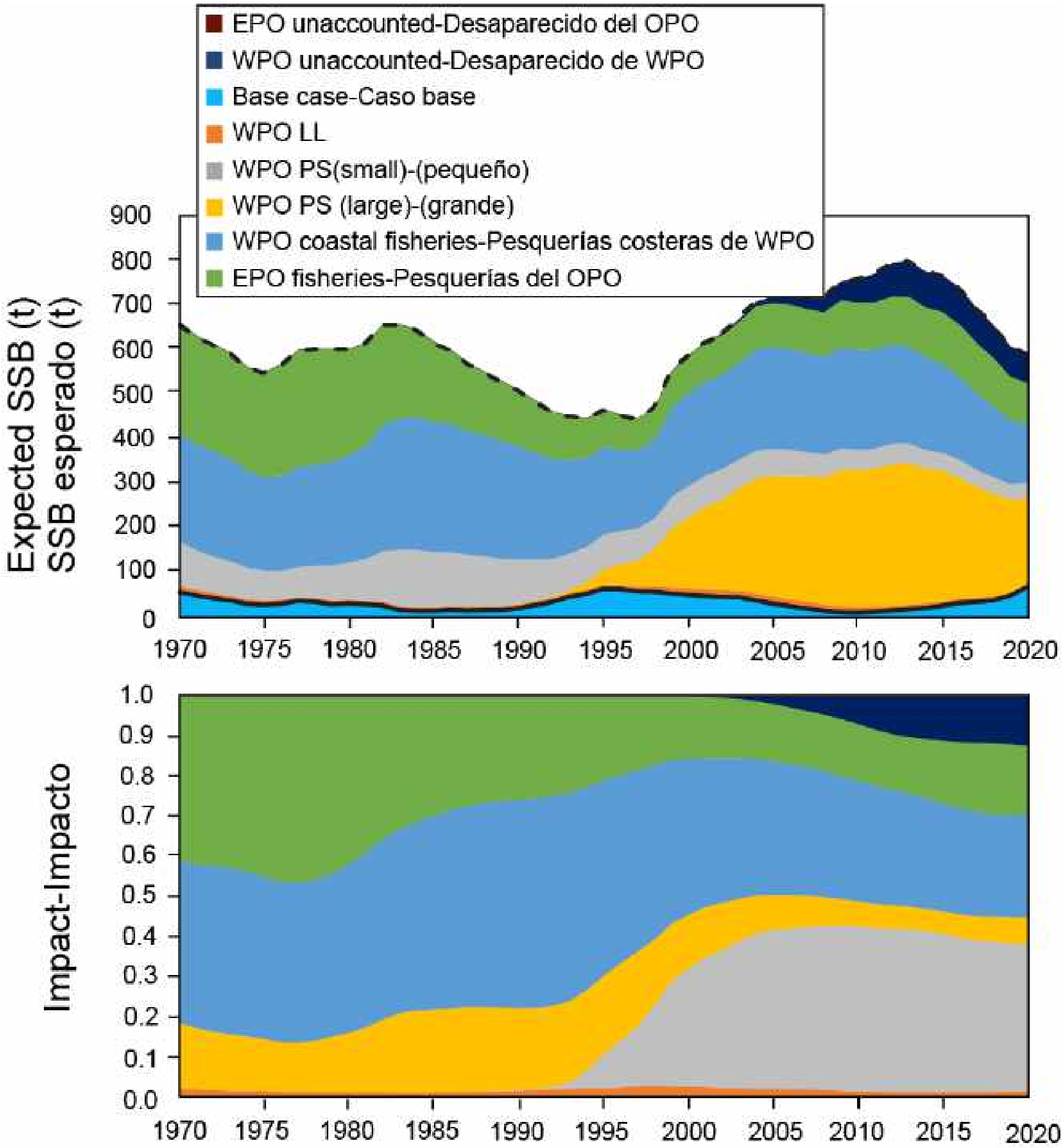

FIGURE E-2. Estimates of the impact on the Pacific bluefin tuna population of fisheries in the EPO and in the WPO (upper panel). The dashed line represents the estimated hypothetical unfished spawning biomass, and the solid line the estimated actual spawning biomass. The shaded areas indicate the impact 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 2022 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 2022 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 is 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 peaked at about 94,500 t in 2017, declining slightly after that. During 2019-2021, the annual albacore catch in the south Pacific averaged about 77,500 t (Figure F-1a), of which about 48.8% was taken in the eastern Pacific Ocean (EPO). The total annual catches of North Pacific albacore increased from about 55,000 t in 1993 to about 126,000 t in 1999 (Figure F-1b). They then declined in the early 2000s then recovered in the early 2010s. Since 2012 catches have declined from about 92,000 to about 40,000t in 2021. The catches averaged about 45,000 t in 2019-2021, of which 24% 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 20ºN and 20ºS latitudes. North Pacific albacore are believed to spawn between March and July in the western and central Pacific.

The movements of North Pacific albacore are strongly influenced by oceanic conditions, and migrating albacore tend to concentrate along oceanic fronts in the North Pacific Transition Zone. Most of the catches are made in water temperatures between about 15º and 19.5ºC. Details of the migration remain unclear, but juvenile fish (2- to 5-year-olds) are believed to move into the eastern Pacific Ocean (EPO) in the spring and early summer, and return to the western and central Pacific, perhaps annually, in the late fall and winter, where they tend to remain as they mature. This pattern may be complicated by sex-related movements of large adult fish (fork length (FL) >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 2021 and 2023, respectively. The assessments indicate that it is not likely that either stock is overfished or that overfishing is taking place.

South Pacific albacore

In collaboration with the IATTC, the Pacific Community (SPC) conducted a benchmark stock assessment for South Pacific albacore tuna in 2021. It is based on a spatially-explicit stock assessment model in which the South EPO is considered as a single area due to the lack of tagging data. Several axes of the structural uncertainties were explored in this benchmark assessment, including steepness, movement, size data weighting, recruitment distribution, and the combination of growth and natural mortality. The final structural uncertainty grid for this assessment consisted of 72 models. Results suggest that the movement scenario (tagging vs. SEAPODYM informed movement rates) is the major source of uncertainty among those uncertainty axes. Based on the weighted grid of the 72 models, the estimated reference points for albacore tuna in the South Pacific are:

- The median value of relative recent (2016-2019) spawning stock biomass depletion ($SSB_{2016\text{-}2019}/SSB_{F=0}$) was 0.52 with a 10th to 90th percentile interval of 0.41 to 0.57.
- There was a 0% probability (0 out of 72 models) that the recent (2016-2019) spawning biomass had breached the limit reference point (0.2) adopted by the WCPFC.
- The median of relative recent fishing mortality as a ratio of that corresponding the MSY ($F_{2015\text{-}2018}/F_{MSY}$) was 0.24 with a 10th to 90th percentile interval of 0.15 to 0.37.
- There was a 0% probability (0 out of 72 models) that the recent (2015-2018) fishing mortality was above F_{MSY}.

In summary, the benchmark assessment suggests that the South Pacific albacore stock is healthy and the recent fishing mortality is much lower than the fishing mortality at MSY. Nevertheless, it should be noted that the spawning biomass of South Pacific albacore was estimated to have decreased sharply since 2017 due likely to the continuing increase in the amount of longline catch in recent years (see SAC-13-03). For albacore in the south EPO, the spawning biomass ratio (spawning biomass divided by spawning biomass in an unfished condition) is estimated to have decreased from above 0.9 in 1960 to less than 0.5 in 2019.The staff will continue collaborating with the Pacific Community (SPC) to monitor the stock status of South Pacific albacore tuna by using stock status indicators and conducting another benchmark assessment with the SPC in 3-4 years.

North Pacific albacore

A new stock assessment for north Pacific albacore was completed in 2023 by the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the north Pacific Ocean (ISC) (SAC-14 INF-R). 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 2019 and 2021 (about 43,000 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 that harvest mainly adults.

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 SSB_{2021} was estimated to be approximately 54% (95% CI: 40 – 68%) of $SSB_{current,\ F=0}$ and 1.8 (95% CI: 1.3 – 2.3) times greater than the estimated threshold reference point (Table ES1). The estimated current fishing intensity ($F_{2018\text{-}2020}$) was estimated to be $F59_{\%SPR}$ (95% CI: $F72_{\%SPR}$ – $F46_{\%SPR}$) and was lower than both the $F45_{\%SPR}$ target reference point and the average fishing intensity during 2002 – 2004 (Table F1).

Based on the results of the new stock assessment for north Pacific albacore, the working group concludes that:

1. The stock is likely not overfished relative to the threshold ($30\%SSB_{current,\ F=0}$) and limit ($14\%SSB_{current,\ F=0}$) reference points adopted by the WCPFC and IATTC, and
2. The stock is likely not experiencing overfishing relative to the target reference point ($F45_{\%SPR}$).

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 2019|-2021 were 56% and 59% of those in 2002-2004, for vessel-days and number of vessels respectively, and are showing a declining trend in the last 10 years (Figure F-2).

In 2022, the Commission adopted the objectives, the target, threshold, and limit reference points, the acceptable level of risk of breaching the limit reference point and the monitoring method for the stock (IATTC Resolution C-22-04) following the completion of the Management Strategy Evaluation (MSE) for the stock by the ALBWG (ISC/21/ANNEX/11). Also, under that resolution, the Commission is expected to adopt a harvest control rule with those elements in 2023. The overarching objective is to ensure the sustainability of the North Pacific albacore tuna stock and current fisheries supported by the stock in the EPO. To reach the overarching objective, the following management objectives were established (C-22-04):

1. Maintain Spawning Stock Biomass (SSB) above the Limit Reference Point, with a probability of at least 80% over the next 10 years.
2. Maintain depletion of total biomass around historical (2006-2015) average depletion over the next 10 years.
3. Maintain fishing intensity (F) at or below the target reference point with a probability of at least 50% over the next 10 years.
4. To the extent practicable, management changes (e.g., catch and/or effort) should be relatively gradual between years.

The reference points adopted are:

1. Target reference point (TRP) of F45%SPR, which is the fishing intensity level that results in the stock producing 45% SPR.
2. Threshold reference point (ThRP, $SSB_{threshold}$) of $30\%SSB_{current,F=0}$, which is 30% of the dynamic unfished spawning stock biomass.
3. Limit reference point (LRP) of $14\%SSB_{current,\ F=0}$, which is 14% of the dynamic unfished spawning stock biomass.

The acceptable level of risk of breaching the LRP based on the most current estimate of SSB shall be no greater than 20%. The resolution further stated that if the LRP is breached, a rebuilding plan should be adopted.

The next step in the MSE process is the adoption of a HCR by the Commission in coordination with the Western and Central Pacific Fisheries Commission taking into account the performance of the tested HCRs to fulfill the management objectives. The ALBWG also discussed the preliminary criteria for identifying exceptional circumstances, which would result in suspending or modifying the application of the adopted harvest strategy, once adopted, and potentially may require updated Management Strategy Evaluation (MSE) simulation work. The finalization of the exceptional circumstances criteria would be done once a harvest strategy is adopted.

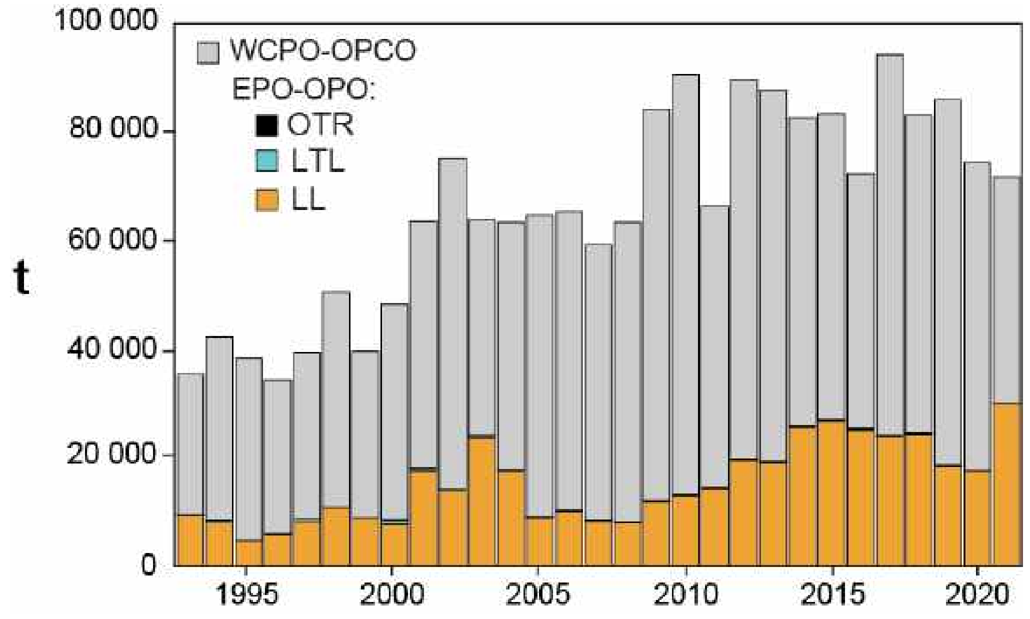

FIGURE F-1a. Retained catches of south Pacific albacore, by region. EPO catches broken down by gear: LL: longline; LTL: troll; OTR: other

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

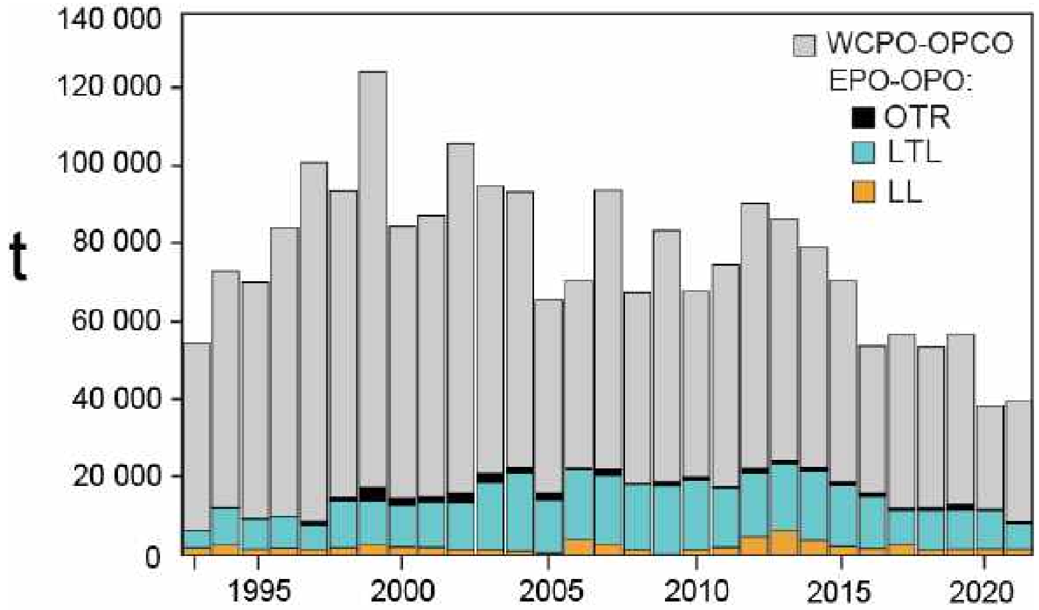

FIGURE F-1b. Retained catches of north Pacific albacore, by region. EPO catches broken down by gear: LL: longline; LTL: troll; OTR: other.

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

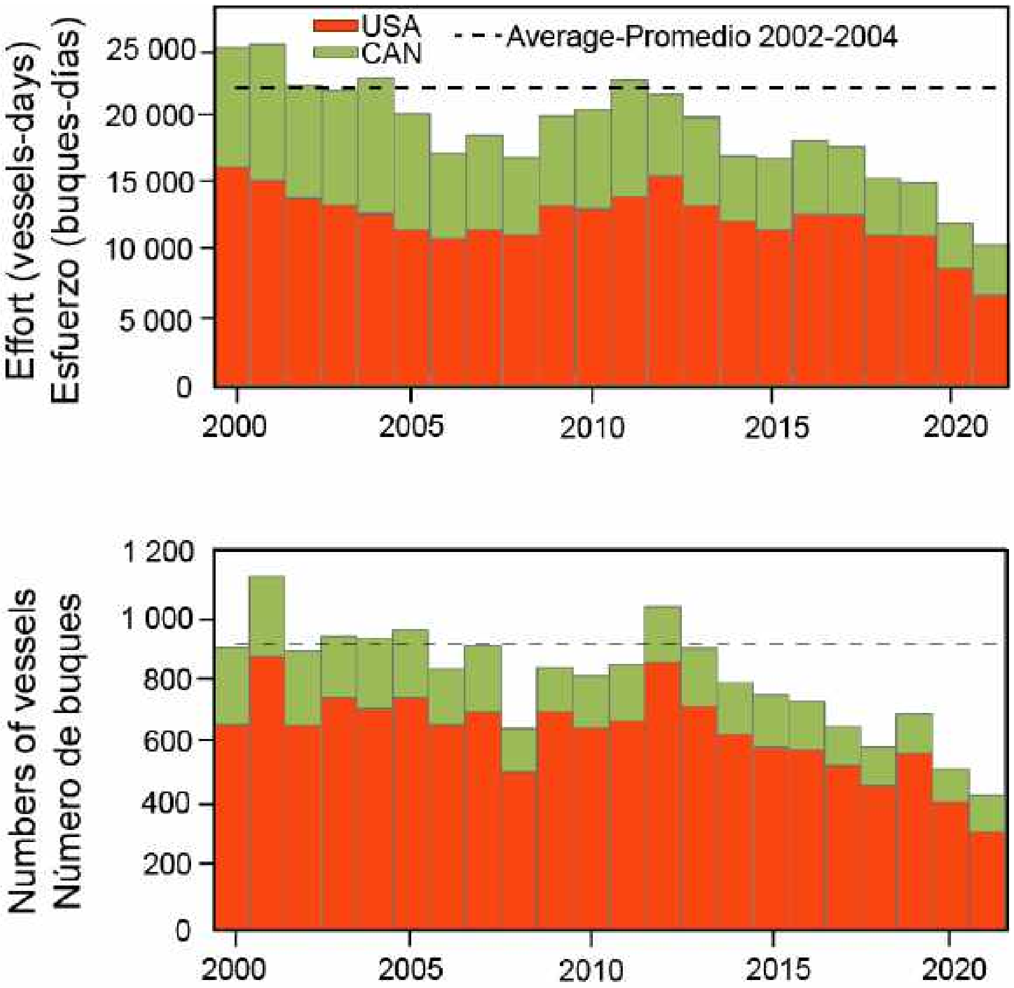

FIGURE F-2. Effort in vessel-days and number of vessels for the north Pacific albacore tuna in the eastern Pacific Ocean.

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

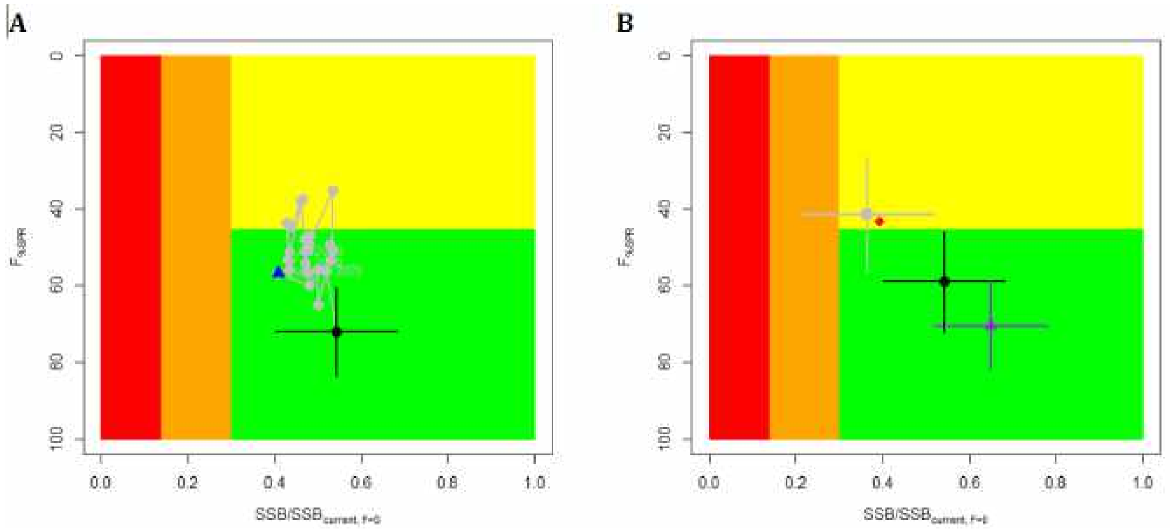

FIGURE F-3. Stock status phase plot showing the status of the north Pacific albacore stock relative to the biomass-based threshold (30%SSB$_{current,\ F=0}$) and limit (14%SSB$_{current,\ F=0}$) reference points, and fishing intensity-based target reference point (F45$_{\%SPR}$) over the modeling period (1994 – 2021). Blue triangle indicates the start year (1994) and black circle with 95% confidence intervals indicates the terminal year (2021). (**B**) Stock status plot showing current stock status and 95% confidence intervals of the base case model (black circle), an important sensitivity run of CV = 0.06 for L$_{inf}$ in the growth model (gray square), an important sensitivity run with an estimated growth model (purple triangle), and a model representing an update of the 2020 base case model to 2023 data (red diamond). 95% confidence intervals are not shown for the update of the 2020 base case model (red diamond) because the model did not have a positive definite Hessian matrix and uncertainty estimates were unreliable. Red zones in both panels indicate female SSBs falling below the limit reference point while the orange zones indicate female SSBs between the threshold and limit reference points. Green zones indicate female SSBs above the threshold reference point and fishing intensity levels below the target reference point. Yellow areas indicate female SSBs above the threshold reference point and fishing intensity levels above the target reference point. The Fs in this figure are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR.

FIGURA F-3. Gráfica de fase de la condición de la población que muestra la condición de la población de atún albacora del Pacífico norte en relación con los puntos de referencia umbral (30%SSBactual, F=0) y límite (14%SSBactual, F=0) basados en la biomasa, y el punto de referencia objetivo basado en la intensidad de pesca (F45%SPR) durante el periodo del modelo (1994-2021). El triángulo azul indica el año inicial (1994) y el círculo negro con intervalos de confianza del 95% indica el año final (2021). (**B**) Gráfica de la condición de la población que muestra la condición actual de la población y los intervalos de confianza del 95% del modelo de caso base (círculo negro), un análisis de sensibilidad importante de CV = 0.06 para L$_{inf}$ en el modelo de crecimiento (cuadrado gris), un análisis de sensibilidad importante con un modelo de crecimiento estimado (triángulo morado) y un modelo que representa una actualización del modelo de caso base de 2020 a los datos de 2023 (diamante rojo). No se muestran los intervalos de confianza del 95% para la actualización del modelo de caso base de 2020 (diamante rojo) porque el modelo no tenía una matriz hessiana positiva definida y las estimaciones de incertidumbre no eran fiables. Las zonas rojas de ambos paneles indican las SSB de las hembras por debajo del punto de referencia límite, mientras que las zonas anaranjadas indican las SSB de las hembras entre los puntos de referencia umbral y límite. Las zonas verdes indican las SSB de las hembras por encima del punto de referencia umbral y los niveles de intensidad de pesca por debajo del punto de referencia objetivo. Las áreas amarillas indican las SSB de las hembras por encima del punto de referencia umbral y los niveles de intensidad de pesca por encima del punto de referencia objetivo. Las F de esta figura son indicadores de la intensidad de pesca basados en la razón de potencial de desove (SPR) y calculados como %SPR.

TABLE F1. Estimates of maximum sustainable yield (MSY), female spawning stock biomass (SSB), fishing intensity (F), and reference point ratios for north Pacific albacore tuna for: 1) the base case model; 2) two important sensitivity models due to uncertainty in growth parameters; and 3) a model representing an update of the 2020 base case model to 2023 data. SSB$_0$, SSB$_{\text{current, F=0}}$ and SSB$_{\text{MSY}}$ are the expected female SSB of a population in the equilibrium, unfished state; in the current, dynamic, unfished state; and at MSY, respectively. The Fs in this table are indicators of fishing intensity based on spawning potential ratio (SPR) and calculated as %SPR. SPR is the ratio of the equilibrium SSB per recruit that would result from the estimated F-at-age relative to that of an unfished population. Depletion is calculated as the proportion of the age-1+ biomass during the specified period relative to an unfished age-1+ equilibrium biomass. The model representing an update of the 2020 base case model is similar to but not identical to the 2020 base case model due to changes in data preparation and model structure. *Model may not have converged, and uncertainty estimates were unreliable because of the lack of a positive, definite Hessian matrix. †A value of >1 for the depletion ratio indicates higher age-1+ biomass in 2021 relative to the 2006 – 2015 period. §Higher %SPR values indicate lower fishing intensity levels. ¶Values of >1 for ratios of F$_{\%\text{SPR}}$ to F$_{\%\text{SPR}}$-based reference points indicate fishing intensity levels lower than the reference points.

TABLA F1. Estimaciones del rendimiento máximo sostenible (RMS), biomasa reproductora de las hembras (SSB), intensidad de pesca (F) y cocientes de puntos de referencia para el atún albacora del Pacífico norte para: 1) el modelo de caso base; 2) dos importantes modelos de sensibilidad debido a la incertidumbre en los parámetros de crecimiento; y 3) un modelo que representa una actualización del modelo de caso base de 2020 a los datos de 2023. SSB$_0$, SSB$_{\text{actual, F=0}}$ y SSB$_{\text{RMS}}$ son la SSB de las hembras esperada de una población en estado de equilibrio, sin pesca; en estado actual, dinámico, sin pesca; y en RMS, respectivamente. Las F de esta tabla son indicadores de la intensidad de pesca basados en la razón de potencial de desove (SPR) y calculados como %SPR. La SPR es la razón de la SSB en equilibrio por recluta que resultaría de la F por edad estimada en relación con la de una población en ausencia de pesca. La reducción se calcula como la proporción de la biomasa de edad 1+ durante el periodo especificado en relación con una biomasa de edad 1+ en equilibrio sin pesca. El modelo que representa una actualización del modelo de caso base de 2020 es similar pero no idéntico al modelo de caso base de 2020 debido a cambios en la preparación de los datos y en la estructura del modelo. *Es posible que el modelo no haya convergido y que las estimaciones de incertidumbre no sean fiables debido a la falta de una matriz hessiana positiva definida. †Un valor de >1 para la razón de reducción indica una mayor biomasa de edad 1+ en 2021 en relación con el periodo 2006-2015. §Valores de %SPR más altos indican niveles de intensidad de pesca más bajos. ¶Valores de >1 para los cocientes de F$_{\%\text{SPR}}$ con respecto a los puntos de referencia basados en F$_{\%\text{SPR}}$ indican niveles de intensidad de pesca inferiores a los puntos de referencia.

Quantity	Base Case	Growth CV = 0.06 for L$_{\text{inf}}$	Growth All parameters estimated	Update of 2020 base case model to 2023 data*
MSY (t)	121,880	93,167	144,792	97,777
SSB$_{\text{MSY}}$ (t)	23,154	18,133	30,435	18,756
SSB$_0$ (t)	165,567	128,155	198,913	132,570
SSB$_{2021}$ (t)	70,229	35,418	101,161	36,909
SSB$_{\text{current, F=0}}$ (2021 estimate)	129,581	97,368	155,542	93,808
SSB$_{2021}$/SSB$_{\text{current, F=0}}$	0.54	0.36	0.65	0.39
SSB$_{2021}$/30%SSB$_{\text{current, F=0}}$	1.81	1.21	2.17	1.31
SSB$_{2021}$/14%SSB$_{\text{current, F=0}}$	3.87	2.60	4.65	2.81
†Depletion$_{2021}$/Depletion$_{2006\text{-}2015}$	1.34	1.33	1.37	1.30
§ F$_{\%\text{SPR, 2018-2020}}$ (%SPR)	59.0	41.4	70.4	43.2
§ F$_{\%\text{SPR, 2011-2020}}$ (%SPR)	55.0	36.6	63.8	37.9
¶ F$_{\%\text{SPR, 2018-2020}}$/F$_{\%\text{SPR, MSY}}$	2.04	1.42	2.78	1.47
¶ F$_{\%\text{SPR, 2011-2020}}$/F45$_{\%\text{SPR}}$	1.22	0.81	1.42	0.84
¶ F$_{\%\text{SPR, 2018-2020}}$/F45$_{\%\text{SPR}}$	1.31	0.92	1.56	0.96
¶ F$_{\%\text{SPR, 2018-2020}}$/F$_{\%\text{SPR, 2002-2004}}$	1.48	1.63	1.40	1.25

Source: SAC-14 INF-R

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—about 80% of the catch in weight on average in recent years —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 harpoon. 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 current frontal zones. Several of these fronts 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 preferred range is about 18° to 22°C, while larvae have been found only at temperatures exceeding 24°C.

There is strong evidence that swordfish in the Pacific comprise multiple stocks. 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 Pacific Ocean, but the exact boundaries of these stocks, as well as their exchange rates—for the purposes of stock assessment—is currently uncertain. 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.

Currently, two stocks are assumed to inhabit the EPO. One in the south and one in the north. The stock boundaries are uncertain, but it was assumed in the most recent assessments that the southern EPO stock could be distributed up to 10°N and that the north Pacific Ocean stock includes the EPO north of 10°N. The area north of 5°S and south of 10°N was added in the South EPO assessment in one of the stock structure hypotheses considered, as there was evidence of connectivity between that area and the area south of 5°S (SAC-13 INF-N), which defined the stock boundary in the previous assessment (SAC-02-09). The definition used in the previous assessment was also included as an alternative stock structure hypothesis. Recent tagging information (presented during SWO-01) on the movement of swordfish across the previously assumed stock boundary for the north Pacific Ocean swordfish stock—a diagonal line from the tropics in the central Pacific to the northern coast of Mexico – motivated the revision of the stock boundary assumed for the north Pacific swordfish stock (ISC/21/BILLWG-01) to include the EPO north of 10°N. This new stock boundary assumption allowed for the inclusion of areas off Mexico and Central America in the 2023 north Pacific swordfish assessment, which were not included in the 2018 assessment (ISC/18/ANNEX/16).

In the northern hemisphere, the annual longline fishing effort for the main longline fleets[8] operating in the EPO increased from about 25 million hooks in 2007 to about 50 million hooks in 2015, and has declined in the last four years from 46 million hooks in 2016 to 17 million hooks in 2021 (Figure G-1). The last five-year average (34 17 million hooks) remains significantly below the 2001–2003 average of 63 million hooks. The Billfish Working Group (BILLWG) of the International Scientific Committee for Tuna and Tuna-like Species in the north Pacific Ocean conducted an assessment in 2023 of the north Pacific swordfish stock, which included the EPO north of 10°N. Preliminary results suggest that the stock biomass has been stable in the last 10 years, that catch overall continues to decline, and that the stock is likely to not be overfished or subject to overfishing. In the EPO, north of 10°N, there has been a long period of relatively stable catches,

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[8] Japan, Korea, Chinese Taipei, China and French Polynesia

in the last two decades, with a sharp decline in the last three years, when the effort also declined (Figure G-2).

In the southern hemisphere, the total annual longline fishing effort for the main longline fleets[1] in EPO in the last 30 years was 210 million hooks in 1991 and declined steadily to about half that in 1999, increasing again to an average of 177 million hooks in 2001–2004, decreasing to about 69 million hooks in 2008. In the past 5 years, the total effort has been relatively stable, averaging 140 million hooks (2017–2021) (Figure G-3). Figure G-4 shows the data on catches reported to the IATTC. For the assessment of south EPO swordfish, a compilation of catch data was done which resulted in higher values than those in Figure G-4 due to some catches, mainly of artisanal fleets, still underreported to the IATTC. The catch data compiled for the EPO south of 10°N showed a dramatic increase since the mid-2000s (Figure 3 in SAC-14-15). The average catch per year from 2000 to 2009 was about 15,000 tons, while the average catch per year for 2010 to 2019 almost doubled to about 29,000 tons. In the last three years of the compilation available for the assessment (2017 - 2019), the average catch was about 34,000 tons a year. For the area south of 5°S, the average annual catch over the past 5 years (during 2015–2019) was 25,718 mt. The fleets that currently take the most catch are the Spanish longline fleet, which catches about 30% of the total catches in weight, followed by the Chilean gillnet fleet with 22%, and the Ecuadorian longline fleet with 20%.

For the south EPO stock, the benchmark assessment with data up to 2019 (SAC-14-15) was finalized. The main uncertainties accounted for were stock structure and the relationship of the indices of abundance with the stock biomass. Associated with the increase in catches, there was a clear increase in the indices of abundance, which was a continuation of the trends already apparent in the 2011 assessment. Four hypotheses were proposed to explain the simultaneous increase of catches and indices of abundance, which included both the possibilities that the increase is either real or not (increase in availability). Dynamic reference points, which are used only for illustrative purposes as reference points have yet to be adopted for swordfish by the Commission, indicated that the stock is approaching one of the hypothetical biomass TRP (of 40% unfished biomass) for one of the hypotheses and is larger for the other hypotheses ($SSB_{current}$/SSBF = 0 > 0.4. In any case, the stock is not approaching the hypothetical limit reference point (20% unfished biomass) (Figure G-5). All models estimate a strong increase in fishing mortality since the start of the fishery in the 1950's. The fishing intensity is slightly above the fishing intensity target reference point for one of the hypotheses and below for the other hypotheses (Figure G-6). There is not enough information in the current data to determine the relative plausibility of the different hypotheses that may explain the simultaneous increases in catch and indices of abundance. There is external evidence that an increase in productivity of the stock may be plausible due to increase in the main prey of swordfish in the South EPO, the jumbo squid. If this is the case, management of the stock should account for potential decreases in productivity if the prey species decreases in abundance. Nevertheless, the other hypotheses are also plausible and should be considered.

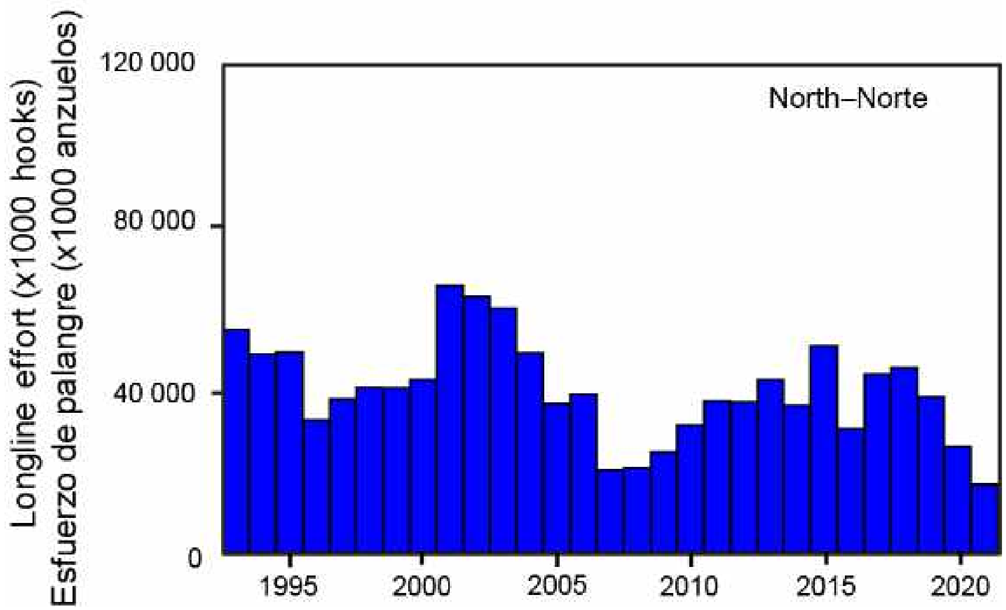

FIGURE G-1. Longline fishing effort (in millions of hooks) in the north EPO for the main longline fleets for 1993–2021 (Table A-9).

FIGURA G-1. Esfuerzo de pesca de palangre (en millones de anzuelos) en el OPO Norte para las principales flotas palangreras para 1993–2021 (Tabla A-9) (al norte 10°N)

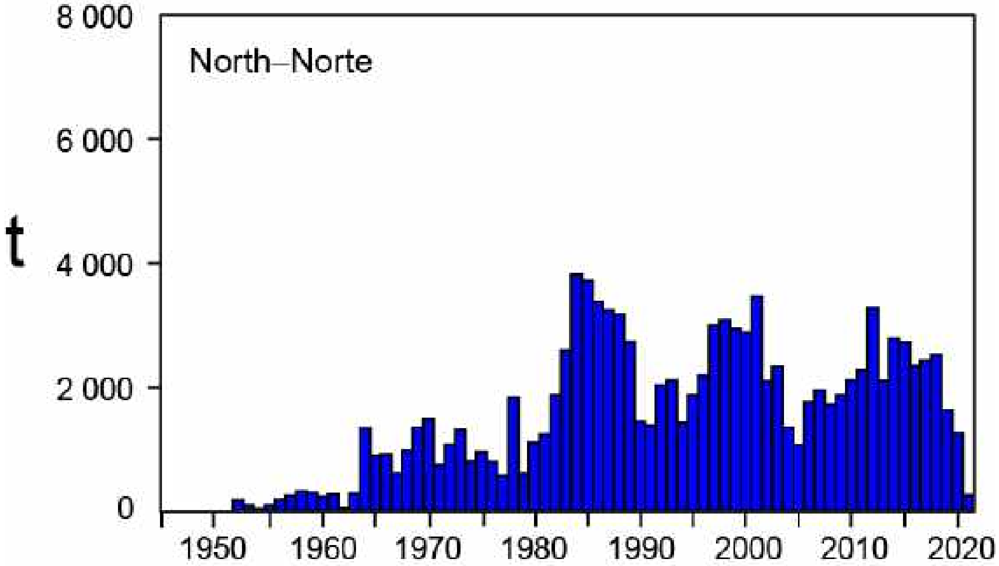

FIGURE G-2. Retained catches of swordfish in the north EPO stock for 1945–2021 (north of 10°N)

FIGURA G-2. Capturas retenidas de pez espada en la población del OPO Norte para 1945–2021 (al norte de 10°N).

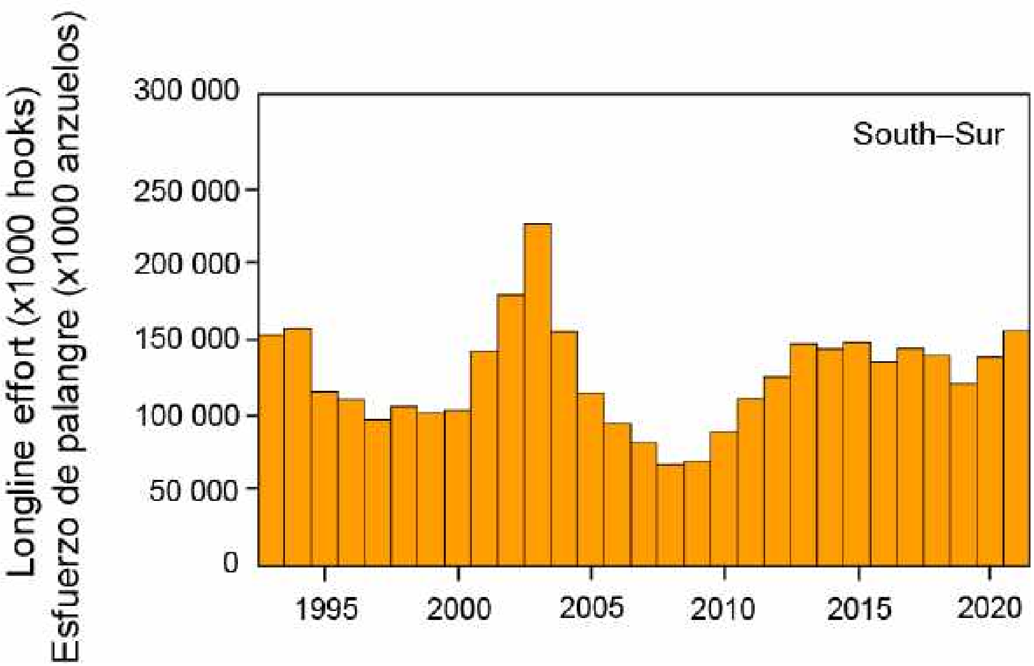

FIGURE G-3. Longline fishing effort (in millions of hooks) in the south EPO for the main longline fleets for 1993–2021 (Table A-9).

FIGURA G-3. Esfuerzo de pesca de palangre (en millones de anzuelos) en el OPO Sur para las principales flotas palangreras para 1993–2021 (Tabla A-9)

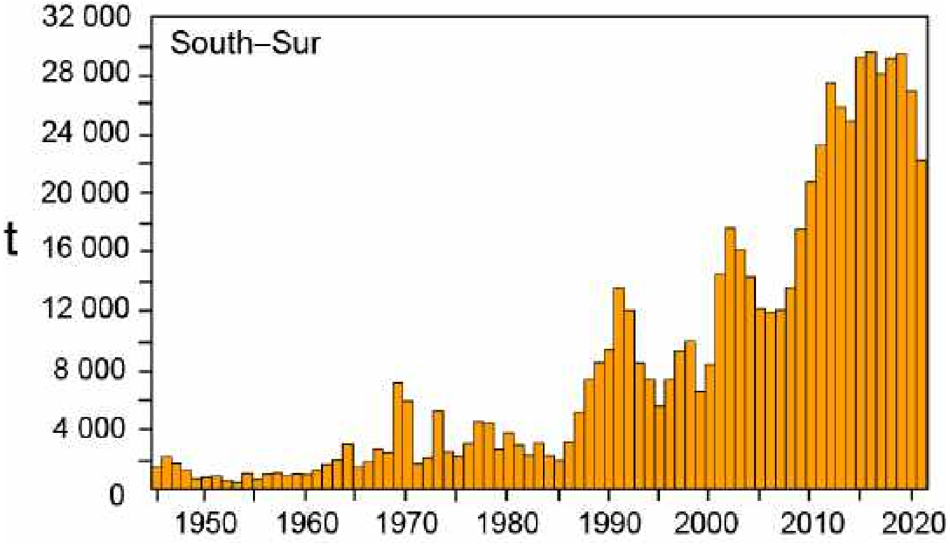

FIGURE G-4. Retained catches of swordfish in the south EPO stock for 1945–2021 (south of 10°N) reported to the IATTC.

FIGURA G-4. Capturas retenidas de pez espada en la población del OPO Sur para 1945–2021 (al sur de 10°N).

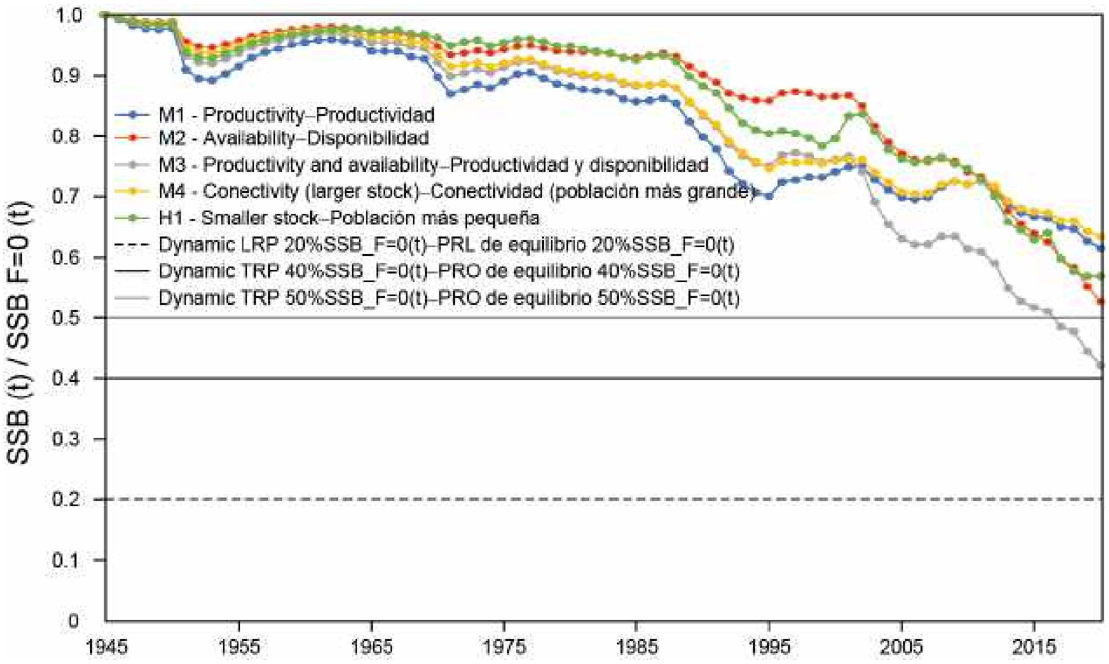

FIGURE G-5. Ratio of the estimated spawning stock biomass and spawning stock biomass with no fishing (dynamic) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1 (north boundary at 5°S). Note that M4 corresponds to the stock structure hypothesis H3 (western boundary at 170°W).

FIGURE G-5. Razón entre la biomasa de la población reproductora estimada y la biomasa de la población reproductora sin pesca (dinámica) para los modelos correspondientes a las cuatro hipótesis que explican el aumento simultáneo de los índices de abundancia y las capturas y el modelo correspondiente a la hipótesis de estructura de la población H1 (límite norte en 5°S). Nótese que el modelo M4 corresponde a la hipótesis de estructura de la población H3 (límite occidental en 170°O).

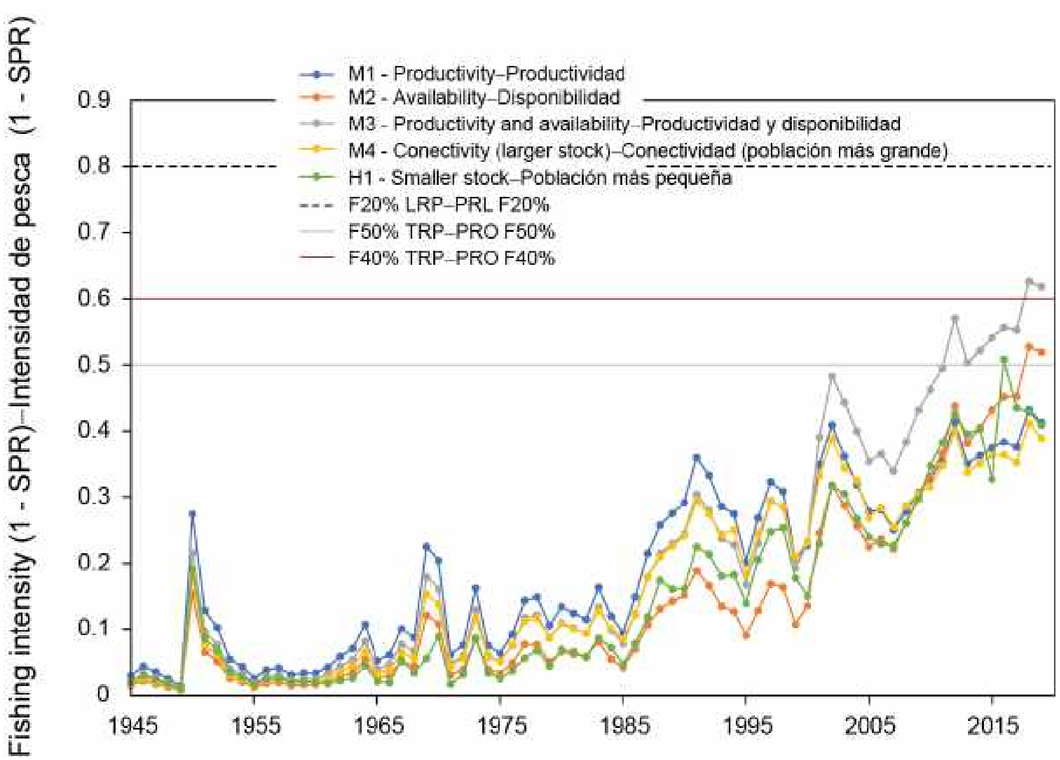

FIGURE G-6. Fishing intensity (1-SPR) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1 (north boundary at 5°S). Note that M4 corresponds to the stock structure hypothesis H3 (western boundary at 170°W). Fishing intensity is a proxy for fishing mortality, based on SPR (proportion of the spawning biomass produced by each recruit with fishing relative to biomass per recruit in the unfished condition, Goodyear 1993). Large SPR are indicative of low fishing mortality, thus a proxy for fishing mortality is 1-SPR.

FIGURE G-6. Intensidad de pesca (1-SPR) para los modelos modelos correspondientes a las cuatro hipótesis que explican el aumento simultáneo de los índices de abundancia y las capturas y el modelo correspondiente a la hipótesis de estructura de la población H1 (límite norte en 5°S). Nótese que el modelo M4 corresponde a la hipótesis de estructura de la población H3 (límite occidental en 170°O). La intensidad de pesca es un sustituto de la mortalidad por pesca, con base en SPR (proporción de la biomasa reproductora producida por cada recluta con pesca en relación con la biomasa por recluta en ausencia de pesca, Goodyear 1993). Una SPR alta indica una mortalidad por pesca baja, por lo que 1-SPR es sustituto de la mortalidad por pesca.

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 some 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 2021, which included data through 2019. It indicated that blue marlin in the Pacific Ocean currently has a stock biomass that is 13% above SSB_{MSY}, while fishing mortality is 40% below F_{MSY}, and is therefore neither overfished nor subject to overfishing. Since 2016, annual catches in the EPO have declined from 4,100 t to an average of 2,578 t in 2019–2021 (Figure H-1)

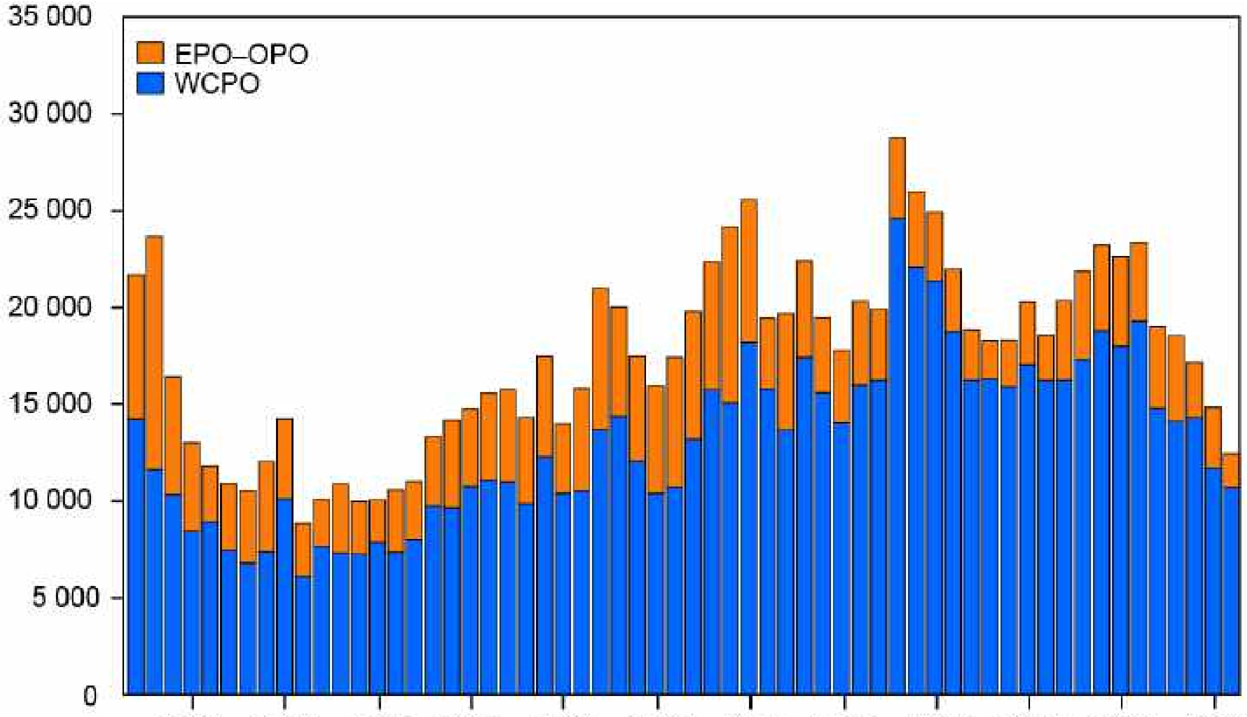

FIGURE H-1. Retained catches of blue marlin in the Pacific Ocean, by region.
FIGURA H-1. Capturas retenidas de marlín azul en el Océano Pacífico, por región.

I. STRIPED MARLIN

Striped marlin (*Kajikia audax*) occurs throughout the Pacific Ocean between about 45°N and 45°S. Significant effort has been devoted to understanding the stock structure of striped marlin in the Pacific Ocean, which is moderately well known. There most likely are a number of stripped marlin stocks in the Pacific Ocean, but the boundaries are uncertain. 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, most 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. The fishing effort by large longline vessels in the North EPO has decreased by about 50% since 2017 (Figure G-1) and remains stable in the south EPO (Figure G-3), but the catch of striped marlin has remained largely unchanged since then. In the last 20 years , 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.

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 fisheries from coastal CPCs may be incomplete. Therefore, the total catch of striped marlin in the EPO, and thus the total impact of fishing on the stock since about 2009, is not known.

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 complicated when the total catch of the species by all fisheries is not known.

The last full assessment of striped marlin in the EPO was conducted in 2008, using Stock Synthesis, and later updated with data through October 2010 (SAC-01-10). The spatial domain of the assessment was north of 10°S, east of about 145°W north of the equator, and east of about 165°W south of the equator. 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 2016–2021 (1,722 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.

In 2022-2023, the Billfish Working Group (BILLWG) of the International Scientific Committee for Tuna and Tuna-like Species in the north Pacific Ocean completed a full assessment of the western and central north Pacific Ocean (WCNPO) stock of striped marlin. A Stock Synthesis model was produced with the best-available life history parameters and catch, abundance index, and length composition data for the period 1977–2020. The preliminary results indicated that, according to the base case model, the WCNPO striped marlin stock was very likely overfished and was likely subject to overfishing relative to the dynamic 20-year 20%SSBF=0-based reference point.

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 most of the striped marlin catch in the EPO not be increased.

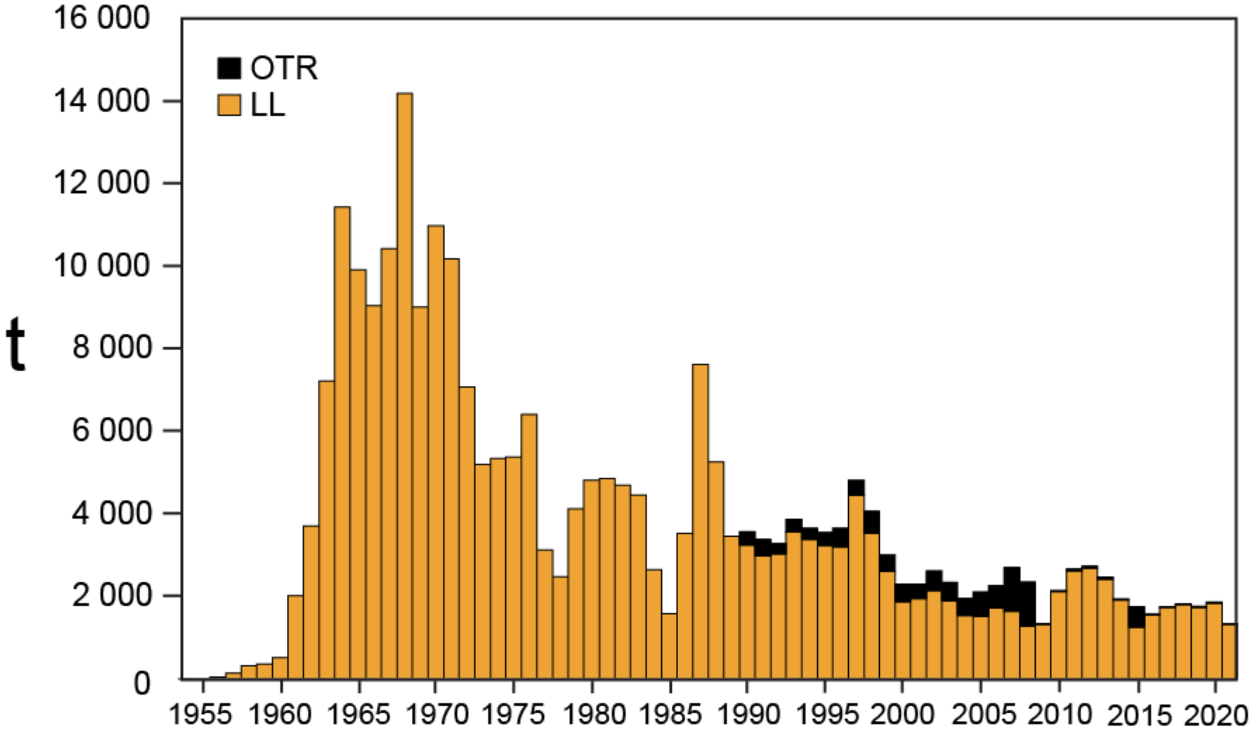

FIGURE I-1. Total reported catches of striped marlin in the North EPO by longline (LL) and other (OTR) fisheries (primarily recreational, 1954–2021. Due to unreported catches by recreational fisheries, estimates for 2009–2021 are minimums.

FIGURA I-1. Capturas totales reportadas de marlín rayado en el OPO Norte por las pesquerías palangreras (LL) y otras (OTR, principalmente recreativas), 1954–2021. Debido a capturas no reportadas por pesquerías recreativas, las estimaciones de 2009–2021 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 (SAC-04-07c). Initial analyses indicated that either this stock had uncharacteristically low productivity and high standing biomass, or—more likely—that a large amount of catch was missing in the data compiled for the assessment. A satisfactorily estimate of the missing catch was unavaible, thus the estimates of stock status and trends using Stock Synthesis—the preferred model for assessments—were unreliable. 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 2016–2021 were 612 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. Assessment 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.

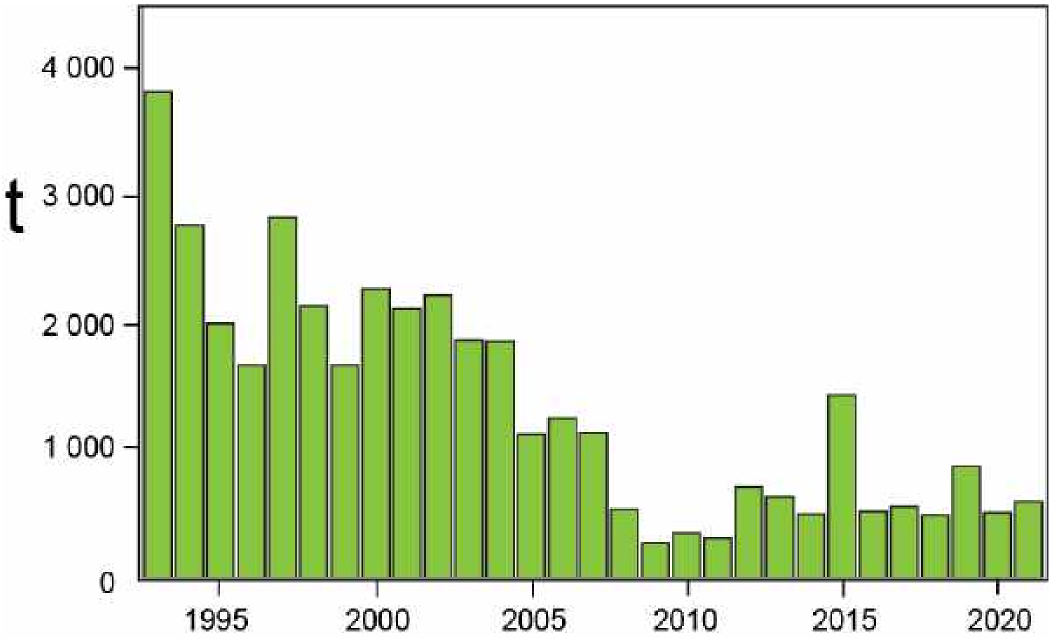

FIGURE J-1. Total reported catches of sailfish in the EPO, 1990–2021. (The actual catches were probably greater.)

FIGURA J-1. Capturas totales reportadas de pez vela en el OPO, 1990–2021. (Las capturas reales fueron probablemente mayores).

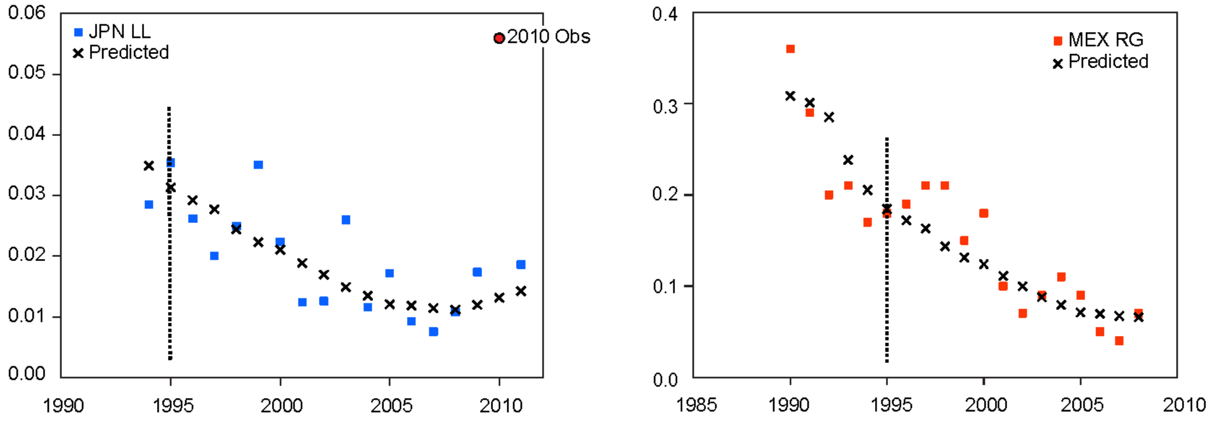

FIGURE J-2. Observed and predicted indices of relative abundance of sailfish in the EPO from Japanese longline (JPN LL) and Mexican recreational (MEX RG) fisheries. The 2010 observation in the JPN LL series was not included in the analyses.

FIGURA J-2. Índices 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. SHARKS

Over 300 species of sharks inhabit the Pacific Ocean, of which at least 49 species have been documented to be caught, either as a target or incidental bycatch, in the industrial and small-scale coastal (*i.e.*, ‘artisanal’) pelagic fisheries of the eastern Pacific Ocean (EPO). In general, sharks are long-lived (20+ years), slow growing, mature late in life and produce a small number of offspring (<10 pups), often every few years, resulting in conservation concerns for many species impacted by fishing. In recognition of the potential negative impacts of fishing on sharks globally, many species interacting with pelagic fisheries in EPO are listed by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species and/or by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Furthermore, the IATTC has implemented a range of conservation and management measures (CMMs) for sharks since at least 2005 to limit or prohibit their capture, or to promote handling practices to maximize their post-release survival. For example, retention prohibition measures have been in place for oceanic whitetip shark in all EPO industrial tuna fisheries since 2011 (Resolution C-11-10) and for silky shark in all purse-seine fisheries since 2016 (Resolution C-16-06).

Sharks are often incidentally caught as bycatch in EPO fisheries targeting tunas and billfish, and therefore insufficient or unreliable catch and biological data available for the majority of shark species has hindered the development of stock assessments, except for a small number of economically important species such as blue and shortfin mako sharks that are assessed by the ISC as contiguous north Pacific stocks. Given data deficiencies, but at the same time acknowledging the need to demonstrate ecological sustainability mandates under the Antigua Convention, the IATTC has developed a strategic research plan to use ecological risk assessment to identify vulnerable species for monitoring, research and management, and where possible, undertake detailed assessments of stock indicators or stock status.

Vulnerability assessment of sharks caught in eastern Pacific Ocean pelagic fisheries

In 2018, the IATTC staff developed of a flexible spatially-explicit quantitative ecological risk assessment approach—Ecological Assessment of Sustainable Impacts of Fisheries (EASI-Fish)—specifically designed to quantify the cumulative impacts of multiple fisheries for data-limited bycatch species to identify vulnerable species and prioritize them for data collection, research and management. In 2022, the IATTC undertook the first comprehensive vulnerability assessment for sharks in the EPO using EASI-Fish (SAC-13-11), which characterized their vulnerability status for 2019, the most recent complete fishing year to be representative of contemporary fishing effort regimes in the EPO before fishing effort, data collection and provision were significantly impacted by the COVID-19 pandemic.

Of the 49 shark species recorded to interact with industrial (purse-seine and longline) and artisanal (longline and gillnet) pelagic fisheries in the EPO, 32 species were formally assessed using EASI-Fish. In 2019, estimates of a proxy for fishing mortality ($\tilde{F}_{2019}$) and the spawning stock biomass per recruit (SBR_{2019}) exceeded biological reference points ($F_{40\%}$ and $SBR_{40\%}$) for 20 species, classifying them as “most vulnerable” (Figure K-1; SAC-13-11). These included hammerhead sharks (5 species; *Sphyrna corona, S. media, S. mokarran, S. lewini,* and *S. zygaena*), requiem sharks (10 species; *Carcharhinus altimus, C. brachyurus, C. falciformis, C. leucas, C. limbatus, C. longimanus, C. plumbeus, C. porosus, Nasolamia velox,* and *Rhizoprionodon longurio*), threshers (2 species; *Alopias superciliosus* and *A. pelagicus*), mesopelagic sharks (3 species; *Dalatias licha, Pseudocarcharias kamoharai,* and *Zameus squamulosus*) and the commercially important blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*). The remaining 12 species were classified as “least vulnerable” (9 species) or “increasingly vulnerable” (3 species). Key knowledge gaps identified were the location of fishing effort and the shark catch in artisanal fisheries and basic biological information for several species. Overall, the most vulnerable species were *S. zygaena, C. falciformis* and *S. lewini*, which coincidentally, were identified by the IATTC as a priority for stock assessments (Resolution C-16-05), while stock indicators for silky shark have been produced annually since 2014 (see below). However, given the lack of species-specific catch data for these species, particularly in artisanal fisheries where catches are believed to be highest, EASI-Fish is planned to be used as an exploratory tool in the interim period until catch and post-release survival data are improved to simulate changes to existing, or additional, management measures, either in isolation or in concert, to determine their efficacy for reducing species-specific vulnerability. This exploratory approach was implemented in 2023, where the effects of 43 different conservation and management measures were simulated for silky shark (*Carcharhinus falciformis*) and three hammerhead species; scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), and smooth hammerhead (*Sphyrna zygaena*) using EASI-Fish (SAC-14-12). This assessment showed that no single management measure was able to reduce the vulnerability status of any species from a "vulnerable" to a "least vulnerable" status. Although scenarios such as temporal EPO closures, banning wire traces, imposing a 100 cm total length minimum retention length for all sharks, and even prohibiting landing of all sharks predicted a significant reduction in at-vessel mortality, this positive effect on vulnerability was mostly negated by high post-release mortality of these species. These results highlighted that the most effective mitigation measure for these sharks is to avoid interaction with EPO fisheries. The assessment identified several major data gaps that need to be addressed through a collaborative participatory research approach between the IATTC and its CPCs, including basic biology and improved species-specific catch and size composition data in artisanal fisheries and the industrial longline fishery. Addressing these data needs will not only help to improve short-term rapid assessments such as EASI-Fish, but also develop longer-term time series data required to undertake new and conventional methods such as close-kin mark recapture or traditional stock assessments from the which population status of these vulnerable species can be determined.

Updated stock status indicators for silky sharks in the eastern Pacific Ocean (1994-2022)

The indices for large silky sharks (> 150 cm total length (TL)), based on data from the purse-seine fishery on floating objects, have been updated through 2022 for the north and south EPO (Figure K-2; SAC-14-14). Previous analyses (SAC-08-08a(i), Lennert-Cody et al., 2019) identified a correlation between north EPO indices, particularly those for small (< 90 cm TL) and medium silky sharks (90 – 150 cm TL), 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"[9], 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 suggest a relatively stable abundance level for over a decade, with the 2022 values similar to (south), or slightly above (north), the 2021 value, 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, SAC-14 INF-L). 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.

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

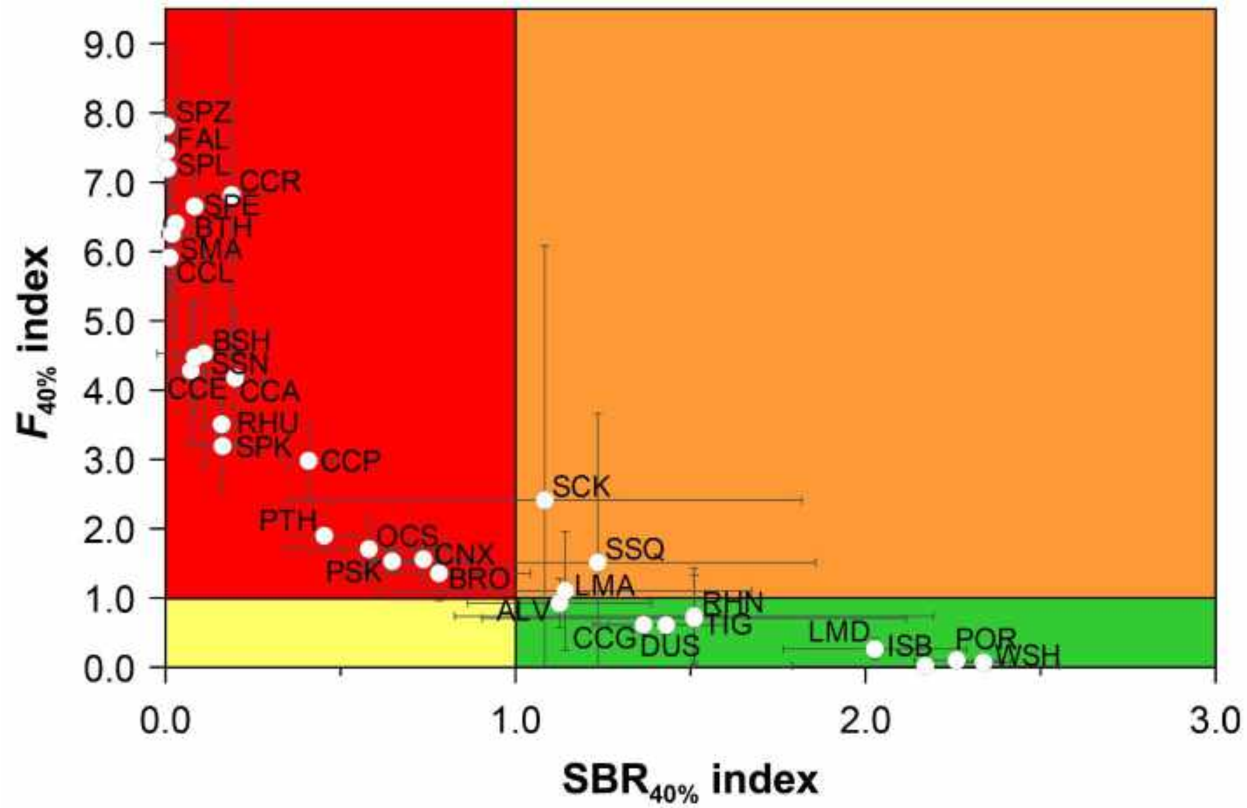

FIGURE K-1. Vulnerability phase plot showing the vulnerability status of 32 shark species caught in eastern Pacific Ocean pelagic fisheries assessed by EASI-Fish represented by mean (± standard deviation) estimates the biological reference points $\tilde{F}_{2019}/F_{40\%}$ and $SBR_{2019}/SBR_{40\%}$. Labels adjacent to symbols denote species codes shown Table 6. Vulnerability status values for each species are provided in Table 6.

FIGURA K-1. Gráfica de fase de vulnerabilidad que muestra el estado de vulnerabilidad de 32 especies de tiburones capturadas en las pesquerías pelágicas del Océano Pacífico oriental evaluadas por EASI-Fish, representadas por estimaciones promedio (± desviación estándar) de los puntos de referencia biológicos $\tilde{F}_{2019}/F_{40\%}$ y $SBR_{2019}/SBR_{40\%}$. Las etiquetas adyacentes a los símbolos indican los códigos de especie mostrados en la Tabla 6. Los valores del estado de vulnerabilidad de cada especie se presentan en la Tabla 6.

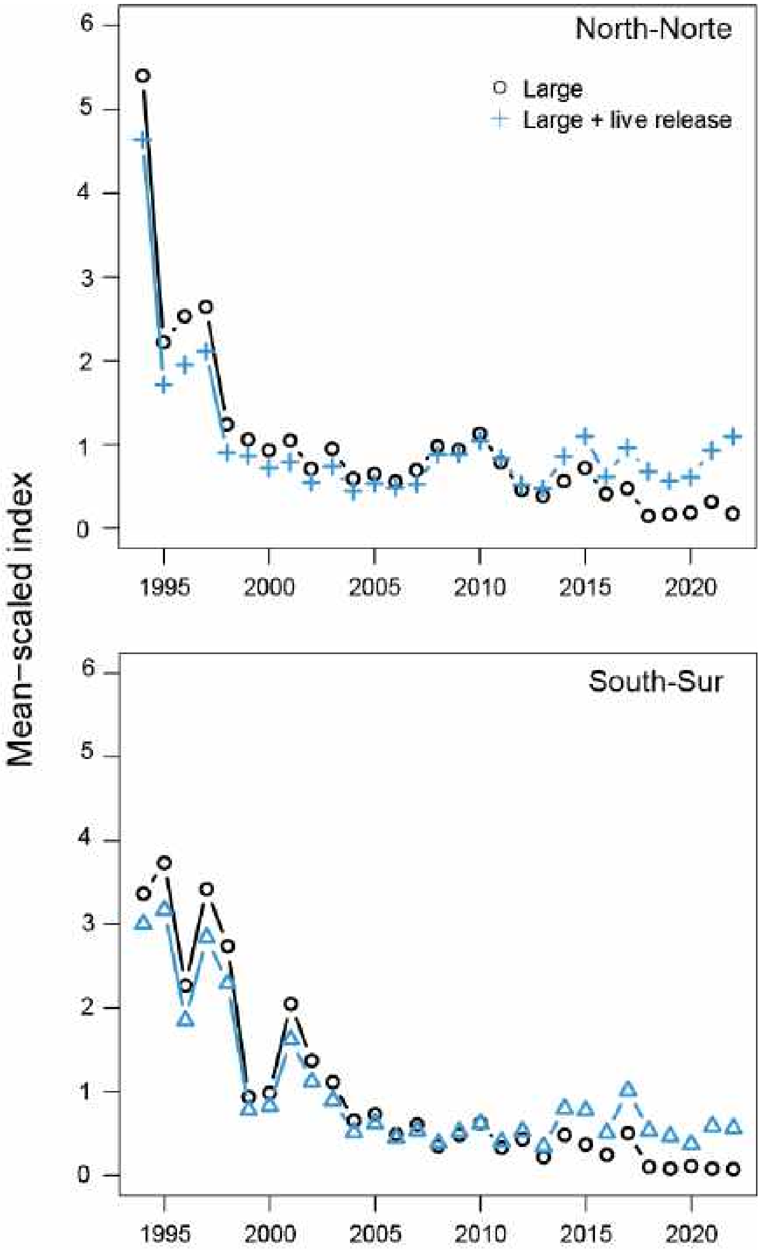

FIGURE K-2. Mean-scaled standardized bycatch-per-set (in numbers of sharks per set) of large silky sharks in sets on floating objects, with and without live release, in the north (top) and south (bottom) EPO. Vertical bars indicate pointwise approximate 95% confidence intervals.

FIGURA K-2. Captura incidental por lance (en número de tiburones por lance) estandarizada de tiburones sedosos grandes en lances sobre objetos flotantes, 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

CONTENTS

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; Juan-Jorda et al. 2018). 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 tools required to implement EAFM in the tuna fisheries of the EPO. Current and planned ecosystem-related activities by the staff is summarized in the SSP (IATTC-93-06a) and the Staff Activities and Research report (SAC-14-01).

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 non-target (i.e. "bycatch") species, especially those that are discarded at sea or have low economic value (see section 2 and IATTC Special Report 25). Furthermore, environmental processes that operate on a variety of time and spatial scales (e.g., El Niño-Southern Oscillation, Pacific Decadal Oscillation, ocean warming, anoxia and acidification) can influence the abundance and horizontal and vertical distribution of species to different degrees, which in turn affects their potential to interact with 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 bycatch species. Similarly, given the complexity of marine ecosystems, there is no single indicator that can holistically 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 since 2003, but in recent years this report has continued to evolve in content, structure, and purpose. Its primary purpose is to complement the annual report on the fishery (SAC-14-03) 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 recent advances in research related to assessing ecological impacts of fishing and the environment on the EPO ecosystem and its associated species.

2. DATA SOURCES

In this report, estimated total catches of bycatch species were obtained from observer data for the large-vessel purse-seine fishery[10], nominal catches reported by the limited observer coverage onboard the small-vessel purse-seine fishery[11], and gross annual removals by the longline fishery were obtained from annual summary reports (TASK I data, see SAC-12-09, WSDAT-01-01) submitted to the IATTC by CPCs. Minimum catches in 2021 reported by observers on longline vessels are also included as an interim measure until observer coverage increases to at least 20% that may allow total annual catches for some bycatch species to be reliably estimated. Currently, observer coverage for some CPCs is about or less than the mandated 5% and are not considered by staff to be representative of the activities of their longline fleets (see section 2.2. below and BYC-10 INF-D). Additionally, a previously undetected error in longline observer data submitted to the IATTC resulted in over-reporting of sharks and large fishes published in SAC-13-10. These values were corrected in April 2023 (see SAC-13-10 CORR), and the data quality control procedures were modified to catch a possible repeat of this issue. Longline data were available through 2021 as the deadline for data reporting for the previous year occurs after the annual SAC meeting (see Resolutions C-03-05; C-19-08). However, some CPCs have temporarily suspended their longline observer programs due to the COVID-19 pandemic and these have not resumed to date. Therefore, 2021 data from these programs are not available. Purse-seine data were available through 2022, with data from the last 2 years considered preliminary as of March 2023. Each data source, and associated data gaps, is described in detail below. Additional information on bycatch data available by fishery can be found in documents SAC-07-INF-C(d) and SAC-12-09.

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

[11] Vessels with a carrying capacity ≤363 t

2.1. Purse-seine

Data from the purse-seine fishery is 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 (Class 6) fishery are the most comprehensive in terms of bycatch species, since the 1992 Agreement on the Conservation of Dolphins (the La Jolla Agreement) has required an observer be placed on all trips for Class- 6 vessels since 1993. An historical perspective of bycatch data collection from the observer programs was recently published and is described in IATTC Special Report 25. 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 fisher-completed logbook and cannery datasets contain very limited data on bycatch species as reporting is primarily focused on commercially important tuna species. The logbook data, like the observer data, includes the exact fishing position, but limited effort data are recorded with only one entry per day, regardless of the number of sets made. The cannery (or "unloading") data do not have an exact fishing position but rather a broad geographic region where fish were caught (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.

Smaller (Class 1-5) purse-seine vessels are not systematically required to carry observers, except under specific circumstances (e.g., certification purposes, fishing during closure periods). The primary sources of unobserved data are logbook records, cannery unloading records, and port sampling by IATTC field office staff, all of which focus on tuna species. The FAD form, a logbook designed in late 2018 to be used by skippers of small vessels fishing on FADs, is also a source of unobserved data for tunas and sensitive species groups, but bycatch data is currently of little use for the purposes of this report as data are aggregated into broad taxonomic groups and data quality is uncertain. As such, there is limited information recorded on interactions with bycatch species by smaller vessels. In recent years there has been an increase in the number of smaller vessels that have carried observers. This is due to AIDCP requirements for fishing during closure periods for Class 6 purse-seine vessels, a desire for dolphin-safe fishery certification, an IATTC pilot project trialing the efficacy of electronic monitoring methodologies (SAC-11-10), and a voluntary observer program for smaller vessels established by the Tuna Conservation Group (TUNACONS)–a consortium of Ecuadorian tuna fishing companies–that began in 2018. The minimum observer-derived catch reported by observers for bycatch species by small vessel trips are included in this report (Table L-8) to provide the basic information currently available for this fishery, with a view to expanding reporting on this fishery as data provision is hoped to improve in future. In 2022, most trips (66%) made by smaller vessels were unobserved, 27% were from the voluntary TUNACONS observer program, 5% from the Ecuadorian National Observer program, 2% from the IATTC observer program and 1% from the Colombian National Observer program.

Therefore, in this report we primarily focus on the comprehensive observer dataset from large purse-seine vessels to provide catch estimates for bycatch species. The bycatch data provided by the observers are used to estimate total catches, by set type (i.e., floating objects (OBJ), unassociated tunas (NOA), and dolphins (DEL))[3]. The numbers of sets of each type made in the EPO during 2007–2022 are shown in Table A-7 of Document SAC-14-03.

Despite the observer requirement on all Class-6 trips, 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[12] to account for such instances.

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[12] The observed data are 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.

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, BYC-10 INF-D). Bycatch data for longline fisheries reported here were obtained using data of gross annual removals estimated by each CPC and reported to the IATTC in summarized form annually (i.e., termed "TASK I" data). Because there is uncertainty in whether the IATTC is receiving all bycatch data from the longline fishery of each CPC and considerable variability has been observed in the reported data by taxa, these data are considered incomplete, or 'sample data', and are therefore regarded as minimum annual reported catch estimates for 1993–2021. A staff-wide collaboration is underway to update 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 (SAC-12-09). A preliminary objective of this work is to initiate a series of collaborative workshops between the staff and CPCs to assess the feasibility of collecting desirable data types and develop data collection templates for each gear type, with clear standards and procedures for data submission that will explicitly include interactions with bycatch species. The first workshop in the series—focused on the industrial longline fishery—was held by videoconference on 09-10 January 2023 and garnered nearly 100 participants. A background document detailing the need for improving longline data, along with case examples, and staff recommendations was prepared by the staff (WSDAT-01-01); a series of presentations on this document, as well as a presentation by an invited speaker, were discussed during the workshop. Staff recommendations for updating Resolution C-03-05, pertaining to industrial longline data, were further revised based on input from workshop participants and consultations with individual CPCs (see SAC-14-14 and SAC-14 INF-Q). The workshop report has also been posted to the IATTC website (WSDAT-01-RPT).

As part of the data-review process for gathering information on data reported to the IATTC under Resolution C-03-05, 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 annual Fishery Status Reports since 2006 but were in fact taken by longline by coastal CPCs. 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 observer data reporting for longline vessels >20 m has been improving since Resolution C-19-08 was adopted in 2019, updating the previous longline observer measure, C-11-08. The staff has received detailed set-by-set operational level observer data for several CPCs, although the level of observer coverage achieved by some CPCs has been less than the current mandated coverage of 5% of effort measured as either the total number of hooks or "effective days fishing" (see e.g., SAC-14 INF-B). This was further exacerbated by the challenges many CPCs had in placing observers during the COVID19 pandemic, which continued to impact at least one longline observer program in 2022. And while some challenges in meeting the 5% requirement persist, the IATTC staff, the Ecosystem and Bycatch Working Group (EB-01) formerly known as the Working Group on Bycatch, and the Scientific Advisory Committee have recommended that the longline observer coverage requirement should be increased to at least 20%. IATTC staff discussed the insufficiency of 5% coverage, as well as concerns about whether the existing observer coverage is representative of the activities of longline fleets in the EPO in BYC-10 INF-D. Although CPCs have made a tremendous effort in improving their reporting of longline observer data, results from the analysis showed that 5% observer coverage is insufficient for estimating the total catch of the relatively data-rich yellowfin and bigeye tunas, and so catch estimates for bycatch species are likely to be less reliable given that less data are available for these species. Additionally,

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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.

the COVID-19 pandemic has in some cases hindered progress in the reporting of longline observer data. The challenges to observer placement and reporting of observer data necessarily implies that the datasets presented in this report are provided for transparency and show only minimum estimates of interactions and mortalities submitted to the IATTC. IATTC staff will seek to provide fleet estimates of longline catches in the EPO based on observer data in the future, but the results of the aforementioned analyses highlight a clear need for data reporting of bycatch species to improve (see SAC-12-09, WSDAT-01-01) prior to data expansion attempts.

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-14-03. An investigation on the effects of the COVID-19 pandemic on the catches of tropical tunas is provided in SAC-14 INF-D. The staff has developed stock assessments and/or stock status indicators (SSIs) for tropical tunas (SAC-14-04), exploratory analyses for bigeye (SAC-14-05) and yellowfin (SAC-14-06) tunas, and skipjack tuna assessment (SAC-14-08), proposed target and limit reference points for skipjack (SAC-14-09), and developed a fisheries independent abundance index for skipjack using echo-sounder buoy data for the OBJ fishery (e.g., FAD-06-03, FAD-07-03), which was included in the interim skipjack assessment (SAC-13-07). The staff has also 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), the assessment of south Pacific albacore tuna led by the Western and Central Pacific Fisheries Commission (WCPFC), and collaborated on the ISC assessments for north Pacific swordfish (2018), blue marlin (2021), striped marlin (2019) and shortfin mako (2022–2023). A southern EPO swordfish benchmark assessment is provided in SAC-14-15.

3.2. Marine mammals

Marine mammals, especially spotted dolphins (*Stenella attenuata*), spinner dolphins (*S. longirostris*), and common dolphins (*Delphinus delphis*), are frequently associated with yellowfin tuna in the EPO. Purse-seine fishers commonly set their nets around herds of dolphins and the associated 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 thereafter (AIDCP-43-02; Figur JL-1). The IATTC staff is collaborating on two research projects on dolphins focused on improving current understanding of the potential impacts of tuna fisheries on dolphin populations (SAC-14 INF-K), including a cow-calf separation study and an abundance survey.

Estimates of incidental mortality of dolphins in the purse-seine fishery of large vessels during 1993–2022 are shown in Table L-1a. In 2022, the stock of dolphins with the highest incidental mortality was the whitebelly spinner (n=300), followed by the eastern spinner (n=271), the western-southern spotted (n=197), and northeastern spotted dolphins (n=147). Common dolphins were least impacted by the fishery, with mortalities of 2 central, 20 southern, and 23 northern common dolphins. The staff plans to analyze available reported and observed marine mammal interaction data for the purse-seine fisheries in the near future.

In recent years significant improvements have been made to the minimum data standards of longline observer data submitted to the IATTC, which now require submission of operational level data under Resolution C-19-08. However, as discussed in section 2.2 the low level of observer coverage (at least 5%) currently mandated for these vessels is not representative of the different fleet components and hinders the extrapolation of observed data to generate fleet totals (see BYC-10 INF-D). For the time being, only the minimum number of observed interactions and mortalities reported for marine mammals is presented for 2021 (Table L-1b). Interactions and mortalities were defined by subjective classification of fate (injured, released, or not reported) and release condition (alive and healthy or not reported) as recorded by observers. Dispositions not reported were precautionarily assumed to represent mortalities. Under these assumptions, all 11 marine mammals reported by observers in 2021 were considered to be mortalities. The staff reiterates that the level of observer coverage should be increased to at least the recommended 20% to help facilitate expansion of the number of interactions and mortalities to the total fleet activities for marine mammals and other vulnerable bycatch species.

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 of fish-aggregating devices (FADs) or other floating objects (FAD-07-04) and drown or be injured or killed by fishing gear.

The number of estimated sea turtle mortalities and interactions recorded by observers on large purse-seine vessels, by set type, from 1993–2022 is shown in Figure L-2a and b, respectively. 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, while mortalities were defined as those with fates recorded as: grave injuries, killed, or consumed. The olive Ridley turtle (*Lepidochelys olivacea*) is, by far, the species of sea turtle most frequently caught, with a total of 21,850 interactions and 951 mortalities (~4%) during 1993–2022, but only 168 interactions and no mortalities occurred in 2022 (Table L-2a). In 2022, there were 44 interactions recorded with eastern Pacific green, 28 loggerhead, 11 hawksbill, 4 leatherback, and 116 unidentified turtles and no mortalities.

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 are available on incidental mortality of turtles by longline and gillnet fishing, 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 albacore, and highest in "shallow" sets (<150 m) targeting 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 (see BYC-11-02).

Data on sea turtle interactions and mortalities in the longline fishery have not been available (SAC-08-07b), although they are beginning to improve with the submission of operational-level observer data since 2019 pursuant to Resolution C-19-08. Recalling the observer coverage for most longline vessels is 5% or less (see BYC-10 INF-D), compared to 100% of observed trips in the large-vessel purse-seine fishery, the observer data provided by CPCs for 2021 are considered minimum numbers of interactions and mortalities (Table L-2b) that have been reported to the IATTC (see section 2.2). Here interactions and mortalities were defined by fate (discarded, injured, grave injuries, released, released with hook, or not reported) and/or release condition (alive and healthy, alive and injured, dead, unknown, or not reported) as recorded by observers. Only 8 interactions of sea turtles (5 olive Ridley turtles and 3 loggerhead turtles) were reported for 2021 and these all resulted in mortalities. 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 the future, although BYC-10 INF-D cautions that the current 5% observer coverage is insufficient for producing reliable estimates of total catch.

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. Additionally, a "circle hook" workshop was held prior to the 13th SAC meeting to discuss a) the effects of different sizes of circle hooks on mitigating bycatch of sea turtles and other vulnerable species in the longline fishery and b) the minimum hook size to satisfy the requirements outlined in Resolution C-19-04. The workshop participants discussed the use of different circle hooks in longline fisheries to satisfy C-19-04, with minimum width of the hook defined on a fishery-specific basis and dependent upon the target species. However, no definitive conclusions or recommendations were made (WSHKS-01), although discussions on this topic resumed during the 11th Bycatch Working Group meeting, in May 2022 and continued during the 1st Ecosystem and Bycatch Working Group meeting in May 2023, with a recommendation to hold a follow-up workshop (EB-01).

A preliminary vulnerability assessment was conducted in collaboration with the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) 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) (BYC-10 INF-B). The vulnerability status of the stock was determined to be "most vulnerable" in 2018. The staff continued to collaborate with IAC in 2020–2023 to improve the species distribution model (BYC-11-01) and vulnerability assessment using updated fisheries data from coastal CPCs (BYC-11-02). The final assessment showed that the vulnerability status of the stock remained as "most vulnerable" in 2019. Modelling of 70 management scenarios showed that the implementation of improved handling and release practices by industrial and artisanal fleets, or use of circle hooks, or use of fish bait by longline fleets could reduce at-vessel and/or post-release mortality to an extent where the vulnerability status of the population could improve to "least vulnerable", assuming fishing effort levels of all EPO fisheries do not increase. The use of these three measures in concert was predicted to reduce vulnerability even further. Detailed results from this work were presented in 2022 at the Bycatch Working Group meeting (BYC-11-01, BYC-11-02) and at the Ecosystem and Bycatch Working Group of ICCAT in May 2023 as an example of successful collaboration between organizations.

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)). Guidelines on fisheries electronic monitoring systems have also been reported by ACAP. Participants in the circle hook workshop, held in March 2022 (WSHKS-01), discussed the influence of circle hooks on seabird capture and mortality. The available data seem to be inconclusive to comment on any conservation value of circle hooks over other hook shapes or sizes to seabirds given a lack of empirical studies. In May 2023, the Ecosystem and Bycatch Working Group recommended the development of an action plan for seabird bycatch, including an update of C-11-02 (EB-01).

As with sea turtles, data on seabird interactions and mortalities in the longline fishery have been unavailable (SAC-08-07b), but with the submission of operational-level observer data for longline vessels >20 m beginning in 2019 some minimum estimates for 2021 are available for reporting (Table L-3) (but see section 2.2 for uncertainties and data gaps in reported data).

The observer data submitted by CPCs for 2021 contained 340 interactions with seabirds—all recorded as "discarded" or precautionarily presumed dead due to incomplete disposition data. With these limited data, the white-chinned petrel, *Procellaria aequinoctialis*, was reported to have interacted the most with the gear (n=63; 19% of all interactions), followed by the wandering albatross, *Diomedea exulans* (n=58; 17%), and the black-browed albatross, *Thalassarche melanophrys* (n=53; 16%). The staff hopes to report the first total longline fleet catch estimate for seabird species in the future using the operational observer data as improvements in data collection continue—but see BYC-10 INF-D for a discussion on the current inadequacy of longline observer data for expanding data to the activities of the longline fleet to provide estimates of total catch.

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 4 shark species in the EPO: silky (*Carcharhinus falciformis*) (Lennert-Cody *et al*. 2018; BYC-10 INF-A, BYC-11 INF-B), 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.

The first quantitative vulnerability assessment of sharks for EPO industrial and artisanal fisheries—using the EASI-Fish methodology (section 5)—was completed in 2022 and was presented at SAC-13 (SAC-13-11). Briefly, a total of 49 shark species were recorded to interact with EPO tuna fisheries, of which 32 species were formally assessed using EASI-Fish for 2019. Overall, 20 species were classified as "most vulnerable", including hammerhead sharks (4 species), requiem sharks (10 species), threshers (*Alopias superciliosus* and *A. pelagicus*), mesopelagic sharks (3 species) and the commercially important blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*). The remaining 12 species were classified as "least vulnerable" (9 species) or "increasingly vulnerable" (3 species). The report recommended further analysis to explore a range of potential hypothetical conservation and management measures (CMMs) that may be implemented—in isolation or in combination—within the EPO to reduce fishery impacts on particularly vulnerable shark species identified, including silky, thresher and hammerhead sharks. The EASI-Fish approach was applied to silky shark and hammerhead sharks during 2022–2023 to determine the relative benefits of alternative management scenarios on species' vulnerability (SAC-14-12).

Catches (t) of sharks in the large-vessel purse-seine fishery (1993–2022) and minimum reported catch estimates[13] by longline fisheries (1993–2021) are provided in Table L-4a, while catches of the most frequently caught species, discussed below, are shown in Figure L-3a. Reporting of many shark species by longline gear began in 2006 (but see section 2 for data gaps, including high variability in this dataset). The majority of the shark catch is from floating-object sets. The silky shark (family Carcharhinidae) is the species of shark most commonly caught in the purse-seine fishery with annual catches averaging 557 t—primarily from sets on floating objects (Figure L-3a)—and being 645 t in 2022. In contrast, minimum reported annual catch in the longline sample data for 2006–2021 averaged 10,683 t while only 12 t were reported in 2021. Annual catch for the oceanic whitetip shark (Carcharhinidae) in the purse-seine fishery averaged 56 t (also primarily from sets on floating objects) and was 12 t in 2022. The minimum reported annual catch in the longline fishery from 2006–2018 averaged 165 t and none were reported in 2019–2021. Catches of oceanic whitetip have declined in the purse-seine fishery since the early 2000s, while minimum reported catches have been variable in the longline fishery (Figure L-3). Minimum annual reported catch of blue shark in the longline fishery from 1993–2021 averaged 6,220 t and was 8,323 t in 2021. By contrast, the annual catch in the purse-seine fishery averaged only 2 t, with 1 t caught in 2022. Anomalies in the reporting of longline data are likely related to the COVID-19 pandemic, although it's important to note the reporting of bycatch data is not compulsory according to the data provision resolution (C-03-05) and the corresponding memorandum of technical guidelines (see SAC-12-09, WSDAT-01-01) which contributes to the variability.

Other important species of sharks caught in the purse-seine and longline fisheries include the smooth

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[13] 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 on harmonizing shark data collection to improve the reliability of total catch estimates (e.g., SAC-11-13).

hammerhead (*Sphyrna zygaena*), the pelagic thresher (*Alopias pelagicus*), and mako sharks (*Isurus* spp.) (Table L-4a, Figure L-3a). Catch estimates for the smooth hammerhead shark in the purse-seine fishery averaged 26 t (primarily caught in floating-object sets) and was 12 t in 2022, while in the longline fishery minimum annual reported catch averaged 900 t (2006–2021) and was 37 t in 2021. In contrast, the pelagic thresher was caught primarily in unassociated tuna school sets in the purse-seine fishery with the estimated annual catch averaging 4 t and was 1 t in 2022. Minimum annual reported catch of the pelagic thresher in the longline fishery averaged 1,928 t (2007–2021) and only 1 t was reported in 2021. Catch estimates for the mako sharks in the purse-seine fishery were lower than the aforementioned shark species averaging 3 t and was 2 t in 2022. However, in the longline fishery the minimum annual reported catch averaged 1,436 t (1993–2021) and was 1,399 t in 2021.

Complementary to the shark catches presented in Figure L-3a and similar to the purse-seine based SSIs reported by set type for the tropical tunas (SAC-14-04), catch by set type was scaled so that their average equals 1 during the 1993–2022 time period (i.e., the start of bycatch data collection) for 3 species of sharks with the highest annual nominal catches by large purse-seine vessels (i.e., silky shark, oceanic whitetip shark and smooth hammerhead shark). This relative catch in weight (t), which helps to better understand anomalies in species catch, is presented in Figure L-3b. In the earlier years (pre-2000), the silky shark relative catch was 3–3.5 times greater than the mean for those caught in dolphin sets, and about 4.5 times greater than the mean (1993) for those caught in unassociated sets, while relative catches were less variable in the floating-object set fishery. For the oceanic white tip shark, a decreasing trend in relative catches was observed for all set types with the greatest relative catches occurring prior to 2000. The relative catches of smooth hammerhead sharks were variable in all set types with relative catches about 5 times greater than the mean in unassociated sets in 2004.

The spatial distribution by 5°x5° grid cells of the catch of the same 3 shark species by set type for the large-vessel purse-seine fishery is presented in Figure L-4b to provide an indication of current (i.e., 2022) and past (average of the last 5 years; 2017–2021) spatial catch dynamics. Catches of silky shark were widely distributed across the EPO, occurred primarily in floating-object sets and were slightly greater in 2022 compared to the 5-year average between the equator and 10°N. Catches of oceanic whitetip shark and smooth hammerhead shark were minimal in both time periods (i.e., primarily <1 t) and the distribution was limited in 2022 compared to the 5-year average (floating-object sets only). Minimal catches of oceanic whitetip were observed around the equator and west of 140°W in 2022 with no catches > 1 t in the 5-year average. For the smooth hammerhead shark, minimal catches were observed east of 100°W in 2022 while only 1 location (10°S and 90°W) had catches slightly >1 t during the 5-year average.

The limited observer data from small purse-seine vessels showed 29 t of silky shark and 4 t of scalloped hammerhead were caught in floating-object sets in 2022, while those of other shark species or species groups were minimal (≤2 t) (Table L-8).

The minimum catches—derived only from observer data—for sharks caught by longline in 2021 are presented in Table L-4b (see section 2.2 and BYC-10 INF-D for uncertainties and data gaps in longline data). Blue shark was by far the most frequently caught shark species in this dataset with over 11,000 animals reported to have interacted with the gear in 2021, followed by the shortfin mako shark with nearly 1,000 animals. Under the disposition criteria described in Table L-4b, nearly all interactions resulted in mortalities for most of the shark species and species groups reported by observers.

The artisanal longline fisheries of the coastal CPCs seasonally 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)).

Since 2014, the IATTC staff has carried out extensive collaborative research with Organización del Sector Pesquero y Acuícola del Istmo Centroamericano (OSPESCA) and IATTC's Central American CPCs to develop a robust sampling methodology to improve data collection for shark fisheries in Central American EPO states. After approximately 7 years (2015–2021), this work—funded by 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, the IATTC capacity building fund, and the European Union—was completed in December 2021. The project's final results were presented at SAC-14 (SAC-14 INF-L), but there is a great need to maintain continuity of data collection to generate key fisheries data to assess and manage shark species in the EPO. Meanwhile, a second phase of the FAO-GEG ABNJ project is underway and the IATTC is receiving support to expand the previous work conducted in Central America to other EPO coastal States (SAC-14 INF-M). Data obtained from these projects may be included in future iterations of this report to provide improved catch estimates, albeit minimum estimates, for sharks by the various longline, gillnet and mixed gear fleets.

In May 2023, the Ecosystem and Bycatch Working Group recommended adoption of new measures for best handling and release practices for elasmobranchs caught by longline gear, that IATTC staff continue to develop improved data collection and reporting standards on elasmobranchs for small purse-seine vessels, and the adoption of a conservation and management measure requiring sharks with fins naturally attached to the body (EB-01).

3.6. RAYS

To better represent estimated annual catches of manta rays (Mobulidae) and stingrays (Dasyatidae), these animals are now reported in numbers of individuals by the large-vessel purse-seine fishery (1993–2022) in Table L-5a, while catches of key species are shown in Figure L-4a. Rays have rarely been reported in the annual summary reports for the longline fishery, although data have been available in the more recently obtained observer data (see Table L-5b). The largest average catches in the purse-seine fishery were observed for unidentified mobulid rays (Mobulidae spp., average 1993–2022: 1,231 individuals; number of individuals in 2022: 246), followed by the pelagic stingray (average: 885; 2022: 684), the smoothtail manta (average: 348; 2022: 103), the spinetail manta (average: 249; 2022: 74), unidentified stingrays (Dasyatidae spp., average: 214; 50) and the giant manta ray (average: 119; 2022: 11). 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-4a).

Similar to the sharks, relative catches of rays in numbers of individuals (i.e., scaled catch with the average equal to 1) by set type for large purse-seine vessels is provided in Figure L-4b. As with the reported observed catch (Figure L-4a), ray relative catches were highly variable with no apparent trends, and peaks of relatively high catches were not consistent between species and set type. The spatial distribution of catches (5°x5° grid cell) was greatest for pelagic stingray with most catches occurring in floating-object sets east of 120°W for 2022 and the 5-year average (2017–2021) (Figure L-4c). Catches from unassociated sets occurred coastally off Baja California and South America, while catches from dolphin sets primarily occurred north of the equator. Minimal catches of the spinetail manta, smoothtail manta and giant manta were observed across space and time with most catches <5 individuals per spatial area.

For the small purse-seine vessel fishery, the limited available observer data for 2022 was minimal with the largest number of individuals caught in floating-object sets corresponding to the pelagic stingray (n=36), followed by the spinetail manta (n=18), the smoothtail manta (n=11) and unidentified manta rays (Mobulidae spp., n=10), while the number of other rays were <10 (Table L-8).

The minimal data available from the reported longline observer dataset for 2021 (see section 2.2. for data gaps and BYC-10 INF-D) showed that the most interactions were with the pelagic stingray (*Pteroplatytrygon violacea*) and 95% of these interactions (3,909 individuals) resulted in mortalities (3,703) (Table L-5b).

The vulnerability status and efficacy of potential conservation and management measures (CMMs) for the spinetail devil ray (*Mobula mobular*) impacted by industrial purse-seine and longline fisheries in the EPO was determined using the EASI-Fish methodology (section 5). In the assessment year of 2018, the estimated fishing mortality exceeded the $F_{/F4}$0% and SBR/S_{BR4}0% biological reference point, leading to a vulnerability status classification of "most vulnerable". A retrospective analysis of vulnerability from 1979–2018 showed the species to be classified as "least vulnerable" between 1979 and 1993, but became "most vulnerable" from 1994, which coincided with the rapid spatial expansion of the industrial purse-seine fishery. Vulnerability increased significantly from 2011 following the rapid increase in the number of purse-seine sets made on floating objects to 2018. Simulating the CMMs in place in 2018 for EPO tuna fisheries (i.e., an EPO-wide closure) and for mobulids specifically (i.e., use of best handling and release practices under C-15-04) resulted in 31 of the 45 scenarios changing the classification of the species from "most vulnerable" to "least vulnerable", which primarily involved a reduction of post-capture mortality by as little as 20%. Implementing appropriate best handling and release practices can be a reasonably simple, rapid and cost-effective conservation measure, but a recommendation from the work was to extend the EASI-Fish analysis to all species of mobulids impacted by EPO tuna fisheries, improve estimates of post-release mortality for these species through dedicated tagging studies, and improve species-specific catch reporting, especially in artisanal fisheries, to improve the reliability of outputs from EASI-Fish assessments.

3.7. Other large fishes

Species composition varies between purse-seine and longline fisheries. Large pelagic fishes caught by the large-vessel purse-seine, primarily on floating-object sets, (1993–2022) and longline (1993–2021) fisheries are shown in Table L-6a, 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 1,356 t (2,334 t in 2022) and the minimum reported annual catch for the longline fishery averaging 5,812 t (1,413 t in 2021). 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 were presented at SAC-10 (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 362 t for the purse-seine fishery, although catches have declined from a peak of 1,025 t in 2001 to 164 t in 2022 (Figure L-5). Minimum reported annual catch of wahoo by the longline fishery have averaged 170 t and was 211 t in 2021. 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 were 47 t, with the peak catch in 2007 at 158 t and declining thereafter to 36 t in 2022 (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 369 t (1993–2021), 369 t (2006–2021), and 53 t (1993–2021), respectively. Catches of all these taxa have increased after the mid-2000s (Figure L-5) but note the uncertainty and data gaps in this dataset (section 2.2). For the most recent year (2021), there were 449 t, 277 t, and 50 t of opah, snake mackerels, and pomfrets reported, respectively (Table L-5a).

The limited observer data available for 2022 for the small purse-seine fishery included 289 t of dorado and 26 t of wahoo caught in floating-object sets, while the remaining species or species groups of large fishes had ≤2 t reported (Table L-8).

For 2021, the minimal available data from longline observers (see section 2.2. and BYC-10 INF-D) is provided in Table L-6b and shows the most frequently caught species in this dataset was the long snouted lancetfish (*Alepisaurus ferox*) with about 11,000 interactions. Most interactions with large fishes resulted in mortalities.

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-7 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 1,021 t from 1993–2022. However, their catches have declined from 1,921 in 2005 to 699 t in 2022 (Figure L-6). Triggerfishes (Balistidae) and filefishes (Monacanthidae) are the second most commonly reported forage group with annual estimated catches averaging 262 t and totaling 545 t in 2022. Catches for this group peaked in 2004 at 922 t but have otherwise been variable. Annual catches of sea chubs (Kyphosidae) have averaged 17 t and have remained minimal with 22 t in 2022. Lastly, annual catches of the various species in the category 'epipelagic forage fishes' averaged 7 t with 15 t estimated to be caught in 2022. A total of 128 t of bullet and frigate tunas and 84 t of triggerfishes and filefishes caught in floating-object sets were reported by observers on the limited number of trips on small purse-seine vessels that carried an observer in 2022. Catches of all other species or species groups of small fishes were minimal (≤3 t) (Table L-8).

4. PHYSICAL ENVIRONMENT

Environmental conditions affect marine ecosystems, the dynamics and catchability of target and bycatch species, and the activities of fishers, and biophysical factors can have important effects on the distribution and abundance of marine species[14] (e.g., SAC-10 INF-D). The following summary of the biophysical environment covers: 1) short- and long-term environmental indicators, and 2) environmental conditions and their potential effect on the fishery during the previous year, in this case, 2022. Additionally, the Ecosystem and Bycatch Working Group recently recommended that climate change be included as a permanent agenda item (EB-01), and as such, the IATTC staff will seek to improve this section accordingly in the future.

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-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).

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 could make tunas less vulnerable to capture, and thus reduce 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 2022 anomalies—

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[14] 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.

defined in the Bulletin as a departure from the monthly mean—in oceanic and atmospheric characteristics (e.g., surface and sub-surface temperatures, thermocline depth, wind, and convection) were consistent with La Niña conditions for the entire year.

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-7a), 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-7b). 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 "extreme" El Niño event. Moderate La Niña conditions persisted throughout 2022 with values ranging from -1.1 to -0.8 (Figure L-7b).

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. The PDO has been in a "cool" phase since early 2020. During 2022, cool conditions persisted with values ranging from -2.22 to -1.35 (see ERSST V5 PDO Time series data).

4.2. Spatio-temporal exploration of environmental conditions

A time series of SST and chlorophyll-a concentration (CHL-a; an indicator of primary productivity biomass) (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 1993–2022, while that for CHL-a concentrations covers data for 2003–2022 due limitations with data availability. The SST plot (Figure L-9, top panel) 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 across the ETP. The CHL-a plot (Figure L-9, bottom panel), although the pattern is less clear than the SST plot, shows an increase in CHL-a concentrations following the strong La Niña events particularly in 2010–2011, likely due to increases in nutrient availability.

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 CHL-a levels 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 environmental variability for 2022, 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 2022. In future, the staff plans to incorporate the catch distribution of key bycatch species and develop species distribution models (SDMs) to better describe potential relationships between environment and species. In 2021–2022, SDMs were developed for the leatherback sea turtle (BYC-11-01) and 32 species of sharks (SAC-13-11) and several high-resolution SDMs are underway for other sensitive bycatch species, including oceanic whitetip, silky and hammerhead sharks.

Cooler waters occurred off northern Mexico and the southwestern United States north of 20°N and off South America, south of the equator and east of 100°W (Figure L-10). These cool waters extended westwards during quarters 1 (January–March) and 2 (April–June), and 3 (July–September) and 4 (October–December), respectively. Warmer waters developed off Central America and extended westwards during quarters 2 and 3 but retracted in quarter 4. A secondary, less intense, warm pool was observed in the southwestern EPO (10–20°S, 140°–150°W) during quarters 1 and 2.

Figure L-11 shows CHL-a concentrations were highest along the equator and the coast of the Americas year-round. The oligotrophic[15] South Pacific Gyre—located between around 20°–40°S and extending from 150°–90°W—was present in quarter 1, slightly retracted in quarters 2 and 3, and returned in quarter 4.

During quarters 1 and 2, skipjack predominated in the catches in waters ~25°C off the coast of South America (Fig. L-10), where CHL-a concentration was high (Fig. L-11). Yellowfin tuna was the predominant tuna species in the catch primarily north of the equator during these same quarters; yellowfin catches were relatively minimal in the warmer waters (~28°–29°C) present off central America in quarter 2. During quarters 3 and 4, the tuna catches along the coast of South America decreased as cooler waters expanded throughout the region. Bigeye tuna catches mostly occurred south of 10°N with larger catches taken west of ~110°W, particularly in quarters 2 and 3. No tuna catches occurred in the oligotrophic gyre located approximately south of 20°S and the western boundary of the EPO (150°W) to about 100°W.

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, is Ecological Risk Assessment (ERA)—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 Productivity-Susceptibility Analysis (PSA) to estimate the relative vulnerability of data-limited, non-target species caught in the EPO by large 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 ($\tilde{F}$) of each species, based on the 'volumetric overlap' of each fishery on the geographic distribution of these species. The estimate of $\tilde{F}$ is then used in length-structured yield and spawning biomass per-recruit models to assess the vulnerability of each species using conventional biological reference points (e.g., F_{MSY}, $\mathrm{SPR}_{40\%}$).

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, BYC-11-02). Therefore, it was decided in the SSP that 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. In 2022, EASI-Fish was used to assess the vulnerability of the eastern Pacific leatherback turtle and shark bycatch species in EPO tuna fisheries and the results were presented at BYC-11 (BYC-11-02) and SAC-13,

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

respectively (SAC-13-11). In 2023, an EASI-Fish assessment for silky shark (*Carcharhinus falciformis*) and three hammerhead species; scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), and smooth hammerhead (*Sphyrna zygaena*) was presented at SAC-14, where the effects of 43 different conservation and management measures were simulated (SAC-14-12). This assessment showed that no single management measure was able to reduce the vulnerability status of any species from “vulnerable” to “least vulnerable”. Although scenarios such as temporal EPO closures, banning wire traces, imposing a 100 cm total length minimum retention length for all sharks, and even prohibiting landing of all sharks was predicted to greatly reduce at-vessel mortality, this positive effect on vulnerability was mostly negated due to high post-release mortality of these species. These results highlighted that the most effective mitigation measure for these sharks is to avoid interaction with EPO fisheries. The assessment identified several major data gaps that need to be addressed through a collaborative participatory research approach between the IATTC and its CPCs, including basic biology and improved species-specific catch and size composition data in artisanal fisheries and the industrial longline fishery. Addressing these data needs will not only help to improve short-term rapid assessments such as EASI-Fish, but also develop longer-term time series data required to undertake new and conventional methods such as close-kin mark recapture or traditional stock assessments from the which population status of these vulnerable species can be determined.

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, including the experimental determination of consumption estimates of yellowfin tuna at the NMFS Kewalo Basin facility on Oahu, HI in the 1980s, to more recent analyses of stomach content and stable isotope analysis 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”). The model required a further update in 2021 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. Therefore, annual catch estimates by species for 1993–2018 were assigned to the relevant functional groups in the ETP-21 model, which was then rebalanced and recalibrated to time series data to provide an updated ecosystem status for 2021 and to undertake simulations to assess potential impacts of the FAD fishery on the structure of the ecosystem (SAC-12-13).

6.1. Ecological indicators

Since 2017, the most recent Ecopath model has been used in the *Ecosystem Considerations* report to provide annual values for seven 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's 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.

Following no update to the model in 2022, ETP-21 was updated in 2023 (named ETP-23) using annual catch estimates by species for 1993–2021 assigned to the relevant functional groups, which was then rebalanced to provide an updated ecosystem status for 2021.

Ecological indicators showed that values for TL_c and MTI decreased from their peak of 4.77 and 4.83 in 1991 to 4.62 and 4.65 in 2019 and 2018, respectively, as the purse-seine fishing effort on floating objects (OBJ) significantly increased (Figure L-13), where there was increasing catches of high trophic level bycatch species that tend to aggregate around floating objects (e.g., sharks, billfish, wahoo and dorado). Since its peak in 1991, TL_c declined by 0.05 of a trophic level in the subsequent 30 years, or 0.04 trophic levels per decade. The increasing number of OBJ sets is also seen in the FIB index that exceeds zero after 1990, as well as the continual change in the evenness of biomass of the community indicated by Shannon's index.

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 $TL_{MC\mathit{4.0}}$ community was at one of its highest values (4.493) in 1986 but has continued to decline to 4.459 in 2021 (Figure L-13). As a result of changes in predation pressure on lower trophic levels, between 1993 and 2021 the biomass of the $TL_{MC\mathit{3.25}}$ community increased from 3.801 to 3.816, while interestingly, the biomass of the $TL_{MC\mathit{2.0}}$ community also increased from 3.092 to 3.114.

Together, these indicators show that the ecosystem structure has likely changed over the 42-year analysis period. The consistent patterns of change in each ecological indicator, particularly in the mean trophic level of the communities since 1993, certainly warrant the continuation, and ideally an expansion, of monitoring programs for fisheries in the EPO. The COVID-19 pandemic in 2020 allowed staff to examine the direct effects of reduced fishing effort on the ecosystem through use of ecological indicators. The most notable change was a 23% decrease in the number of purse-seine OBJ sets from 14,987 sets in 2019 to 11,543 sets in 2020. This decrease in effort resulted in abrupt changes in most ecological indicators for 2020 and mostly returning to pre-pandemic levels in 2021 when the number of OBJ sets increased to 14,865 (Figure L-13). These results suggest that the increase in OBJ sets is likely primarily responsible for the continued change in ecosystem structure over the past two decades.

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 and assessments 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 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 (e.g., sharks, rays, teleosts, turtles and cetaceans). All pelagic shark species and the critically endangered eastern Pacific leatherback turtle stock were assessed in 2022.
- Given the high number of species classified as "most vulnerable" in the 2022 shark EASI-Fish assessment, a high priority is to develop a strategy for future conservation and management of these vulnerable species. As a first step EASI-Fish will be used to explore the potential efficacy of hypothetical conservation and management measures for silky and hammerhead sharks in 2023 (SAC-14-12).
- Significant knowledge gaps identified for sharks in the EASI-Fish assessment pertained to the

fundamental parameter values required to characterize the population dynamics of several species in the EPO, even those that have been commonly recorded as bycatch for decades. Therefore, significant efforts are required by the IATTC and its Members to establish a strategy for undertaking cost-effective studies to collect data to develop morphometric relationships (e.g., length-weight and length-length), growth curves, and maturity ogives. In addition to the GEF-FAO ABNJ shark fishery data collection work recently completed in Central America and about to expand to other IATTC Members in 2023, which could be seen as an opportunity to achieve such a strategy (SAC-13-12, SAC-14 INF-L, SAC-14 INF-M), the IATTC staff has prepared a document identifying data gaps and potential opportunities for a phase-based approach to obtaining morphometric measurements and biological sampling of tunas, billfishes, and priority bycatch species on purse seiners and longliners (SAC-14 INF-J).

- A shortcoming of the ETP-23 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 and fishery 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 2018–2023 to establish an ecological monitoring program to collect stomach content data to update the ecosystem model. Given the emerging requirements for biological data on sharks, such a monitoring program could incorporate all biological and ecological requirements of the IATTC. Again, the GEF-FAO ABNJ project which continues to expand among IATTC Members offers some opportunities for integrating such a sampling program, especially if the ABNJ pilot project continues in perpetuity as recommended by the staff. In addition, the proposed morphometric and biological sampling study (SAC-14 INF-J) aims to opportunistically collect biological samples, including stomachs, to obtain updated diet data for future use in a spatially-explicit ecosystem model.
- A second limitation of the ETP-23 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. Future work by the IATTC staff will address this relationship in more detail, at different spatio-temporal scales, including long-term environmental implications, such as ENSO regimes or climate change effects. Furthermore, the Ecosystem and Bycatch Working Group recommended that climate change is included as a permanent agenda item "*to ensure that the IATTC is prepared to address the possible effects of these changes on the target and non-target populations under its purview*" (EB-01). 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, analyses conducted by the staff provide conclusive evidence that these data are not representative of the fleet (BYC-10 INF-D) and therefore brings into question the validity of using submitted longline data for future environmental analyses until the observer coverage reaches at least 20%.
- The task of disentangling the spatial and temporal overlap of multiple target and non-target species requires an in-depth exploration of risk and trade-offs across management scenarios and species groups. Although the scientific community has argued for the importance of exploring dynamic spatial management over the past 20 years, there are currently few examples of dynamic or adaptive spatial management measures being implemented in tuna fisheries to reduce bycatch. In fact, no spatial management measures have been implemented to date to specifically reduce the catch of non-target species in tuna RFMOs. The identification of areas of potential interest for spatial management in the open ocean is directly dependent on the everchanging species-environment relationship, which can

be modeled to estimate and predict species' distributions and relative abundance across space and time and inform the design of adaptive management measures. Although the IATTC staff has started to investigate this issue in the EPO for both target and non-target species (e.g. SAC-10 INF-D, Pons et al 2022, BYC-11-04, Druon et al 2022), the potential implementation and operationalization of adaptive management options should be explored in the coming years.

- The quality of ecological analyses and the annual reporting of EPO-wide catch estimates for bycatch species is currently hampered by IATTC's existing resolution on data provision (C-03-05), which no longer aligns with IATTC's evolving responsibilities under the Antigua Convention (see SAC-12-09). Such responsibilities include ensuring the sustainable impacts of EPO fisheries on associated and dependent species, which is the primary reason for the creation, and annual updates of, this *Ecosystem Considerations* report. Presently, the only reliable source of bycatch data is from observers onboard large, size Class-6, purse-seine vessels. Limited to no data on bycatch exists for other pelagic fisheries in the EPO. Proposed capacity building opportunities and a series of workshops involving IATTC staff and CPCs to develop clear data reporting standards are expected to facilitate improved data submission, catch estimates and reporting, which in turn will improve ecological analyses to allow the IATTC to meet its obligations under the Antigua Convention. Discussions commenced during the first workshop on improving data collection for the industrial longline fisheries (WSDAT-01, WSDAT-01-RPT) and a series of staff recommendations, which culminated from workshop participation and individual consultation with CPCs, was presented at the 14th meeting of the SAC (see SAC-14-14, SAC-14 INF-Q).
- The IATTC staff is collaborating on two research projects on dolphins focused on improving current understanding of the potential impacts of tuna fisheries on dolphin populations (SAC-14 INF-K), including a cow-calf separation study and an abundance survey.

ACKNOWLEDGMENTS

We would like to thank Nick Vogel, Joydelee Marrow, and Joanne Boster for their assistance with data preparation, Alexandre Aires-da-Silva and Paulina Llano for their reviews of this document, and Christine Patnode for improving the figures. We gratefully acknowledge the early ecosystem research by Robert Olson that contributed to this report. His initiation of the *Ecosystem Considerations* report in 2003 was first presented at the 8th Meeting of the Working Group to Review Stock Assessments in 2007 (SAR-8-17 J) and has been updated annually.

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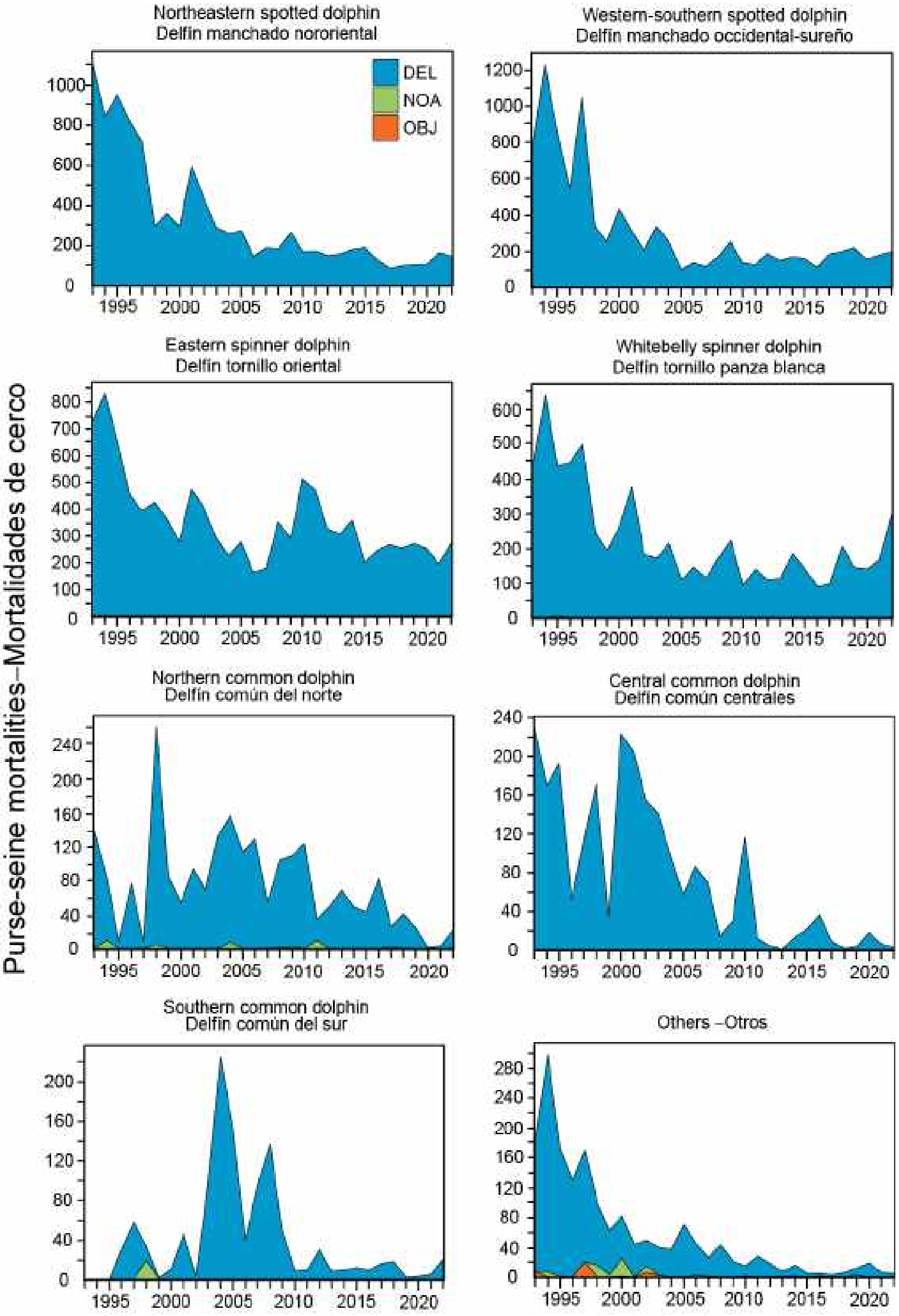

FIGURE L-1. Estimated number of incidental dolphin mortalities by observers onboard purse-seine vessels, 1993–2022.

FIGURA L-1. Número estimado de mortalidades incidentales de delfines por observadores a bordo de buques cerqueros grandes, 1993–2022.

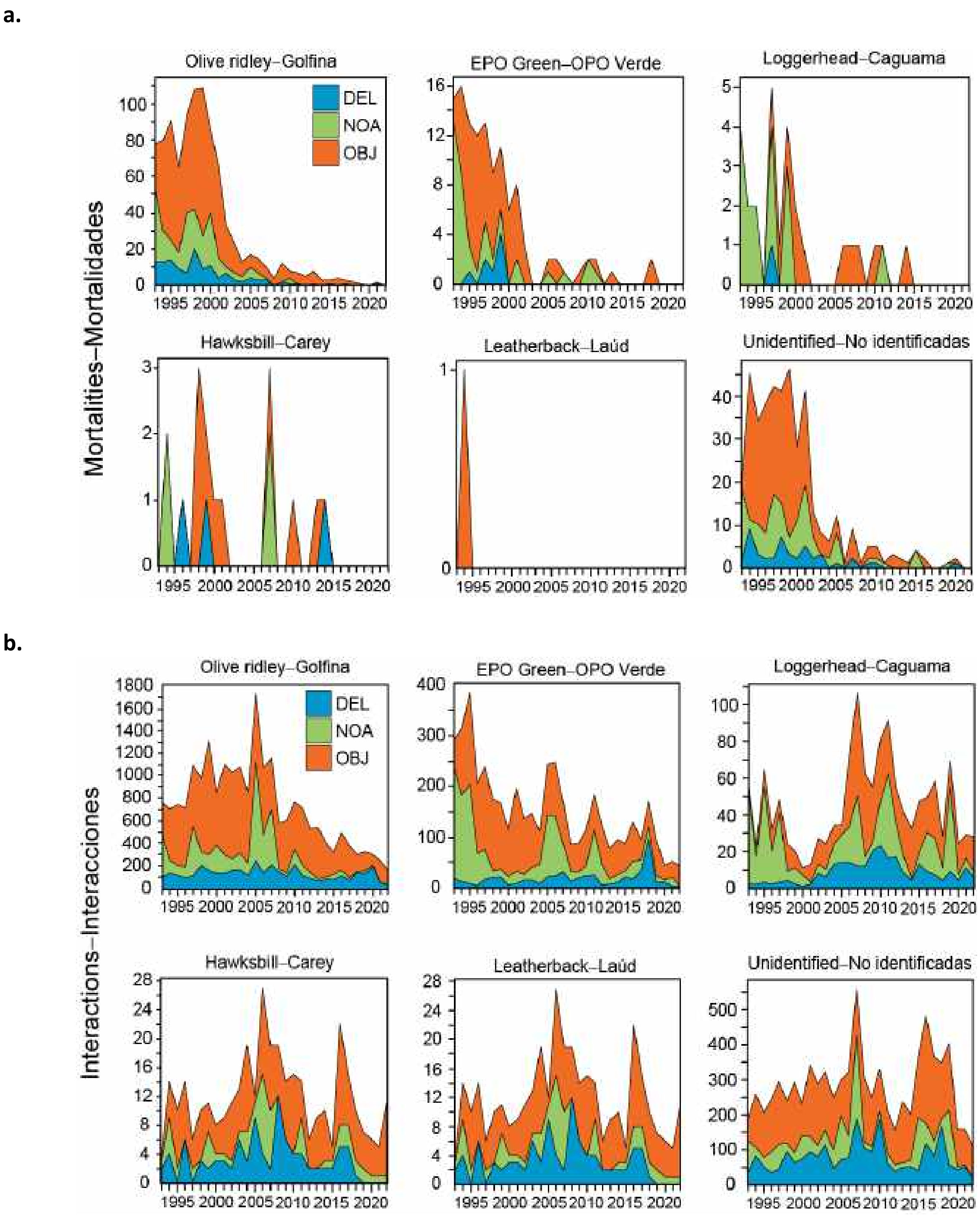

FIGURE L-2. Estimated number of sea turtle a) mortalities and b) interactions by observers onboard large purse-seine vessels, 1993–2022, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)).

FIGURA L-2. Número estimado de a) mortalidades y b) interacciones de tortugas marinas por observadores a bordo de buques cerqueros grandes, 1993-2022, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)).

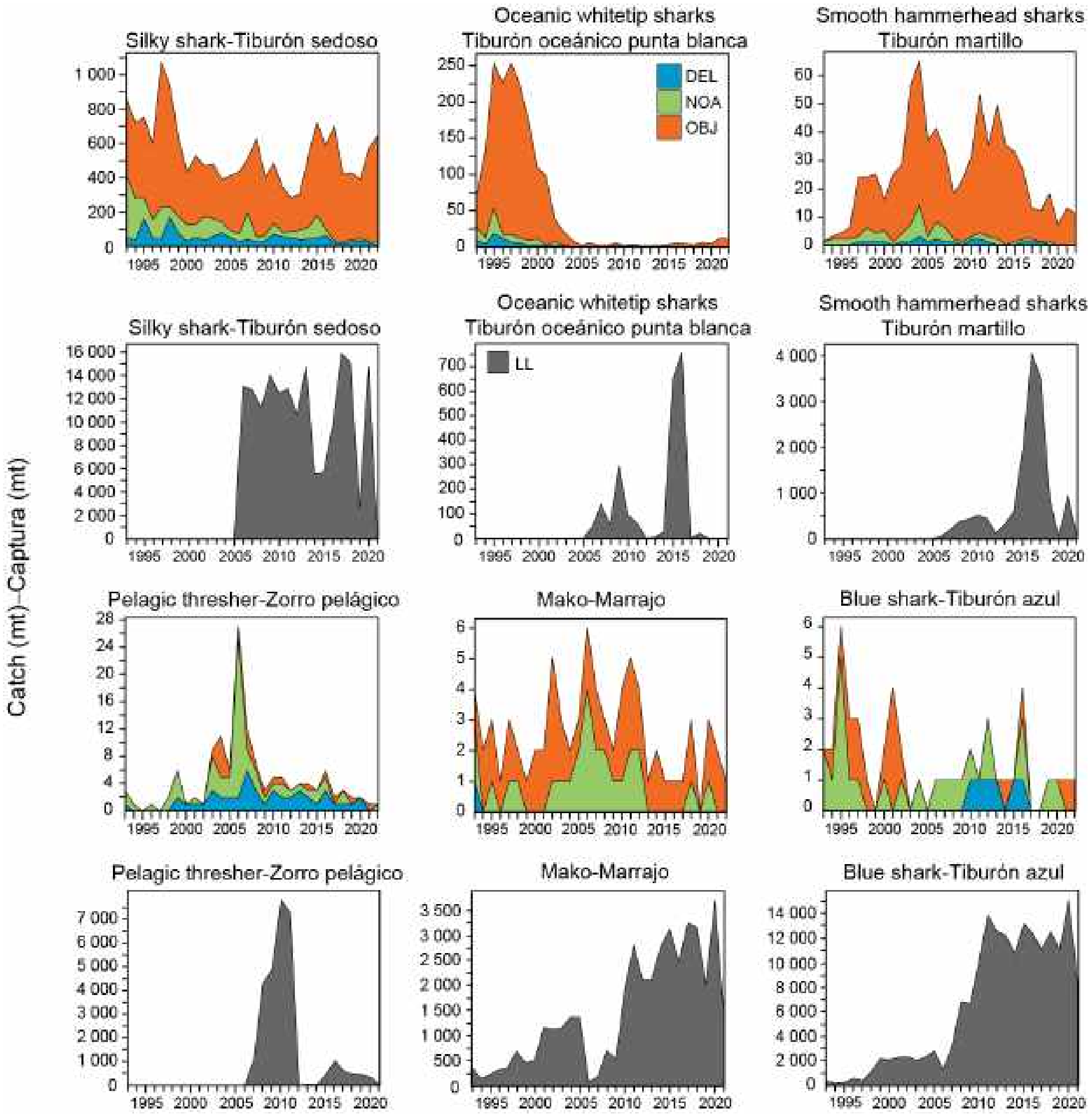

FIGURE L-3a. Estimated catches in metric tons (t) of key shark species in the eastern Pacific Ocean recorded by observers onboard large purse-seine vessels and minimum longline (LL) estimates of gross annual removals reported by CPCs (see section 2.2. for uncertainty and data gaps in reporting of bycatch species caught by longline). Purse-seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2022) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline catches (1993–2021) 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-3a. Capturas estimadas en toneladas (t) de especies clave de tiburones en el Océano Pacífico oriental registradas por observadores a bordo de buques cerqueros grandes y estimaciones mínimas de palangre (LL) de extracciones anuales brutas reportadas por los CPC (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos en la notificación de especies capturadas incidentalmente con palangre). Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2022) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras (1993–2021) 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).

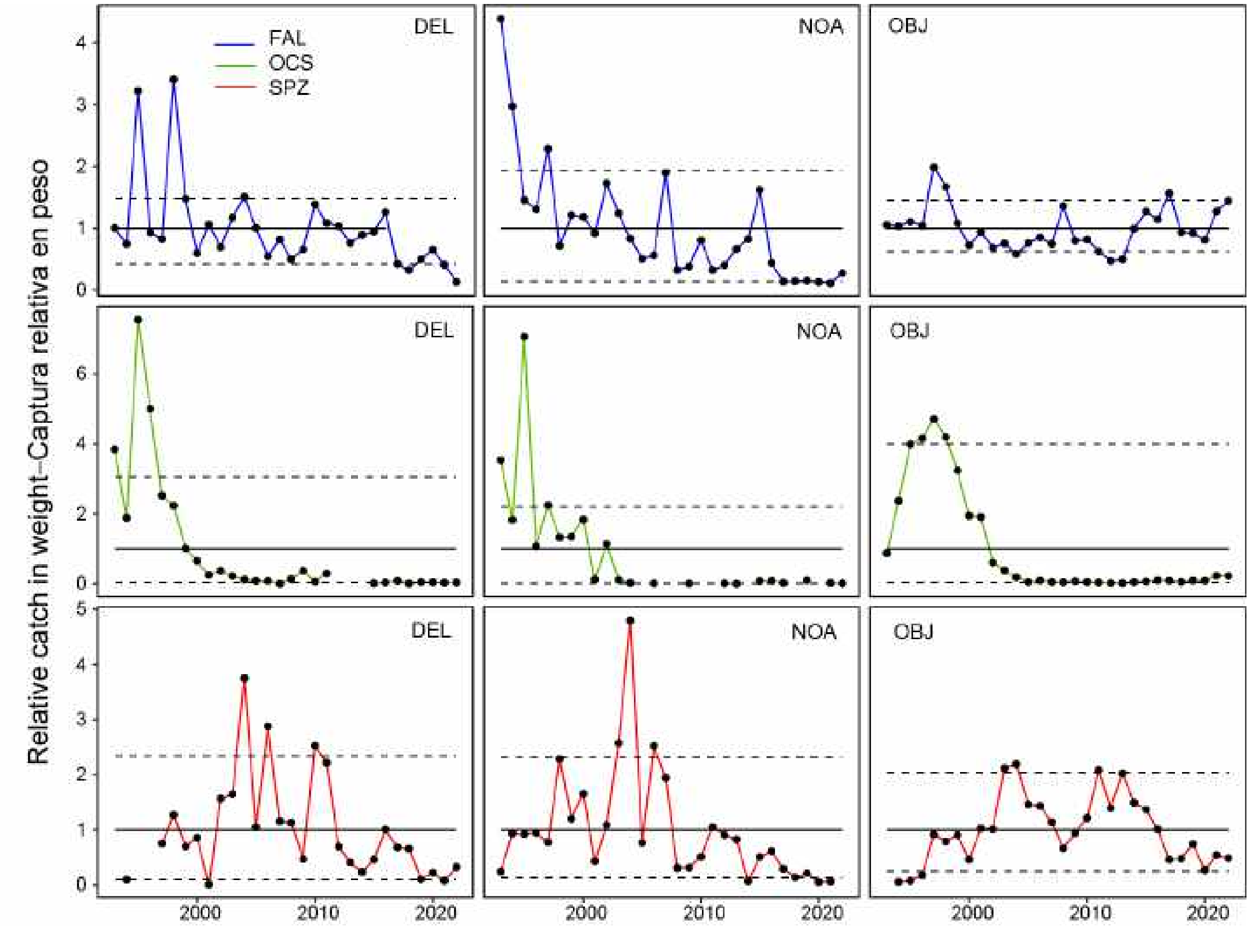

FIGURE L-3b. Indicators of relative catch of key shark species reported by observers onboard large purse-seine vessels (Class 6, carrying capacity > 363 t) by set type: dolphins (DEL), unassociated tuna schools (NOA) and floating object (OBJ). The solid line is the average equal to 1 and the dashed lines represent the 10th and 90th percentiles. FAL: silky shark (*Carcharhinus falciformis*), OCS: oceanic whitetip shark (*Carcharhinus longimanus*), SPZ: smooth hammerhead shark (*Sphyrna zygaena*).

FIGURA L-3b. Indicadores de captura relativa de especies clave de tiburones notificada por observadores a bordo de buques cerqueros grandes (clase 6, capacidad de acarreo > 363 t) por tipo de lance: sobre delfines (DEL), no asociados (NOA) y sobre objetos flotantes (OBJ). La línea continua es el promedio igual a 1 y las líneas punteadas representan los percentiles de 10 y 90%. FAL: tiburón sedoso (*Carcharhinus falciformis*), OCS: tiburón oceánico punta blanca (*Carcharhinus longimanus*), SPZ: cornuda cruz (*Sphyrna zygaena*).

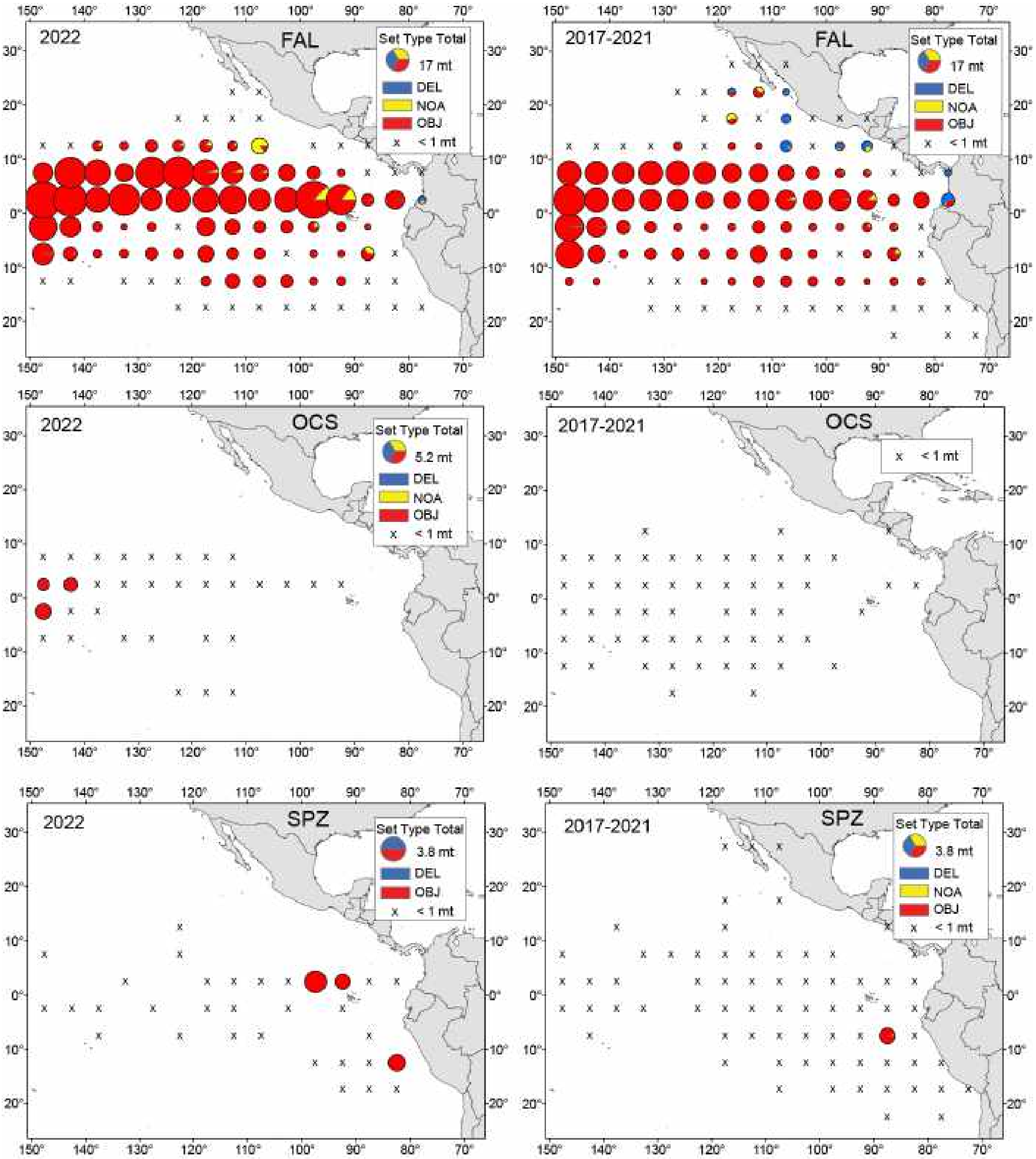

FIGURE L-3c. Purse-seine catches (Class 6, carrying capacity > 363 t) (at 5°x5° resolution) of key species of sharks by set type: floating object (OBJ) unassociated tuna schools (NOA) and dolphins (DEL), for 2022 (left panel) and the 2017-2021 averages (right panel). FAL: silky shark (*Carcharhinus falciformis*), OCS: oceanic whitetip shark (*Carcharhinus longimanus*), SPZ: smooth hammerhead shark (*Sphyrna zygaena*).
FIGURA L-3c. Capturas cerqueras (clase 6, capacidad de acarreo > 363 t) (resolución de 5°x5°) de especies clave de tiburones por tipo de lance: sobre objetos flotantes (OBJ), no asociados (NOA) y sobre delfines (DEL), para 2022 (panel izquierdo) y los promedios de 2017-2021 (panel derecho). FAL: tiburón sedoso (*Carcharhinus falciformis*), OCS: tiburón oceánico punta blanca (*Carcharhinus longimanus*), SPZ: cornuda cruz (*Sphyrna zygaena*).

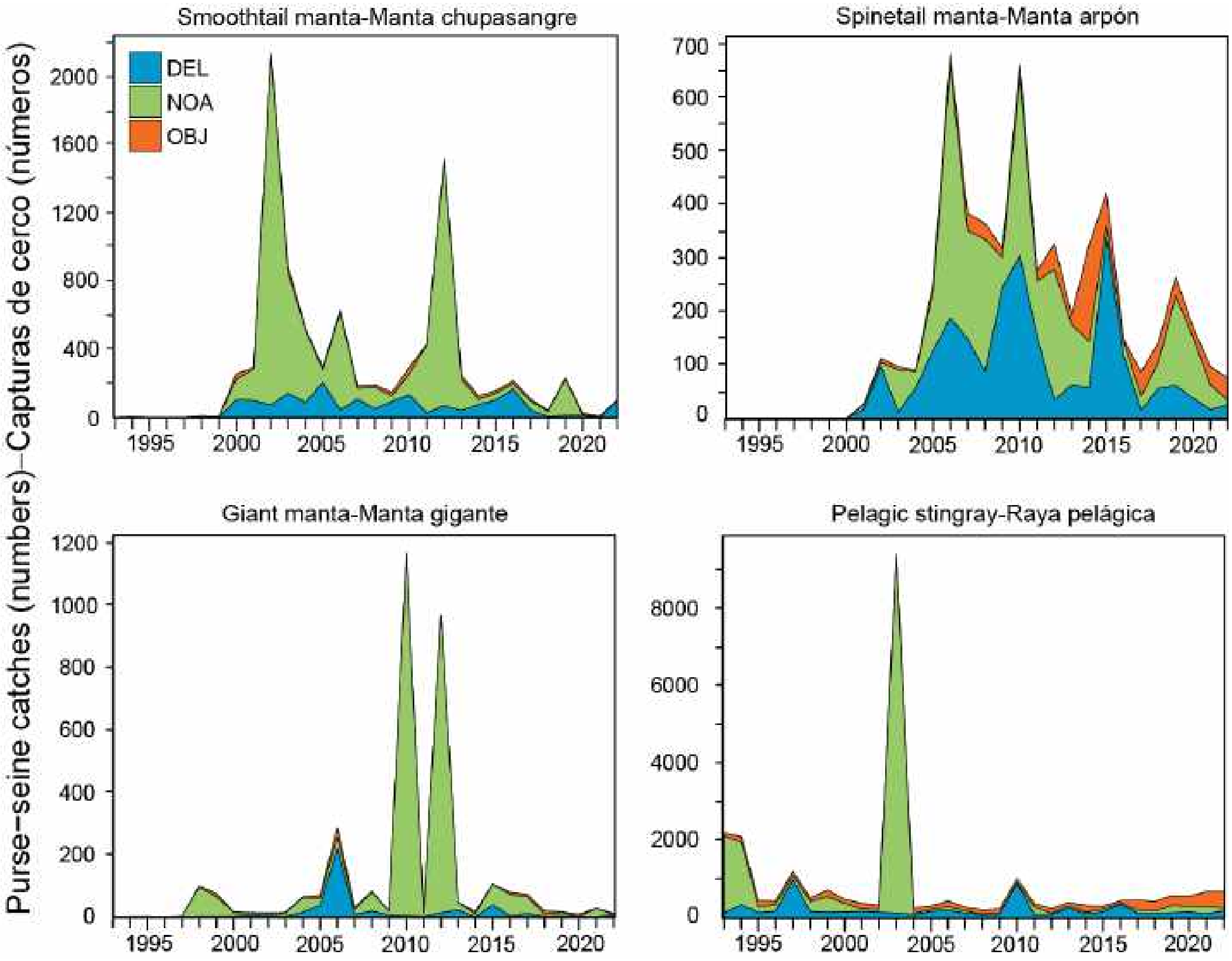

FIGURE L-4a. Estimated purse-seine catches in numbers of individuals of key species of rays in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2022) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL).

FIGURA L-4a. Capturas cerqueras estimadas en número de individuos 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 (1993-2022) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL).

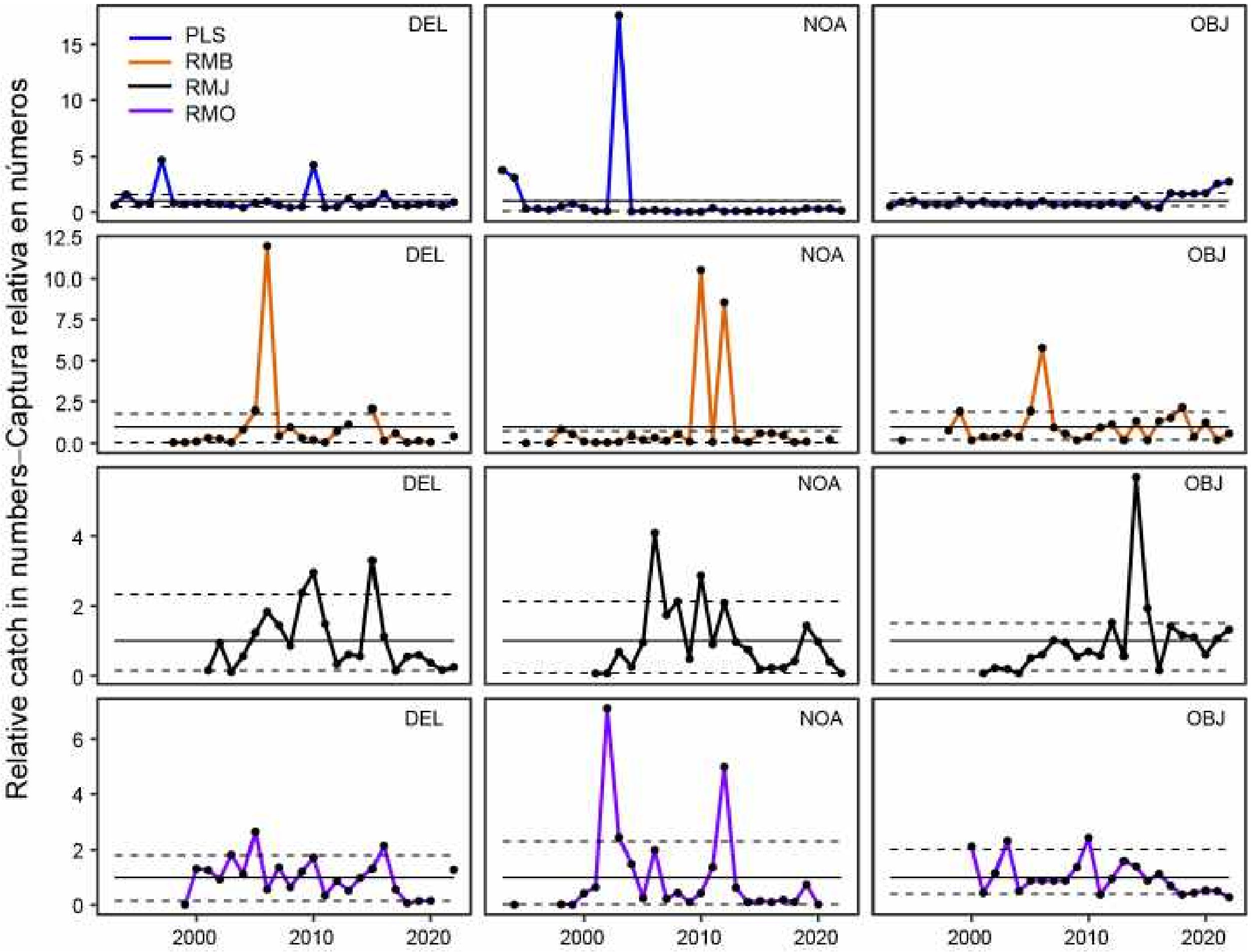

FIGURE L-4b. Indicators of relative number of individuals of rays reported by observers onboard large purse-seine vessels (Class 6, carrying capacity > 363 t) by set type: dolphins (DEL), unassociated tuna schools (NOA) and floating object (OBJ). The solid line is the average equal to 1 and the dashed lines represent the 10th and 90th percentiles. PLS: pelagic stingray (*Pteroplatytrygon violacea*), RMB: giant manta (*Mobula birostris*), RMJ: spinetail manta (*Mobula mobular*), RMO: smoothtail manta (*Mobula thurstoni*).

FIGURA L-4b. Indicadores del número relativo de individuos de rayas notificado por observadores a bordo de buques cerqueros grandes (clase 6, capacidad de acarreo > 363 t) por tipo de lance: sobre delfines (DEL), no asociados (NOA) y sobre objetos flotantes (OBJ). La línea continua es el promedio igual a 1 y las líneas punteadas representan los percentiles de 10 y 90%. PLS: raya pelágica (*Pteroplatytrygon violacea*), RMB: manta gigante (*Mobula birostris*), RMJ: manta mobula (*Mobula mobular*), RMO: manta diablo (*Mobula thurstoni*).

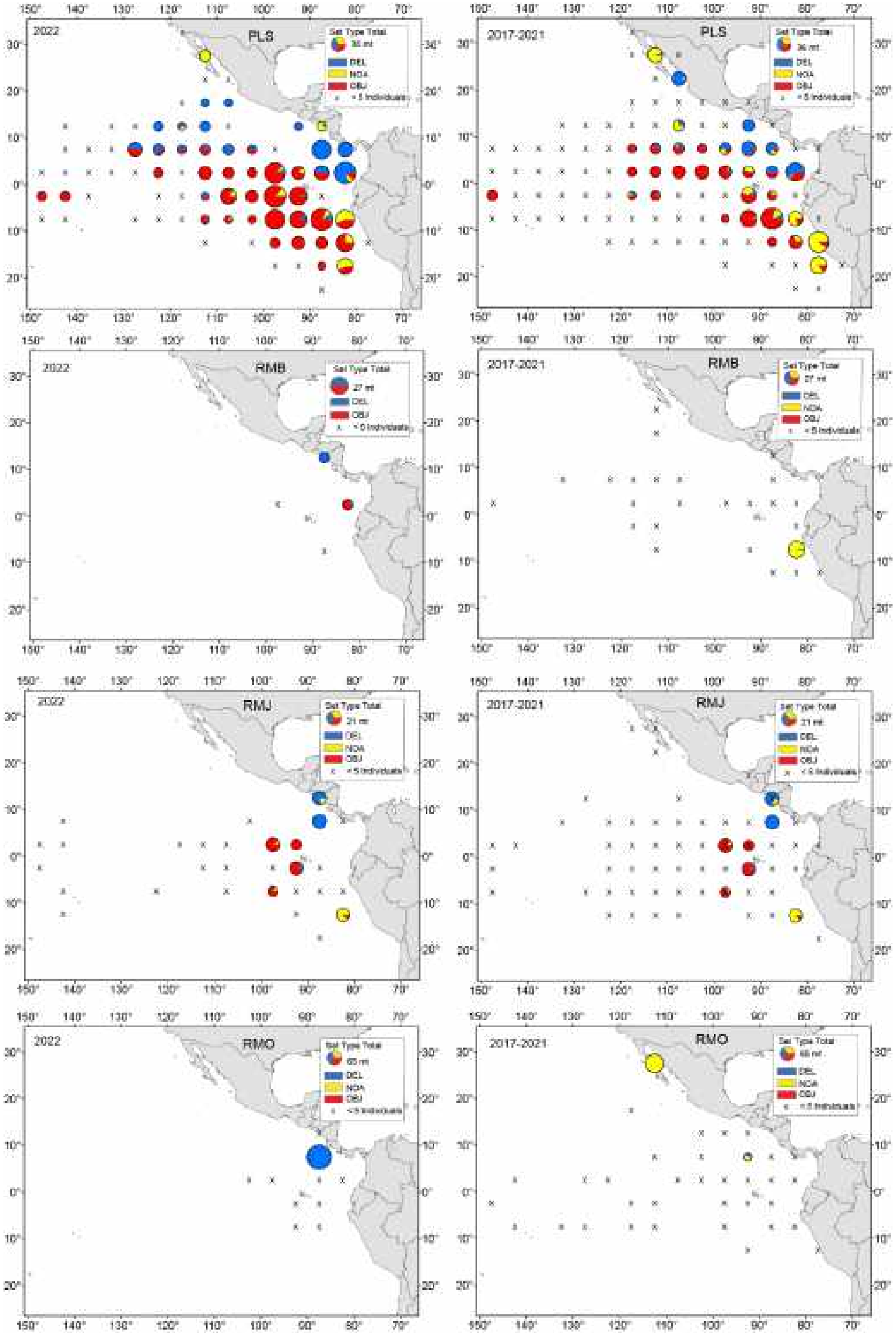

FIGURE L-4c. Purse-seine catches (Class 6, carrying capacity > 363 t) (at 5°x5° resolution) of key species of rays by set type: floating object (OBJ) unassociated tuna schools (NOA) and dolphins (DEL), for 2022 (left panel) and the 2017–2021 averages (right panel). PLS: pelagic stingray (*Pteroplatytrygon violacea*), RMB: giant manta (*Mobula birostris*), RMJ: spinetail manta (*Mobula mobular*), RMO: smoothtail manta (*Mobula thurstoni*).

FIGURA L-4c. Capturas cerqueras (clase 6, capacidad de acarreo > 363 t) (resolución de 5°x5°) de especies clave de rayas por tipo de lance: sobre objetos flotantes (OBJ), no asociados (NOA) y sobre delfines (DEL), para 2022 (panel izquierdo) y los promedios de 2017–2021 (panel derecho). PLS: raya pelágica (*Pteroplatytrygon violacea*), RMB: manta gigante (*Mobula birostris*), RMJ: manta mobula (*Mobula mobular*), RMO: manta diablo (*Mobula thurstoni*).

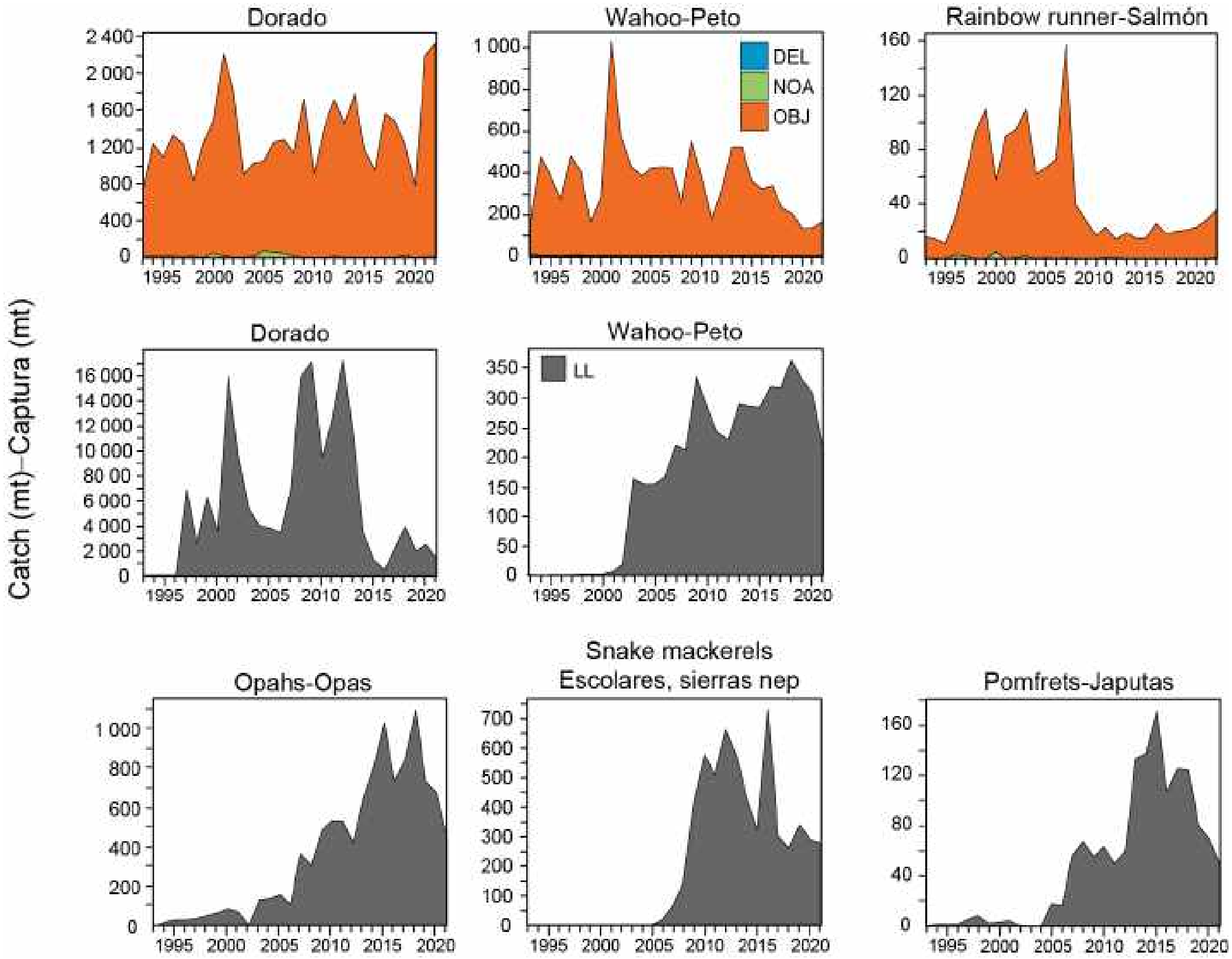

FIGURE L-5. Estimated purse-seine and longline catches in metric tons (t) of key species of large fishes in the eastern Pacific Ocean. Purse-seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2022) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline (LL) catches (1993–2021) are minimum reported gross-annual removals (see section 2.2. for uncertainty and data gaps in reporting of bycatch species caught by longline).

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 (1993-2022) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras (LL) (1993–2021) son extracciones anuales brutas mínimas reportadas (ver la Sección 2.2 para consultar información sobre la incertidumbre y las deficiencias de los datos en la notificación de especies capturadas incidentalmente con palangre).

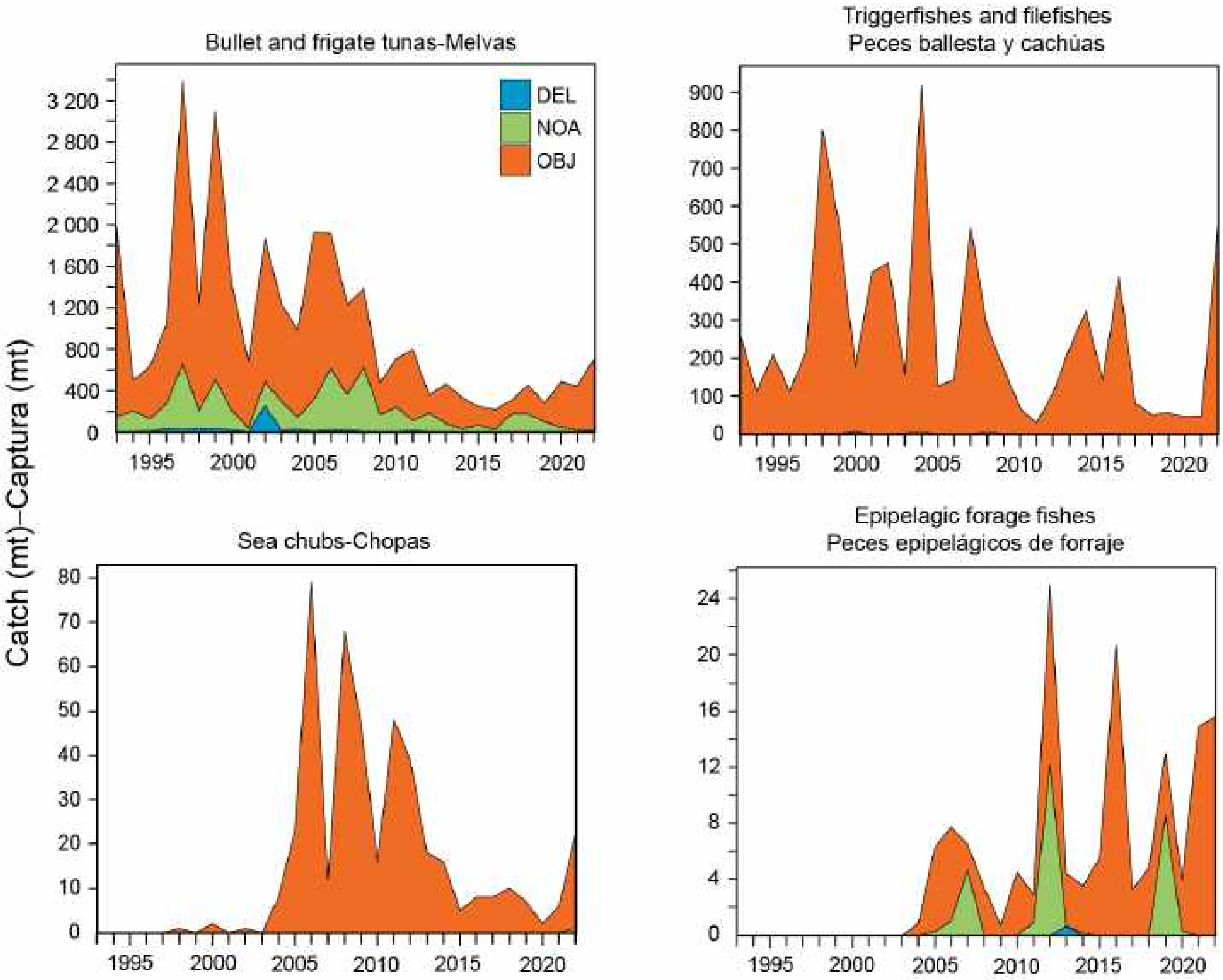

FIGURE L-6. Estimated purse-seine catches in metric tons (t) of key species of small fishes in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2022) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (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 (1993-2022) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL).

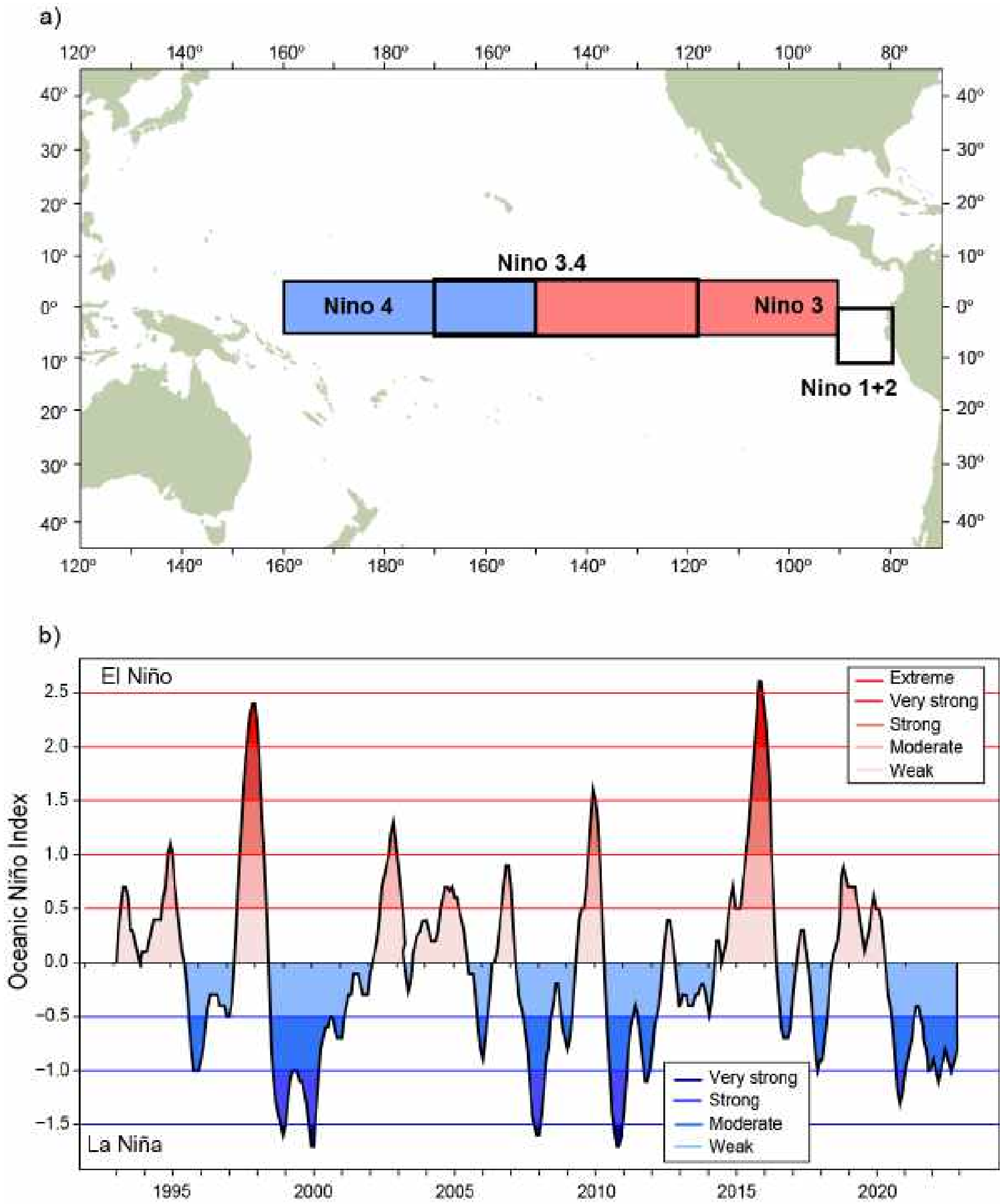

FIGURE L-7. El Niño regions used as indicators of El Niño Southern Oscillation (ENSO) events in the Pacific Ocean (top panel), and the Oceanic Niño Index (ONI) used to monitor ENSO conditions in Niño region 3.4 from 5°N to 5°S and 120°W to 170°W (bottom panel). Time series shows the running 3-month mean ONI values from the start of the IATTC observer program through December 2022. ONI data obtained from: http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

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 2022. Datos del ONI obtenidos de: http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

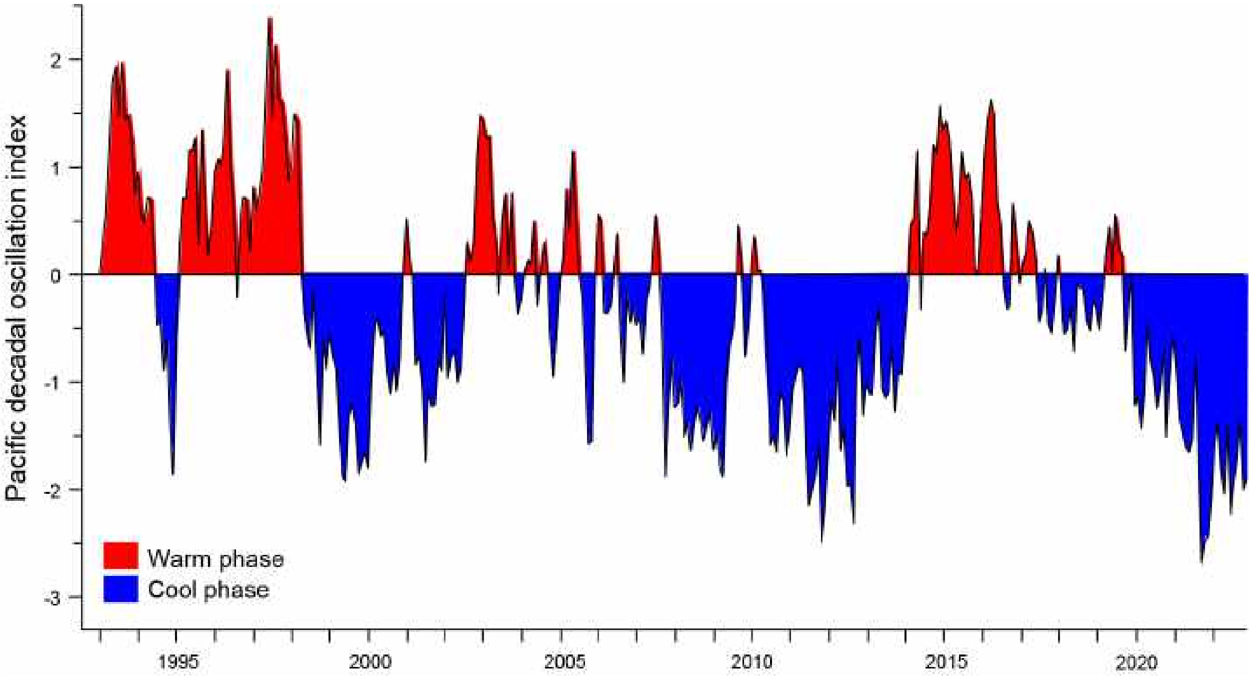

FIGURE L-8. Monthly values of the Pacific Decadal Oscillation (PDO) Index, January 1993–December 2022. ERSST V5 PDO Time Series data obtained from: https://psl.noaa.gov/pdo/

FIGURA L-8. Valores mensuales del índice de Oscilación Decadal del Pacífico (PDO), enero de 1993–diciembre de 2022. Datos de la serie de tiempo ERSST V5 PDO obtenidos de: https://psl.noaa.gov/pdo/

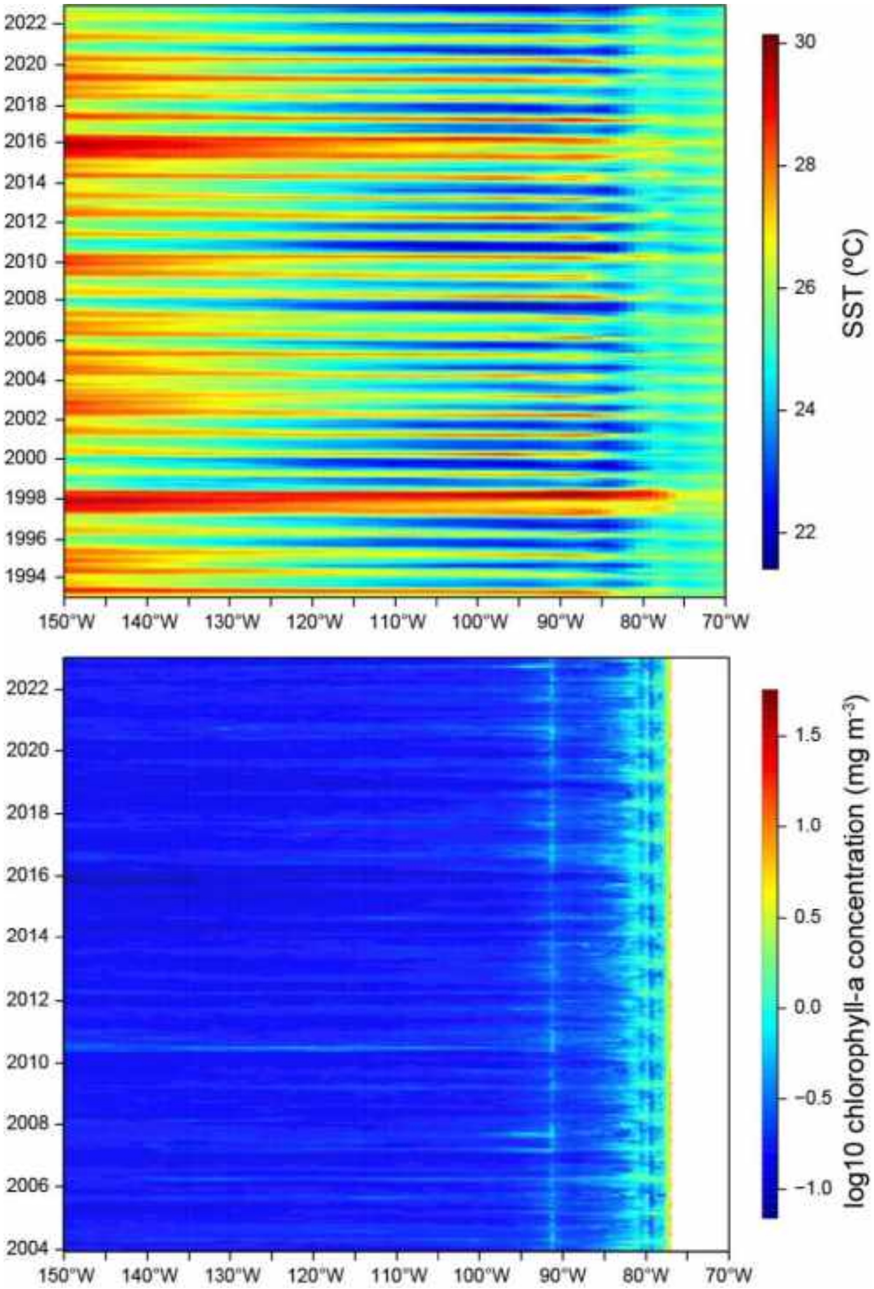

FIGURE L-9. Time-longitude Hovmöller diagram with data averaged across the tropical eastern Pacific Ocean from 5°N to 5°S for mean monthly SST for January 1993–December 2022 (top panel) (https://www.esrl.noaa.gov/psd/) and mean monthly chlorophyll-a concentration for January 2003–December 2022 (bottom panel) (https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/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 diciembre de 2022 (panel superior) (https://www.esrl.noaa.gov/psd/) y concentración promedio mensual de clorofila-a de enero de 2003 a diciembre de 2022 (panel inferior) (https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html).

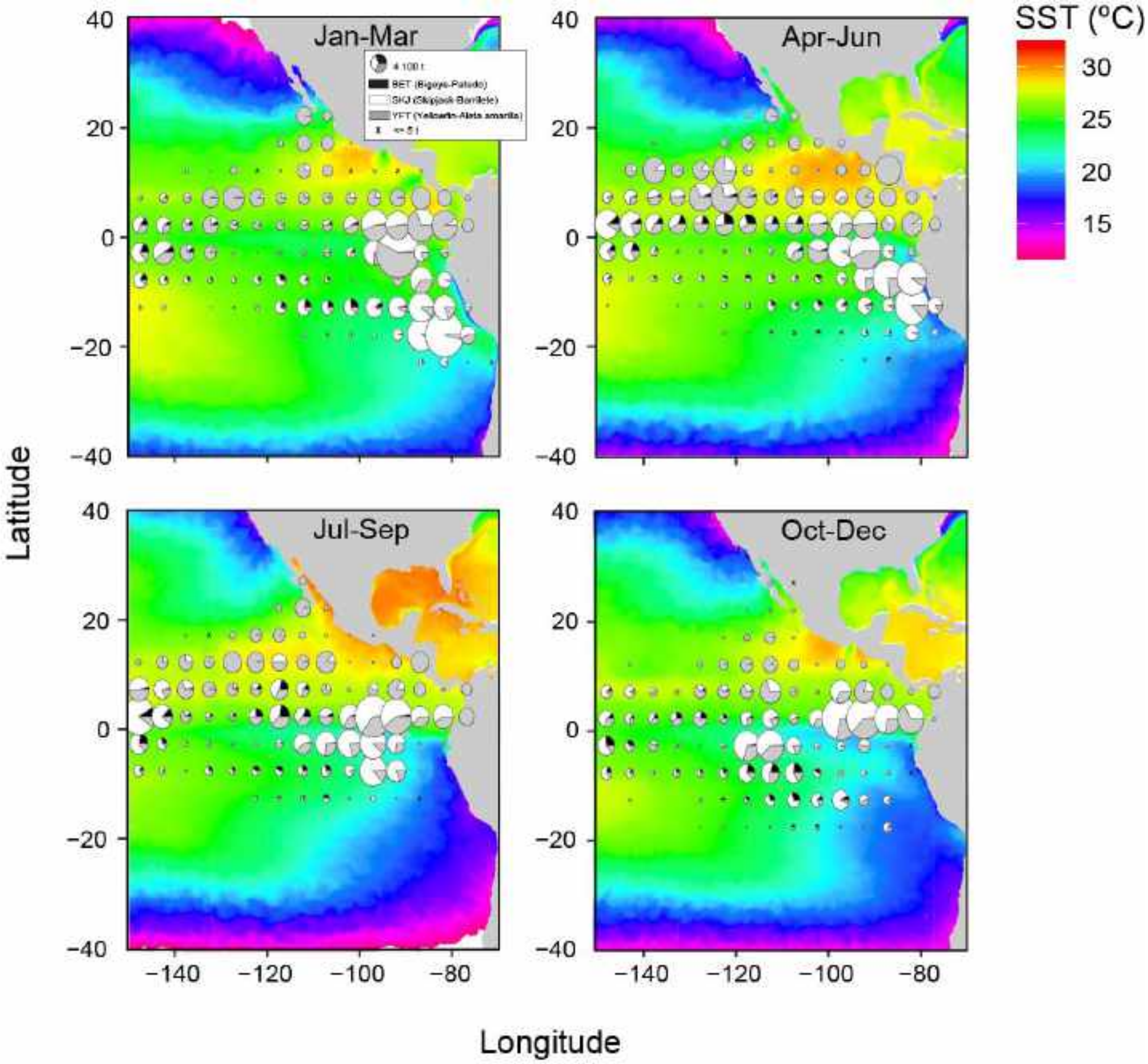

FIGURE L-10. Mean sea surface temperature (SST) for each quarter during 2022 with catches of tropical tunas overlaid. SST data obtained from NOAA NMFS SWFSC ERD on January 19, 2023, “Multi-scale Ultra-high Resolution (MUR) SST Analysis fv04.1, Global, 0.01°, 2002–present, Monthly”, https://coastwatch.pfeg.noaa.gov/erddap/info/jplMURSST41mday/index.html.

FIGURA L-10 Temperatura superficial del mar (TSM) promedio para cada trimestre de 2022 con las capturas de atunes tropicales superpuestas. Datos de TSM obtenidos de NOAA NMFS SWFSC ERD el 19 de enero de 2023, “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.

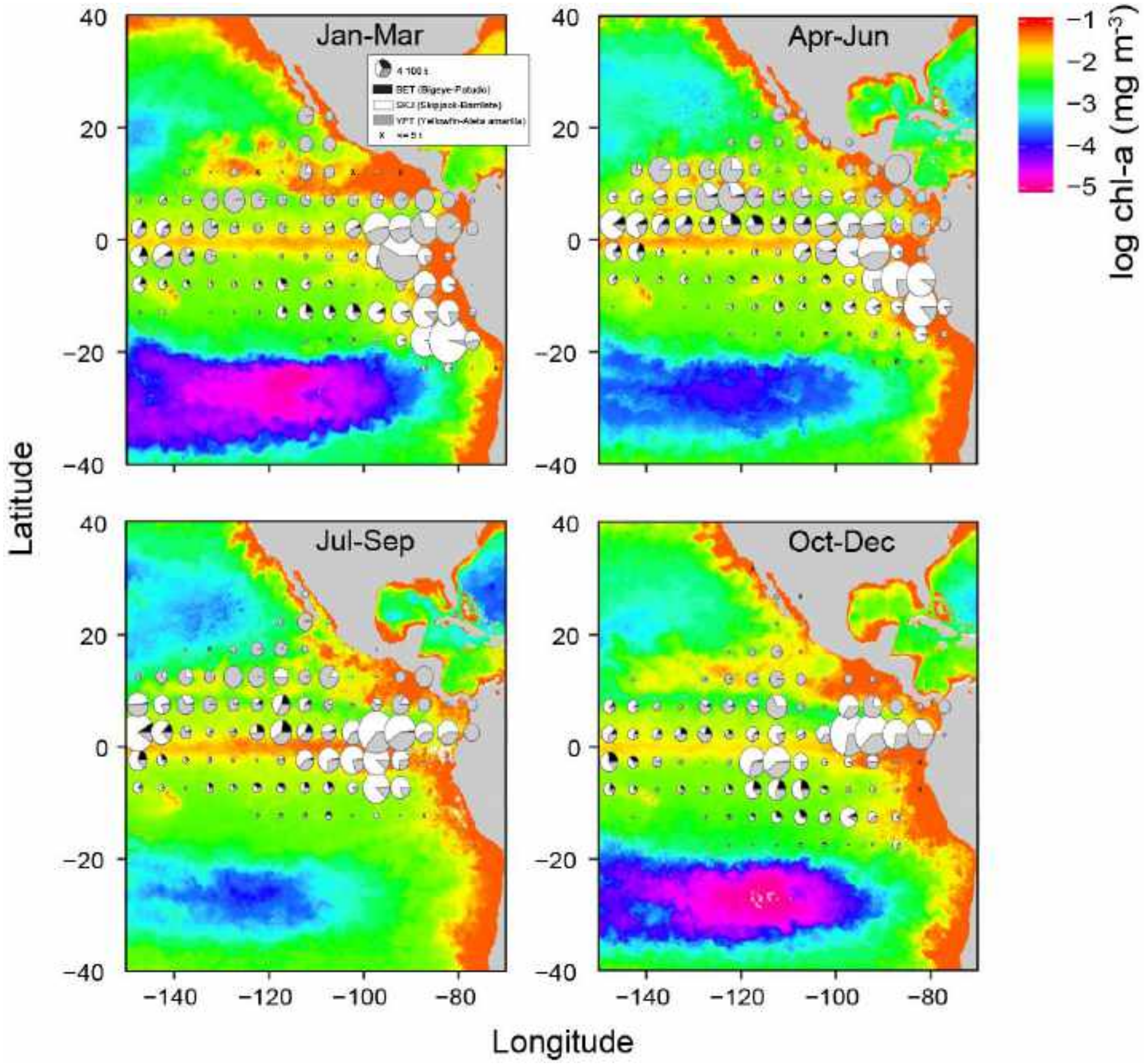

FIGURE L-11. Mean log chlorophyll-a concentration (in mg m^3) for each quarter during 2022 with catches of tropical tunas overlaid. Chlorophyll data obtained from NOAA CoastWatch on March 3, 2023, “Chlorophyll-a, Aqua MODIS, NPP, L3SMI, Global, 4km, R2022 SQ, 2003-present (Monthly Composite)”, NOAA NMFS SWFSC ERD, https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html.

FIGURA L-11. Concentración promedio de clorofila-a (en mg m^3) para cada trimestre de 20222 con las capturas de atunes tropicales superpuestas. Datos de clorofila obtenidos de NOAA CoastWatch el 3 de marzo de 2023, “Chlorophyll-a, Aqua MODIS, NPP, L3SMI, Global, 4km, R2022 SQ, 2003-present (Monthly Composite)”, NOAA NMFS SWFSC ERD, https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html.

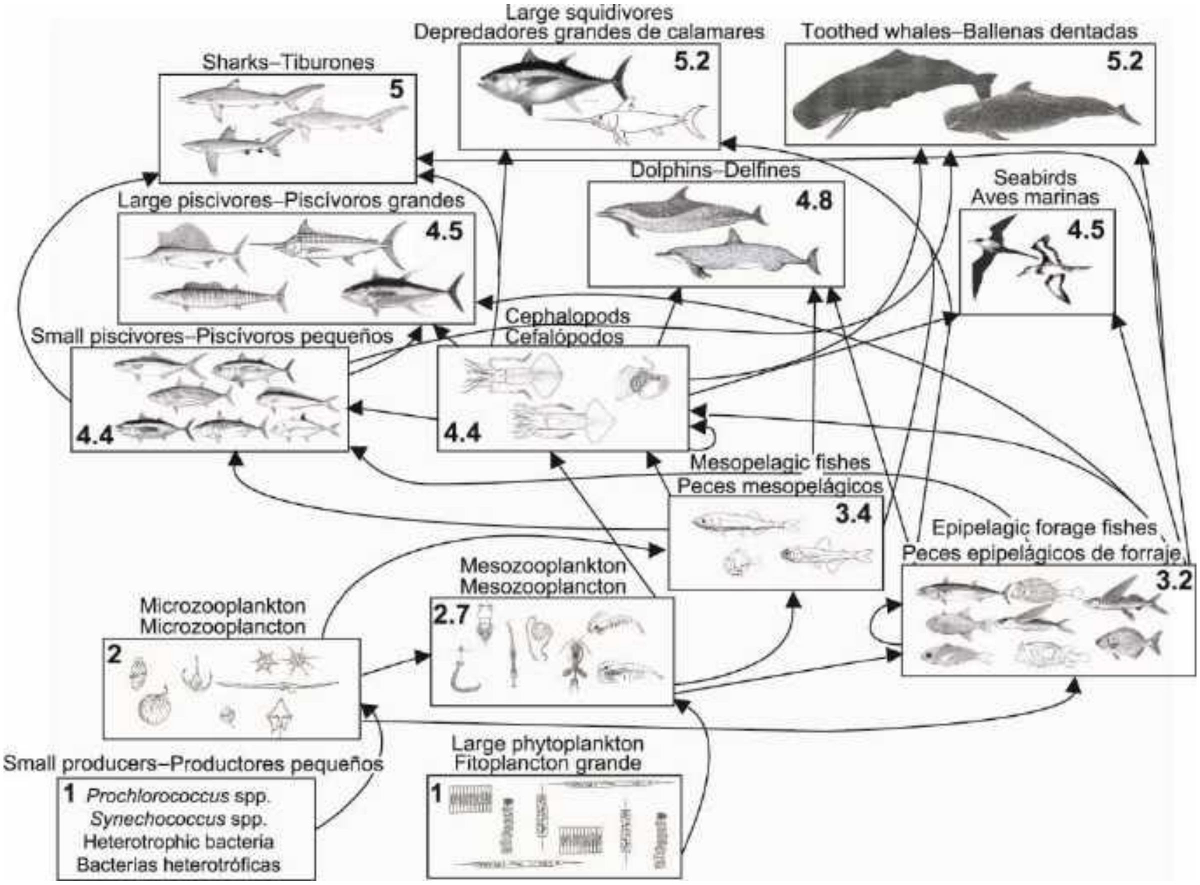

FIGURE L-12. Simplified food-web diagram of the pelagic ecosystem in the tropical EPO. The numbers inside the boxes indicate the approximate trophic level of each group.

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.

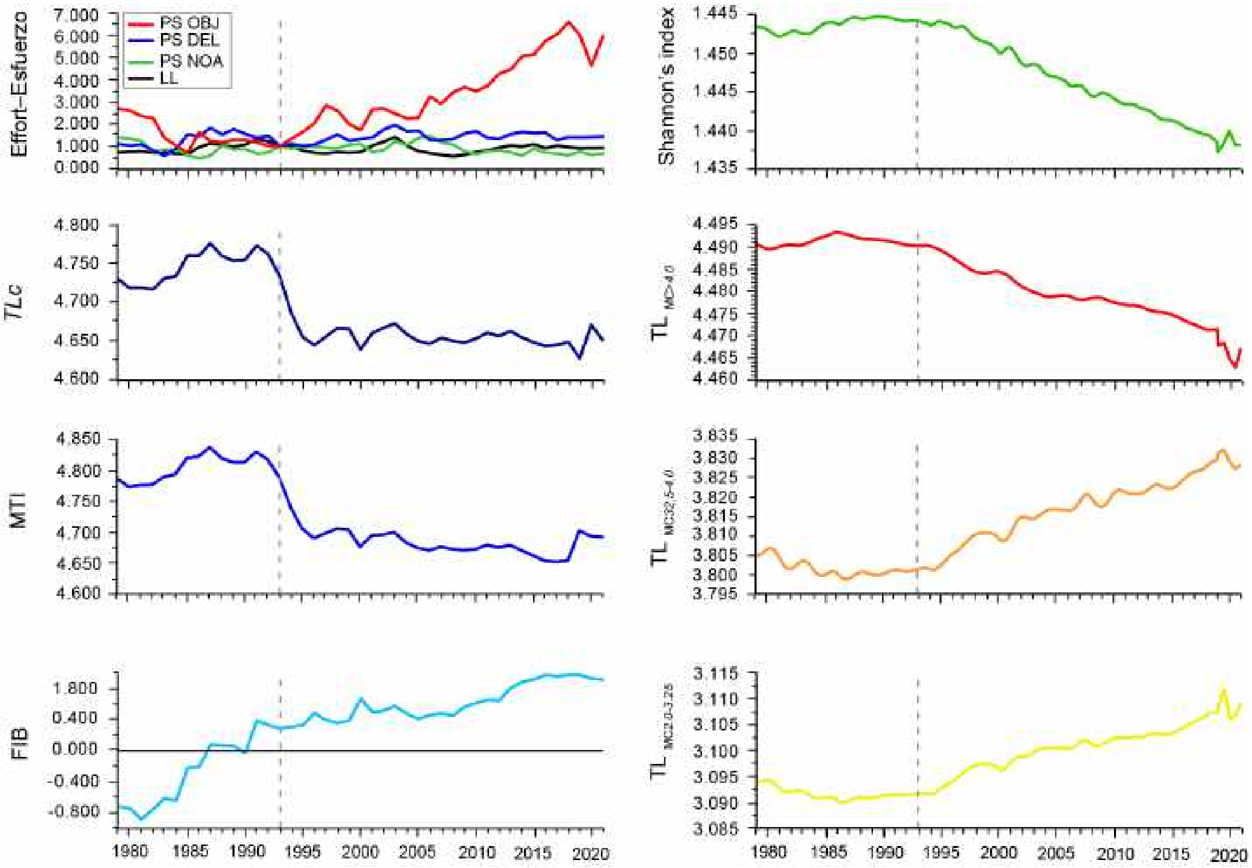

FIGURE L-13. Annual values for seven ecological indicators of changes in different components of the tropical EPO ecosystem, 1979–2021 (see Section 6 of text for details), and an index of longline (LL) and purse-seine (PS) fishing effort, by set type (dolphin (DEL), unassociated (NOA), floating object (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 del OPO tropical, 1979–2021 (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-1a. Estimated number of individuals of incidental dolphin mortalities by set type and stock in the eastern Pacific Ocean by the purse-seine fishery from 1993-2022. Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Data for 2022 are considered preliminary.

Tabla L-1a. Número estimado de individuos de mortalidades incidentales de delfines por la pesquería de cerco durante 1993-2022, por tipo de lance y población en el Océano Pacífico oriental. Tipos de lances de cerco: sobre objetos flotantes (OBJ), no asociados (NOA) y sobre delfines (DEL). Los datos de 2022 se consideran preliminares.

	Northeastern spotted			Western-southern spotted			Eastern spinner			Whitebelly spinner		
	Purse seine			Purse seine			Purse seine			Purse seine		
Year	DEL	NOA	OBJ	DEL	NOA	OBJ	DEL	NOA	OBJ	DEL	NOA	OBJ
1993	1,112	-	-	773	-	-	725	-	-	437	-	-
1994	847	-	-	1,228	-	-	828	-	-	640	-	-
1995	952	-	-	859	-	-	654	-	-	431	5	-
1996	818	-	-	545	-	-	450	-	-	447	-	-
1997	718	3	-	1,044	-	-	391	-	-	498	-	-
1998	298	-	-	341	-	-	422	-	-	249	-	-
1999	358	-	-	253	-	-	363	-	-	192	-	-
2000	295	-	-	435	-	-	275	-	-	262	-	-
2001	592	-	-	315	-	-	470	-	-	374	-	-
2002	435	-	-	203	-	-	403	-	-	182	-	-
2003	288	-	-	335	-	-	290	-	-	170	-	-
2004	261	-	-	256	-	-	223	-	-	214	-	-
2005	273	-	-	100	-	-	275	-	-	108	-	-
2006	147	-	-	135	-	-	160	-	-	144	-	-
2007	189	-	-	116	-	-	175	-	-	113	-	-
2008	184	-	-	167	-	-	349	-	-	171	-	-
2009	266	-	-	254	-	-	288	-	-	222	-	-
2010	170	-	-	135	-	-	510	-	-	92	-	-
2011	172	-	-	124	-	-	467	-	-	139	-	-
2012	151	-	-	187	-	-	324	-	-	107	-	-
2013	158	-	-	145	-	-	303	-	-	111	-	-
2014	181	-	-	168	-	-	356	-	-	183	-	-
2015	191	-	-	158	-	-	196	-	-	139	-	-
2016	127	-	-	111	-	-	243	-	-	89	-	-
2017	85	-	-	183	-	-	266	-	-	95	-	-
2018	99	-	-	197	-	-	252	-	-	205	-	-
2019	104	-	-	220	-	-	269	-	-	143	-	-
2020	106	-	-	153	-	-	251	-	-	138	-	-
2021	166	-	-	173	-	-	194	-	-	172	-	-
2022	147	-	-	197	-	-	271	-	-	300	-	-
Total	9,891	3	-	9,511	-	-	10,644	-	-	6,768	5	-

Table L-1a continued

	Northern common			Central common			Southern common			Other dolphins		
	Purse seine			Purse seine			Purse seine			Purse seine		
Year	DEL	NOA	OBJ	DEL	NOA	OBJ	DEL	NOA	OBJ	DEL	NOA	OBJ
1993	139	-	-	230	-	-	-	-	-	178	-	7
1994	75	10	-	170	-	-	-	-	-	291	7	-
1995	9	-	-	192	-	-	-	-	-	171	1	-
1996	77	-	-	51	-	-	30	-	-	129	-	-
1997	9	-	-	114	-	-	58	-	-	150	-	20
1998	256	5	-	172	-	-	14	19	-	84	16	-
1999	85	-	-	34	-	-	1	-	-	59	3	-
2000	54	-	-	223	-	-	10	-	-	57	24	1
2001	94	-	-	205	-	-	46	-	-	44	-	-
2002	69	-	-	155	-	-	3	-	-	34	9	6
2003	133	-	-	140	-	-	97	-	-	37	-	2
2004	148	8	-	97	-	-	225	-	-	37	-	-
2005	114	-	-	57	-	-	154	-	-	70	-	-
2006	129	-	-	86	-	-	40	-	-	43	2	-
2007	55	-	-	69	-	-	95	-	-	25	1	-
2008	103	1	-	14	-	-	137	-	-	43	-	-
2009	107	2	-	30	-	-	49	-	-	21	-	-
2010	124	-	-	116	-	-	8	-	-	14	-	1
2011	25	10	-	12	-	-	9	-	-	28	-	-
2012	49	-	-	4	-	-	30	-	-	18	-	-
2013	69	-	-	-	-	-	8	-	-	6	1	-
2014	49	-	-	13	-	-	9	-	-	15	-	1
2015	43	-	-	21	-	-	12	-	-	5	-	-
2016	82	-	-	36	-	-	9	-	-	4	-	1
2017	24	2	-	9	-	-	16	-	-	3	-	-
2018	41	-	-	1	-	-	18	-	-	6	-	-
2019	25	-	-	3	-	-	2	-	-	10	-	2
2020	1	-	-	18	-	-	3	-	-	19	-	-
2021	3	-	-	6	-	-	5	-	-	6	-	-
2022	23	-	-	2	-	-	20	-	-	5	-	-
Total	2,214	38	-	2,280	-	-	1,108	19	-	1,612	64	41

Table L-1b. Minimum number of marine mammal interactions and mortalities in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. All reported marine mammal interactions were precautionarily presumed to be mortalities (i.e., disposition was either not reported or reported as "Injured"). These data are considered incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting).

Tabla L-1b. Número mínimo de interacciones con mamíferos marinos y mortalidades en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Se supuso precautoriamente que todas las interacciones con mamíferos marinos reportadas resultaron en mortalidades (es decir, no se reportó la disposición o se reportó como "Herido"). Estos datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre)

Marine Mammal taxa	Interactions	Mortalities
Bottlenose dolphin, *Tursiops truncatus*	1	1
Unidentified spinner dolphin, *Stenella longirostris*	2	2
Dolphin, nei, Delphinidae	2	2
False killer whale, *Pseudorca crassidens*	4	4
Pygmy killer whale, *Feresa attenuata*	1	1
Unidentified cetacean, nei, Cetacea	1	1
Total numbers	11	11

Table L-2a. Estimated number of turtle interactions and mortalities by observers onboard purse-seine size-class 6 vessels with a carrying capacity >363 t (1993–2022). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Data for 2022 are considered preliminary.

Tabla L-2a. Número estimado de mortalidades e interacciones de tortugas por observadores a bordo de buques cerqueros de clase 6 con una capacidad de acarreo >363 t (1993–2022). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Los datos de 2022 se consideran preliminares.

	Lepidochelys olivacea, olive Ridley (LKV)						*Chelonia agassizii, Chelonia mydas,* eastern Pacific green (TUG)						*Caretta caretta,* loggerhead (TTL)					
	Purse seine						Purse seine						Purse seine					
	interactions			mortality			interactions			mortality			interactions			mortality		
Year	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL
1993	285	376	102	24	41	13	54	220	18	2	13	-	3	51	2	-	4	-
1994	455	114	137	50	17	13	132	170	12	7	9	-	6	15	2	-	2	-
1995	537	89	117	66	11	14	181	196	8	10	2	1	9	52	3	-	2	-
1996	520	97	96	47	9	9	138	63	4	11	1	-	12	18	2	-	-	-
1997	544	439	112	54	33	7	164	59	16	8	3	2	7	38	3	1	3	1
1998	649	116	209	66	22	20	141	13	20	7	1	1	15	5	4	1	-	-
1999	1,005	140	160	82	18	9	130	16	21	5	2	4	9	9	2	1	3	-
2000	463	248	139	46	29	11	93	17	5	6	-	-	4	6	1	2	-	-
2001	802	162	136	51	11	4	164	24	8	6	2	-	10	1	2	1	-	-
2002	767	97	165	23	3	7	110	11	15	3	-	-	14	5	8	-	-	-
2003	762	147	168	16	4	3	107	25	15	-	-	-	14	4	6	-	-	-
2004	624	110	120	8	3	2	65	38	8	-	-	-	10	11	13	-	-	-
2005	606	872	249	7	6	4	101	122	21	1	1	-	5	15	14	-	-	-
2006	595	337	140	8	4	3	106	119	23	2	-	-	39	19	14	1	-	-
2007	450	494	210	6	1	3	83	56	31	-	1	-	56	38	12	1	-	-
2008	408	27	147	4	-	-	54	20	12	-	-	-	45	5	12	1	-	-
2009	464	30	110	10	-	2	56	12	19	1	-	-	30	5	20	-	-	-
2010	424	128	212	4	3	1	71	20	23	-	2	-	34	24	23	1	-	-
2011	502	96	115	6	-	1	70	89	25	1	1	-	29	46	16	-	1	-
2012	388	53	91	5	-	-	77	42	5	-	-	-	19	19	17	-	-	-
2013	454	20	66	7	1	-	61	10	7	1	-	-	24	9	8	-	-	-
2014	304	19	83	3	-	-	69	16	10	-	-	-	27	1	4	1	-	-
2015	195	49	78	2	-	1	54	12	21	-	-	-	28	6	13	-	-	-
2016	333	49	113	4	-	-	78	35	17	-	-	-	19	21	9	-	-	-
2017	285	24	72	2	-	1	39	21	34	-	-	-	31	20	7	-	-	-
2018	150	5	147	2	-	-	50	24	96	2	-	-	17	7	4	-	-	-
2019	170	28	129	1	-	-	72	13	10	-	-	-	14	46	9	-	-	-
2020	91	14	197	-	-	-	29	4	11	-	-	-	17	3	4	-	-	-
2021	191	2	54	1	-	1	32	17	3	-	-	-	13	5	11	-	-	-
2022	133	2	33	-	-	-	40	-	4	-	-	-	19	3	6	-	-	-
Total	13,557	4,385	3,908	606	215	130	2,619	1,485	522	73	38	8	579	507	251	11	14	1

Table L-2a continued

	Eretmochelys imbricata, hawksbill						*Dermochelys coriacea*, leatherback						Unidentified turtles					
	Purse seine						Purse seine						Purse seine					
	interactions			mortality			interactions			mortality			interactions			mortality		
Year	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**	**OBJ**	**NOA**	**DEL**
1993	1	1	2	-	-	-	2	-	3	-	-	-	66	89	38	3	16	2
1994	5	5	4	-	2	-	3	2	-	1	-	-	151	27	83	34	2	9
1995	8	2	-	-	-	-	-	-	-	-	-	-	130	27	52	24	7	3
1996	8	-	6	-	-	1	5	-	-	-	-	-	151	58	37	30	6	2
1997	4	2	-	-	-	-	3	1	1	-	-	-	180	72	46	25	15	2
1998	7	-	3	3	-	-	1	2	1	-	-	-	121	24	97	26	8	7
1999	4	5	2	1	-	1	-	-	-	-	-	-	202	28	65	39	4	3
2000	4	1	3	1	-	-	1	1	1	-	-	-	92	68	74	17	9	2
2001	5	1	3	1	-	-	-	-	1	-	-	-	206	43	96	22	14	5
2002	8	1	2	-	-	-	1	1	-	-	-	-	175	33	82	6	5	2
2003	6	1	6	-	-	-	-	1	1	-	-	-	169	40	117	5	-	3
2004	12	4	3	-	-	-	1	4	4	-	-	-	151	53	48	4	2	-
2005	1	2	9	-	-	-	1	1	3	-	-	-	103	126	73	4	7	1
2006	12	11	4	-	-	-	1	3	2	-	-	-	184	64	77	1	-	-
2007	9	8	2	1	2	-	3	2	2	-	-	-	130	240	191	7	-	2
2008	7	-	12	-	-	-	2	3	2	-	-	-	182	18	107	1	-	-
2009	8	-	6	-	-	-	1	-	2	-	-	-	141	16	95	3	1	1
2010	11	-	4	1	-	-	3	-	-	-	-	-	122	24	187	3	1	1
2011	5	5	4	-	-	-	1	1	1	-	-	-	125	28	63	-	1	-
2012	4	-	2	-	-	-	1	1	-	-	-	-	99	19	40	3	-	-
2013	7	-	2	1	-	-	1	2	2	-	-	-	175	13	51	2	-	-
2014	7	1	2	-	-	1	7	1	2	-	-	-	132	18	53	1	-	-
2015	2	1	2	-	-	-	4	2	-	-	-	-	174	152	42	-	4	-
2016	14	3	5	-	-	-	2	1	-	-	-	-	307	59	120	2	-	-
2017	7	3	5	-	-	-	2	1	1	-	-	-	243	43	83	-	-	-
2018	7	2	1	-	-	-	3	-	1	-	-	-	160	22	169	-	-	-
2019	5	2	-	-	-	-	-	-	-	-	-	-	193	155	59	-	1	-
2020	5	1	-	-	-	-	2	1	-	-	-	-	108	8	45	1	-	1
2021	4	1	-	-	-	-	1	-	-	-	-	-	102	5	53	-	-	-
2022	10	1	-	-	-	-	2	1	1	-	-	-	92	1	23	-	-	-
Total	197	64	94	9	4	3	54	32	31	1	-	-	4,567	1,571	2,365	264	103	46

Table L-2b. Minimum number of sea turtle interactions and mortalities in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. Dispositions considered to indicate a survival event are those reported by observers as “Alive and Healthy”, “Light injuries” and “Released with a hook”, while those considered to indicate a mortality event are dispositions reported as “Dead”, “Discarded”, “Grave Injuries”, “Injured”, “Alive and injured”, or precautionarily where disposition was not reported. For 2021, all sea turtle interactions were precautionarily presumed to result in mortalities as dispositions were reported as “Injured”, “Dead” or not reported. These data are considered incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting).

Tabla L-2b. Número mínimo de interacciones con tortugas marinas y mortalidades en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Las disposiciones que se considera que indican un evento de supervivencia son las reportadas por los observadores como "Viva y sana", "Heridas leves" y "Liberada con un anzuelo", mientras que las que se considera que indican un evento de mortalidad son las disposiciones reportadas como "Muerta", "Descartada", "Heridas graves", "Herida", "Viva y herida" o, de manera precautoria, cuando la disposición no fue reportada. Para 2021, se supuso precautoriamente que todas las interacciones con tortugas marinas resultaron en mortalidades, ya que las disposiciones fueron reportadas como "Herida", "Muerta" o no se reportaron. Estos datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre).

Sea turtle taxa	Interactions	Mortalities
Olive ridley turtle, *Lepidochelys olivacea*	5	5
Loggerhead turtle, *Caretta caretta*	3	3
Total numbers	8	8

Table L-3. Minimum number of seabird interactions in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. All reported seabird interactions are precautionarily presumed to be mortalities (i.e., disposition was reported as “Discarded” or not reported). These data are considered incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting).

Tabla L-3. Número mínimo de interacciones con aves marinas en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Se supone precautoriamente que todas las interacciones con aves marinas reportadas son mortalidades (es decir, la disposición fue reportada como "Descartada" o no fue reportada). Estos datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre).

Seabird taxa	Interactions	Mortalities
White-chinned petrel, *Procellaria aequinoctialis*	63	63
Wandering albatross, *Diomedea exulans*	58	58
Black-browed albatross, *Thalassarche melanophrys*	53	53
Laysan albatross, *Phoebastria immutabilis*	45	45
Black-footed albatross, *Phoebastria nigripes*	44	44
Cape petrel, *Daption capense*	27	27
Albatross nei, *Diomedea* spp.	25	25
Boobies and gannets nei, Sulidae	16	16
White-capped albatross, *Thalassarche steadi*	3	3
Terns nei, *Sterna* spp.	3	3
Great shearwater, *Puffinus gravis*	2	2
Petrels or shearwaters nei, Procellariidae	1	1
Total numbers	340	340

Table L-4a. Estimated purse-seine catches by set type in metric tons (t) of sharks by observers onboard size-class 6 vessels with a carrying capacity >363 t (1993–2022) and minimum reported longline (LL) catches of sharks (gross-annual removals in t) (1993–2021, *data not available; see section 2.2. for uncertainty and data gaps in reporting of bycatch caught by longline). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2021 (longline) and 2022 (purse-seine) are considered preliminary.

Tabla L-4a. Capturas cerqueras estimadas de tiburones, por tipo de lance, en toneladas (t), por observadores a bordo de buques de clase 6 con una capacidad de acarreo >363 t (1993–2022) y capturas palangreras (LL) mínimas reportadas de tiburones (extracciones anuales brutas en t) (1993–2021, *datos no disponibles; ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos en la notificación de especies capturadas incidentalmente con palangre). 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 2021 (palangre) y 2022 (cerco) se consideran preliminares.

	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	-	11,086	54	<1	2	2,562
2018	397	12	16	15,072	3	-	<1	19	<1	<1	<1	12,499	28	3	1	1,360
2019	392	13	25	2,599	5	<1	<1	-	<1	<1	<1	11,070	26	4	6	10
2020	345	11	33	14,752	4	-	<1	-	<1	<1	-	15,080	87	5	4	2,896
2021	542	10	21	12	12	<1	<1	-	<1	<1	<1	8,323	30	<1	<1	-
2022	615	23	7	*	11	<1	<1	*	1	<1	-	*	30	2	2	*
Total	12,726	2,463	1,508	170,932	1,505	111	64	2,143	21	24	9	180,390	558	130	131	28,695

Table L-4a 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	33	11	2	<1	43	1	-	<1	-	5	<1	<1	5
2020	7	<1	<1	941	13	<1	<1	39	<1	-	<1	-	5	<1	<1	1,021
2021	13	<1	<1	37	31	<1	<1	<1	2	-	<1	-	7	-	<1	-
2022	11	-	<1	*	47	<1	<1	*	<1	-	-	*	9	<1	<1	*
Total	676	69	22	14,406	470	97	26	814	62	4	5	-	741	146	52	3,122

Table L-4a Continued

	Alopiidae															
	***Alopias pelagicus*, pelagic thresher**				*Alopias superciliosus*, bigeye thresher				*Alopias vulpinus*, thresher shark				*Alopias* spp., thresher shark, 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	-	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	2	<1	<1	<1	850
2015	<1	2	1	463	<1	1	<1	859	<1	-	<1	13	<1	<1	<1	283
2016	<1	2	3	1,045	<1	<1	4	944	<1	1	<1	549	<1	<1	1	96
2017	<1	<1	<1	582	<1	<1	<1	1,148	-	<1	<1	1,682	<1	<1	<1	153
2018	<1	2	<1	464	<1	<1	<1	32	<1	<1	<1	1,684	<1	<1	<1	39
2019	1	<1	<1	444	<1	<1	<1	17	-	-	<1	1	<1	<1	<1	31
2020	<1	<1	2	342	<1	<1	1	1,273	-	-	<1	746	<1	<1	<1	6
2021	<1	<1	<1	1	<1	<1	<1	3	<1	<1	<1	<1	<1	<1	<1	1
2022	<1	<1	<1	*	<1	<1	<1	*	<1	<1	<1	*	<1	<1	<1	*
Total	23	66	45	28,925	17	108	55	7,496	5	28	13	5,116	15	70	47	3,814

Table L-4a 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	-	<1	-	-	-	-	-	-	84	19	14	271	623	438	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	2,778	-	-	-	51	-	-	-	4,067	24	<1	<1	2,075	540	78	56	29,082
2015	<1	<1	<1	3,118	-	-	-	79	-	-	-	621	18	3	3	10,593	645	151	58	39,823
2016	1	<1	<1	2,476	-	-	-	91	-	-	-	538	19	3	<1	2,245	602	50	78	37,880
2017	<1	<1	-	3,256	-	-	-	112	-	-	-	987	16	1	<1	1,267	766	21	27	42,506
2018	2	<1	<1	3,161	-	-	-	111	-	-	-	730	5	<1	<1	1,161	460	21	20	37,357
2019	<1	<1	<1	2,021	-	-	-	8	-	-	-	<1	6	<1	<1	18	465	23	34	16,302
2020	2	<1	-	3,694	-	-	-	95	-	-	-	1,032	3	2	<1	2,261	467	21	42	44,178
2021	2	<1	-	1,399	-	-	-	7	-	-	-	2	6	<1	<1	32	646	12	24	9,820
2022	1	<1	-	*	-	-	-	*	-	-	-	*	2	<1	<1	*	731	27	11	*
Total	49	28	4	41,649	-	<1	-	649	-	-	-	16,414	942	319	287	94,652	17,810	3,663	2,270	599,216

Table L-4b. Minimum number of shark interactions and mortalities in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. Data are considered incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting). Dispositions considered to indicate a survival event are those reported by observers as “Alive and Healthy”, “Alive with light injuries” and “Alive”, while those considered to indicate a mortality event are dispositions reported as “Dead”, “Alive mortal”, “Alive injured”, “Discarded”, “Unknown”, or precautionarily where disposition was not reported.

Tabla L-4b. Número mínimo de interacciones con tiburones y mortalidades en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Los datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre). Las disposiciones que se considera que indican un evento de supervivencia son las reportadas por los observadores como "Vivo y sano", "Vivo con heridas leves" y "Vivo", mientras que las que se considera que indican un evento de mortalidad son las disposiciones reportadas como "Muerto", "Vivo, mortalidad probable", “Vivo herido", “Descartado", "Desconocida" o precautoriamente cuando la disposición no fue reportada.

Shark taxa	Interactions	Mortalities
Blue shark, *Prionace glauca*	11,262	11,221
Short fin mako shark, *Isurus oxyrinchus*	975	975
Silky shark, *Carcharhinus falciformis*	486	477
Pelagic thresher shark, *Alopias pelagicus*	342	342
Bigeye thresher shark, *Alopias superciliosus*	207	195
Oceanic whitetip shark, *Carcharhinus longimanus*	181	172
Scalloped hammerhead shark, *Sphyrna lewini*	120	120
Crocodile shark, *Pseudocarcharias kamoharai*	62	44
Longfin mako shark, *Isurus paucus*	35	35
Sharks, rays, skates, etc. nei, Elasmobranchii	31	31
Velvet dogfish, *Scymnodon squamulosus*	30	28
Thresher shark, nei, *Alopias* spp.	19	11
Smooth hammerhead shark, *Sphyrna zygaena*	14	14
Thresher shark, *Alopias vulpinus*	13	13
Other sharks*	7	6
Total numbers	13,784	13,684
*"Other sharks" include those with ≤2 interactions from 5 taxa in 2021		

Table L-5a. Estimated purse-seine catches by set type in numbers of rays by observers onboard size-class 6 vessels with a carrying capacity >363 t (1993–2022). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2022 are considered preliminary.

Tabla L-5a. Capturas cerqueras estimadas de rayas, por tipo de lance, en número de rayas, por observadores a bordo de buques de clase 6 con una capacidad de acarreo >363 t (1993–2022). 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 2022 se consideran preliminares.

	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	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL
1993	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1994	-	3	-	-	-	-	-	-	-	-	-	-	1	-	-
1995	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
1996	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1997	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
1998	-	8	-	-	-	-	-	-	-	-	-	-	4	94	1
1999	-	2	1	-	-	-	-	-	-	-	-	-	10	63	1
2000	34	121	101	-	-	-	-	-	-	-	-	-	1	12	2
2001	7	185	98	2	8	16	-	-	3	4	-	-	2	6	6
2002	18	2,048	72	7	8	96	1	3	10	7	15	7	2	6	5
2003	37	707	141	6	79	11	7	35	26	-	-	8	3	10	1
2004	8	429	86	2	30	57	-	15	17	1	28	4	2	47	15
2005	14	72	205	16	111	126	-	21	14	3	42	79	10	23	36
2006	14	572	43	19	473	187	-	65	31	5	52	45	30	37	219
2007	14	64	105	32	202	148	2	29	24	24	37	55	5	17	8
2008	14	126	50	30	247	87	8	127	36	10	276	30	3	61	18
2009	22	31	93	17	56	243	9	45	6	2	21	190	1	11	6
2010	39	123	132	22	334	303	1	48	33	7	12	148	2	1,163	4
2011	6	397	27	18	104	152	11	58	29	9	28	78	5	9	1
2012	15	1,435	67	48	243	34	3	63	6	7	94	21	6	949	13
2013	25	180	40	18	112	62	6	55	6	7	29	26	1	24	21
2014	22	29	75	179	87	57	6	4	15	5	10	18	7	9	-
2015	14	41	101	61	21	338	6	11	74	12	25	93	1	67	38
2016	18	31	166	5	26	115	2	236	86	13	17	26	7	68	3
2017	11	52	43	45	26	15	8	15	10	10	-	11	8	53	11
2018	6	29	5	37	48	56	22	4	12	8	2	2	11	7	1
2019	7	214	11	35	167	61	9	-	8	24	8	18	2	11	3
2020	9	4	12	19	113	37	1	-	47	5	2	7	7	-	1
2021	8	-	-	34	46	16	10	5	-	11	3	13	1	26	-
2022	4	-	98	42	8	25	12	-	4	22	-	12	3	-	8
Total	367	6,904	1,771	693	2,549	2,243	125	839	497	197	702	892	135	2,777	422

Table L-5a 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	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL	OBJ	NOA	DEL
1993	297	5,736	503	80	1,983	134	-	-	-	-	-	-	377	7,719	637
1994	52	1,266	375	140	1,632	337	-	-	-	-	-	-	193	2,901	712
1995	69	2,248	500	159	151	144	-	-	-	-	-	-	228	2,400	643
1996	124	1,341	385	101	165	176	-	-	-	-	-	-	225	1,506	561
1997	126	707	396	106	106	993	-	-	-	-	-	-	232	816	1,390
1998	73	2,906	337	95	258	170	-	1,136	-	2	1	-	174	4,403	508
1999	140	1,498	474	164	403	151	-	-	-	-	-	-	314	1,966	627
2000	36	1,805	1,276	104	221	159	-	-	-	-	-	-	175	2,159	1,537
2001	50	289	447	150	64	174	-	-	-	-	-	-	215	553	744
2002	40	1,994	723	113	60	153	2	-	-	-	-	-	190	4,133	1,066
2003	130	1,005	904	94	9,188	135	-	-	-	-	-	-	277	11,025	1,226
2004	63	656	351	138	39	86	4	282	5	-	-	-	218	1,526	620
2005	36	259	177	91	52	173	9	13	20	-	1,724	-	179	2,317	831
2006	43	340	295	153	91	202	29	764	30	-	-	160	293	2,394	1,213
2007	40	205	237	98	54	132	9	931	21	-	19	-	225	1,557	730
2008	41	145	91	97	19	87	14	20	28	-	-	-	217	1,022	427
2009	37	107	270	116	17	105	5	4	68	-	-	-	209	292	981
2010	97	629	256	101	21	901	5	-	60	-	1,596	-	274	3,926	1,837
2011	27	227	81	92	193	90	13	114	18	-	24	-	181	1,154	476
2012	18	186	41	121	30	100	13	17	3	1	12	7	232	3,029	292
2013	15	121	323	90	59	255	27	2	6	-	-	403	189	582	1,142
2014	24	72	24	173	43	108	19	22	18	-	-	-	436	277	315
2015	20	54	141	82	65	163	11	5	32	-	-	-	207	289	980
2016	41	248	162	60	37	352	12	-	70	-	-	-	159	663	980
2017	141	290	100	258	76	130	31	68	144	-	-	137	512	580	601
2018	102	117	155	247	61	123	62	17	14	-	-	-	495	286	368
2019	87	484	165	255	185	143	40	38	27	-	8	1	460	1,114	437
2020	62	67	163	260	145	160	17	14	41	-	-	-	380	345	468
2021	85	73	154	388	178	117	46	3	14	-	25	-	584	360	314
2022	128	23	95	421	76	187	34	9	7	-	-	-	667	116	437
Total	2,244	25,099	9,601	4,548	15,672	6,339	403	3,459	626	3	3,409	709	8,716	61,410	23,100

Table L-5b. Minimum number of ray interactions and mortalities in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. Data are considered incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting). Dispositions considered to indicate a survival event are those reported by observers as “Alive and Healthy”, “Alive with light injuries” and “Alive”, while those considered to indicate a mortality event are dispositions reported as “Dead”, “Alive mortal”, Alive injured”, Discarded”, “Unknown”, or precautionarily where disposition was not reported.

Tabla L-5b. Número mínimo de interacciones con rayas y mortalidades en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Los datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre). Las disposiciones que se considera que indican un evento de supervivencia son las reportadas por los observadores como "Viva y sana", "Viva con heridas leves" y "Viva", mientras que las que se considera que indican un evento de mortalidad son las disposiciones reportadas como "Muerta", "Viva, mortalidad probable", “Viva herida", “Descartada", "Desconocida" o precautoriamente cuando la disposición no fue reportada.

Ray taxa	Total interactions	Mortalities
Pelagic stingray, *Pteroplatytrygon violacea*	3,909	3,703
Stingray, nei, Dasyatidae	45	
Manta rays, Mobulidae	4	4
Total numbers	3,960	3,708
*"Other rays" include those with ≤2 interactions from 2 taxa in 2021.		

Table L-6a. Estimated purse-seine catches by set type in metric tons (t) of large fishes by observers onboard size-class 6 vessels with a carrying capacity >363 t (1993–2022) and minimum reported longline (LL) catches of large fishes (gross-annual removals in t) (1993–2021, *data not available , see section 2.2. for uncertainty and data gaps in reporting of bycatch caught by longline). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2021 (longline) and 2022 (purse-seine) are considered preliminary.

Tabla L-6a. Capturas cerqueras estimadas de peces grandes, por tipo de lance, en toneladas (t), por observadores a bordo de buques de clase 6 con una capacidad de acarreo >363 t (1993–22) y capturas palangreras (LL) mínimas reportadas de peces grandes (extracciones anuales brutas en t) (1993–2021, *datos no disponibles; ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos en la notificación de especies capturadas incidentalmente con palangre). 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 2021 (palangre) y 2022 (cerco) se consideran preliminares.

	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	1,779	9	<1	3,342	517	2	<1	287	15	<1	<1	-	6	2	-	-	3	<1	<1	-
2015	1,167	8	<1	1,206	357	1	<1	285	15	<1	-	-	6	<1	-	-	9	8	<1	-
2016	949	7	<1	446	318	2	<1	321	26	<1	<1	-	12	<1	<1	-	4	<1	8	-
2017	1,557	11	<1	2,118	335	<1	<1	319	18	<1	<1	-	12	5	<1	-	4	12	-	-
2018	1,483	5	5	3,927	230	<1	<1	366	20	<1	-	-	62	<1	-	-	9	<1	-	-
2019	1,208	29	<1	1,964	201	<1	<1	331	21	<1	<1	-	12	4	<1	-	5	<1	-	-
2020	783	4	<1	2,506	130	<1	<1	310	23	-	<1	-	9	1	-	<1	3	<1	<1	-
2021	2,183	13	<1	1,413	132	<1	<1	211	28	<1	<1	-	81	3	-	-	3	<1	-	-
2022	2,320	12	2	*	164	<1	<1	*	35	<1	0	*	25	4	-	*	6	<1	-	*
Total	40,102	550	33	168,551	10,806	42	10	4,924	1,375	20	<1	-	459	183	<1	2	101	360	9	1

Table L-6a Continued

	Carangidae				Molidae				Lobotidae				Sphyraenidae				Lampridae			
	Seriola, Caranx spp., amberjacks, jacks, crevalles, nei				*Molidae spp., molas, nei*				*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	-	-	-	-	-	-	1039
2016	7	5	<1	11	10	7	<1	275	2	-	-	-	<1	<1	-	-	-	-	-	741
2017	4	4	-	-	8	4	<1	<1	5	-	<1	-	<1	-	-	-	-	-	-	846
2018	2	-	-	-	5	2	<1	-	3	<1	-	-	<1	<1	-	-	-	-	-	1102
2019	3	<1	-	-	2	6	<1	-	2	-	<1	-	<1	-	-	-	-	-	<1	740
2020	<1	1	-	-	1	<1	<1	-	2	<1	-	-	<1	-	-		-	-	-	683
2021	2	<1	-	-	<1	2	<1	-	1	<1	-	-	1	<1	-	-	-	-	-	449
2022	4	<1	-	*	2	2	<1	*	4	<1	<1	*	<1	-	-	*	-	-	-	*
Total	522	341	5	162	159	338	34	362	98	<1	<1	0	11	41	<1	8	0	<1	<1	10,692

Table L-6a Continued

	***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	1,848	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	<1	14,418
2012	-	-	-	661	-	-	-	61	<1	2	<1	11	1	<1	-	1,305	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	2,329	25	2	6,115
2015	-	-	-	321	<1	-	-	172	<1	<1	-	7	2	<1	-	1,367	1,568	30	2	4,495
2016	<1	-	-	730	-	-	-	108	<1	<1	<1	100	<1	1	-	506	1,328	23	9	3,238
2017	-	-	-	301	-	-	-	126	<1	<1	-	62	1	-	-	1,532	1,946	36	1	5,304
2018	-	-	-	260	-	-	-	125	<1	-	-	1	-	-	-	222	1,816	9	6	6,003
2019	-	-	-	338	-	-	-	81	<1	-	-	26	<1	<1	<1	272	1,455	41	1	3,753
2020	-	-	-	288	-	-	-	70	<1	-	-	213	<1	<1	<1	462	953	9	<1	4,533
2021	-	-	-	277	-	-	-	50	<1	<1	-	<1	<1	<1	-	1,153	2,432	19	1	3,553
2022	-	-	-	*	<1	-	-	*	<1	<1	-	*	<1	-	-	*	2,560	19	3	*
Total	<1	-	-	5,901	<1	<1	-	1,427	57	298	<1	628	75	24	13	28,776	53,765	2,198	105	221,433

Table L-6b. Minimum number of interactions and mortalities of large fishes in 2021 reported by observers onboard longline vessels under the current mandate of at least 5% coverage (C-19-08) of each CPC fleet operating in the eastern Pacific Ocean. Data are incomplete as some CPCs suspended their observer programs due to the COVID-19 pandemic and data are insufficient for expanding to fleet totals (BYC-10 INF-D) (see section 2.2 for uncertainty and data gaps associated with longline data reporting). Dispositions considered to indicate a survival event are those reported by observers as "Alive and Healthy", "Alive with light injuries" and "Alive", while those considered to indicate a mortality event are dispositions reported as "Dead", "Alive mortal", Alive injured", Discarded", "Unknown", or where disposition was not reported.

Tabla L-6b. Número mínimo de interacciones y mortalidades de peces grandes en 2021 reportadas por observadores a bordo de buques palangreros bajo el mandato actual de al menos 5% de cobertura (C-19-08) de cada flota de los CPC que opera en el Océano Pacífico oriental. Los datos se consideran incompletos ya que algunos CPC suspendieron sus programas de observadores debido a la pandemia de COVID-19 y los datos son insuficientes para expandirlos a totales de la flota (BYC-10 INF-D) (ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos asociadas a la notificación de datos de palangre). Las disposiciones que se considera que indican un evento de supervivencia son las reportadas por los observadores como "Vivo y sano", "Vivo con heridas leves" y "Vivo", mientras que las que se considera que indican un evento de mortalidad son las disposiciones reportadas como "Muerto", "Vivo, mortalidad probable", "Vivo herido", "Descartado", "Desconocida" o cuando la disposición no fue reportada.

Large fish taxa	Interactions	Mortalities
Long snouted lancetfish, *Alepisaurus ferox*	11,309	11,309
Escolar, *Lepidocybium flavobrunneum*	6,007	6,002
Snake mackerel, *Gempylus serpens*	3,050	3,031
Wahoo, *Acanthocybium solandri*	2,717	2,717
Opah, *Lampris guttatus*	2,394	2,393
Dorado, mahi mahi, dolphin fish, nei, Coryphaenidae	2,306	2,306
Sickle pomfret, *Taractichthys steindachneri*	1,272	1,272
Common dolphinfish, *Coryphaena hippurus*	602	601
Pomfrets, ocean breams nei, Bramidae	571	570
Oilfish, *Ruvettus pretiosus*	407	402
Mackerels nei, Scombridae	122	122
Pompano dolphinfish, *Coryphaena equiselis*	117	117
Ocean sunfish, Mola, *Mola mola*	44	43
Great barracuda, *Sphyraena barracuda*	40	40
Barracudas nei, *Sphyraena* spp.	23	23
Rough pomfret, *Taractes asper*	10	4
Other large fishes*	40	40
Total numbers	31,031	30,992

"Other large fishes" includes those with <10 interactions from 15 taxa in 2021.

Table L-7. Estimated purse-seine catches by set type in metric tons (t) of small forage fishes by observers onboard size-class 6 vessels with a carrying capacity >363 t (1993–2022) and minimum reported longline (LL) catches of small forage fishes (gross-annual removals in t) (1993–2021, *data not available, see section 2.2. for uncertainty and data gaps in reporting of bycatch caught by longline). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2021 (longline) and 2022 (purse seine) 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*).

Tabla L-7. Capturas cerqueras estimadas de peces forrajeros pequeños, por tipo de lance, en toneladas (t), por observadores a bordo de buques de clase 6 con una capacidad de acarreo >363 t (1993–2022) y capturas palangreras (LL) mínimas reportadas de peces forrajeros pequeños (extracciones anuales brutas en t) (1993-2021, *datos no disponibles; ver Sección 2.2. para consultar información sobre la incertidumbre y las deficiencias de los datos en la notificación de especies capturadas incidentalmente con palangre). 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 2021 (palangre) y 2022 (cerco) 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*).

	***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	-	-	55	8	25	-
1997	2,734	623	25	-	219	<1	<1	-	-	-	-	-	-	-	-	-	<1	-	-	-	151	12	2	-
1998	1,033	168	32	-	801	2	1	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	91	15	3	-
1999	2,589	473	29	-	551	3	<1	-	<1	<1	-	-	<1	-	-	-	<1	<1	-	-	85	3	2	-
2000	1,210	181	19	-	168	<1	9	-	2	-	-	-	-	-	-	-	<1	-	-	-	68	8	6	-
2001	641	38	-	-	426	1	-	-	<1	-	-	-	-	-	-	-	<1	-	-	-	27	2	<1	-
2002	1,382	234	248	-	453	<1	-	-	<1	-	-	-	-	-	-	-	<1	-	-	-	25	3	<1	-
2003	944	278	16	-	157	4	<1	-	<1	-	-	-	<1	-	-	-	<1	-	-	-	75	1	1	-
2004	834	115	24	-	914	7	2	-	8	<1	<1	-	<1	<1	-	-	<1	<1	-	-	22	1	<1	-
2005	1,606	309	6	-	129	<1	<1	-	23	<1	<1	-	6	<1	<1	-	2	<1	<1	-	<1	9	<1	-
2006	1,300	591	19	-	145	<1	<1	-	79	<1	<1	-	7	1	-	-	2	<1	<1	-	5	1	<1	-
2007	868	336	18	-	544	1	<1	-	12	<1	<1	-	2	5	-	-	<1	<1	<1	-	4	<1	<1	-
2008	759	619	2	-	276	7	2	-	68	<1	<1	-	3	<1	-	-	10	<1	-	-	2	<1	<1	-
2009	303	165	1	-	174	1	<1	-	47	<1	-	-	<1	<1	-	-	<1	<1	<1	-	1	<1	<1	-
2010	474	234	<1	-	69	<1	<1	-	16	-	<1	-	4	<1	<1	-	1	<1	-	-	<1	-	<1	-
2011	677	97	11	-	31	<1	-	-	48	<1	-	-	2	<1	<1	-	<1	<1	-	-	<1	<1	<1	-
2012	173	179	1	-	110	<1	-	-	39	-	-	-	13	12	-	-	<1	<1	-	-	4	2	-	-
2013	385	77	-	-	228	<1	<1	-	18	-	<1	-	4	-	<1	-	<1	4	<1	-	2	<1	<1	-
2014	297	30	<1	-	325	<1	<1	-	16	-	-	-	3	<1	<1	-	<1	<1	-	-	1	<1	<1	-
2015	177	64	-	-	140	4	<1	-	5	-	<1	-	6	-	-	-	<1	<1	-	-	1	<1	<1	-
2016	189	23	<1	-	416	2	<1	-	8	-	-	-	21	-	<1	<1	<1	<1	-	-	3	<1	<1	77
2017	131	172	-	-	83	<1	-	-	8	-	-	-	3	-	-	-	<1	<1	-	-	<1	<1	-	-
2018	276	172	-	-	54	<1	<1	-	10	-	-	-	5	<1	-	-	<1	-	-	-	<1	<1	<1	-
2019	182	94	<1	-	57	<1	<1	-	7	<1	<1	-	5	8	<1	-	<1	<1	-	-	<1	5	-	-
2020	435	44	<1	-	47	<1	<1	-	2	-	<1	-	4	<1	-	<1	<1	<1	-	<1	<1	<1	<1	<1
2021	423	18	-	-	50	<1	-	-	6	-	<1	-	15	-	-	-	<1	<1	-	-	<1	1	<1	<1
2022	682	17	<1	*	543	2	<1	*	21	1	-	*	15	-	<1	*	<1	<1	-	*	1	3	<1	*
Total	24,092	6,046	496	-	7,804	48	16	-	445	2	<1	-	118	28	<1	<1	23	6	<1	<1	1,184	100	51	78

Table L-8a. Minimum nominal purse-seine catches of a) sharks, large fishes and small fishes in metric tons (t) and b) rays in numbers of individuals in 2022 for size-class 1–5 vessels with a carrying capacity <363 t as reported by observers in 34% of all trips that carried an observer. Purse-seine set types: floating object (OBJ) and unassociated tuna schools (NOA).

Tabla L-8a. Capturas cerqueras nominales mínimas de a) tiburones, peces grandes y peces pequeños, en toneladas (t), y b) rayas en número de individuos en 2022 para buques de clases 1-5 con una capacidad de acarreo <363 t según lo reportado por los observadores en el 34% de todos los viajes que llevaban observador a bordo. Tipo de lances cerqueros: objeto flotante (OBJ) y atunes no asociados (NOA).

a.

			Set type	
Broad group	Common name	Scientific name	OBJ	NOA
Sharks	Silky shark	*Carcharhinus falciformis*	29	<1
	Oceanic whitetip shark	*Carcharhinus longimanus*	<1	-
	Blue shark	*Prionace glauca*	<1	-
	Other Carcharhinidae spp.	Carcharhinidae spp.	<1	-
	Scalloped hammerhead shark	*Sphyrna lewini*	4	-
	Smooth hammerhead shark	*Sphyrna zygaena*	2	-
	Great hammerhead shark	*Sphyrna mokarran*	<1	-
	Pelagic thresher shark	*Alopias pelagicus*	<1	-
	Bigeye thresher shark	*Alopias superciliosus*	<1	-
	Mako shark	*Isurus* spp.	<1	-
Large fishes	Dorado	Coryphaenidae spp.	289	<1
	Wahoo	*Acanthocybium solandri*	26	<1
	Rainbow runner	*Elagatis bipinnulata*	2	
	Amberjack, nei	*Seriola* spp.	2	
	Jacks, crevalles, nei	*Caranx* spp.	<1	
	Amberjack, jack, crevalles, nei	*Seriola, Caranx* spp.	<1	
	Tripletail	*Lobotes surinamensis*	2	
	Mola, nei	Molidae spp.	<1	
	Other large fish		<1	
Small fishes	Bullet and frigate tunas	*Auxis spp.*	128	-
	Triggerfishes, Filefishes	Balistidae, Monacanthidae spp.	84	<1
	Sea chubs	Kyphosidae spp.	3	
	Small carangid, nei	Carangidae spp.	<1	
	Epipelagic forage fishes		<1	

b.

			Set type	
Broad group	Common name	Scientific name	OBJ	NOA
Rays	Pelagic stingray	*Pteroplatytrygon violacea*	36	5
	Spinetail manta	*Mobula mobular*	18	8
	Smoothtail manta	*Mobula thurstoni*	11	
	Mobulidae ray, nei	Mobulidae spp.	10	
	Giant manta	*Mobula birostris*	8	
	Chilean devil ray	*Mobula tarapacana*	7	
	Stingray nei	Dasyatidae spp.	3	