INTER-AMERICAN TROPICAL TUNA COMMMISSION
COMISIÓN INTERAMERICANA DEL ATÚN TROPICAL

QUARTERLY REPORT—INFORME TRIMESTRAL

October-December 2016—Octubre-Diciembre 2016

The Quarterly Report of the Inter-American Tropical Tuna Commission is an informal account of the current status of the tuna fisheries in the eastern Pacific Ocean in relation to the interests of the Commission, and of the research and the associated activities of the Commission's scientific staff. The research results presented should be regarded, in most instances, as preliminary and in the nature of progress reports.

El Informe Trimestral de la Comisión Interamericana del Atún Tropical es un relato informal de la situación actual de la pesca atunera en el Océano Pacífico oriental con relación a los intereses de la Comisión, y de la investigación científica y demás actividades del personal científico de la Comisión. Gran parte de los resultados de investigación presentados en este informe son preliminares y deben ser considerados como informes del avance de la investigación.

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INTRODUCTION

The Inter-American Tropical Tuna Commission (IATTC) operated from 1950 to 2010 under the authority and direction of a Convention signed by representatives of the governments of Costa Rica and the United States of America on 31 May 1949. The Convention was open to the adherence by other governments whose nationals participated in the fisheries for tropical tunas and tuna-like species in the eastern Pacific Ocean (EPO). The original convention was replaced by the "Antigua Convention" on 27 August 2010, 15 months after it had been ratified or acceded to by seven Parties that were Parties to the original Convention on the date that the Antigua Convention was open for signature. On that date, Belize, Canada, China, Chinese Taipei, and the European Union became members of the Commission, and Spain ceased to be a member. Spanish interests were henceforth handled by the European Union. Kiribati joined the IATTC in June 2011. There were 21 members of the IATTC at the end of the second quarter of 2017.

The Antigua Convention states that the "Scientific Staff shall operate under the supervision of the Director," that it will "conduct scientific research … approved by the Commission," and "provide the Commission, through the Director, with scientific advice and recommendations in support of the formulation of conservation and management measures and other relevant matters." It states that "the objective of this Convention is to ensure the long-term conservation and sustainable use of the "tunas and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna-like species," but it also states that the Commission 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."

The scientific program is now in its 67th year. The results of the IATTC staff's research are published in the IATTC's Bulletin and Stock Assessment Report series in English and Spanish, its two official languages, in its Special Report and Data Report series, and in books, outside scientific journals, and trade journals. Summaries of each year's activities are reported upon in the IATTC's Annual Reports and Fishery Status Reports, also in the two languages.

MEETINGS

IATTC meetings

The following meetings of the IATTC were held in La Jolla, California, USA, on 10 October 2016:

Meeting	Number
Permanent Working Group on Tuna Tracking	38
Working Group to Promote and Publicize the AIDCP Dolphin Safe Tuna Certification System	25
International Review Panel	60
Parties [to the Agreement on the International Dolphin Conservation Program]	34

Amended Procedures for AIDCP Dolphin Safe Tuna Certification were adopted at the 38th meeting of the Permanent Working Group on Tuna Tracking.

A Technical Meeting on Tuna Conservation Measures was held in La Jolla, California, USA, on 11 October 2016.

The 90th Meeting of the IATTC (resumed [a continuation of a meeting initiated on 27 June 2016]) was held in La Jolla, California, USA, on 12-14 October 2016. The following background papers were presented at the meeting:

Document IATTC-90 INF-A, Background Information to Address Issues Relevant to Proposal IATTC-90 D-1 on Discards;

Document IATTC-90 INF-B, Alternative Management Measures for Tropical Tunas in the Eastern Pacific Ocean;

Document IATTC-90 INF-B, Addendum 1, Additional Alternative Management Measures for Tropical Tunas in the Eastern Pacific Ocean;

Document IATTC-90 INF-C, Safety at Sea for IATTC and AIDCP Observers on Tuna Purse-Seine Vessels;

Document IATTC-90 INF-D, Overview of IATTC Field Office Operations;

An IATTC Workshop on Methods for Monitoring the Status of Eastern Tropical Pacific Ocean Dolphin Populations was held in La Jolla, California, USA, on 18-29 October 2016. The following background papers were presented at the meeting:

Data Available for Assessing Dolphin Population Status in the Eastern Tropical Pacific Ocean, by Michael D. Scott, Cleridy E. Lennert-Cody, Tim Gerrodette, Hans J. Skaug, Carolina V. Minte-Vera, Jenny Hofmeister, Jay Barlow, Susan J. Chivers, Kerri Danil, Leanne M. Duffy, Robert J. Olson, Aleta A. Hohn, Paul C. Fiedler, Lisa T. Ballance, and Karin A. Forney;

Review of Potential Methodologies for Estimating Abundance of Dolphin Stocks in the Eastern Tropical Pacific by Stephen T. Buckland, Cleridy E. Lennert-Cody, Tim Gerrodette, Jay Barlow, Jeffrey E. Moore, Andrew Webb, Peter T. Fretwell, Hans J. Skaug, and Wayne L. Perryman;

Review of Contemporary Cetacean Stock Assessment Models by André E. Punt.

The IATTC's Third Technical Meeting on Dorado, Evaluating Data Needs and Assessment Methods for Data-limited Dorado Fisheries in the Eastern Pacific Ocean, was held in Panama, R.P., on 25-27 October 2016. The meeting was organized by ARAP (Autoridad de los Recursos Acuaticos de Panamá) and CEDEPESCA (Centro Desarrollo y Pesca Sustentable). Dr. Alexandre Aires-da-Silva served as chairman of the meeting. The following background papers were presented:

A Step-by-step Illustration of the Basis for the Monthly Depletion Estimator in a Stock Synthesis Model for Dorado, by Mark N. Maunder, Alexandre Aires-da-Silva, Carolina Minte-Vera, Cleridy Lennert-Cody, Juan L. Valero, and Jimmy Martínez-Ortiz;

Exploratory Stock Assessment of Dorado (*Coryphaena hippurus*) in the Southeastern Pacific Ocean, by Alexandre Aires-da-Silva, Juan L. Valero, Mark. N. Maunder, Carolina Minte-Vera, Cleridy Lennert-Cody, Marlon H. Román, Jimmy Martínez-Ortiz, and Edgar J. Torrejón-Magallanes;

Exploratory Management Strategy Evaluation (MSE) of Dorado (*Coryphaena hippurus*) in the Southeastern Pacific Ocean, by Juan L. Valero, Alexandre Aires-da-Silva, Mark N. Maunder, Carolina Minte-Vera, Jimmy Martínez-Ortiz, Edgar J. Torrejón-Magallanes, and Miguel N. Carranza.

Other meetings

Mr. Kurt M. Schaefer participated in the 124th meeting of the Scientific and Statistical Committee of the Western Pacific Regional Fishery Management Council (WPRFMC) of the United States in Honolulu, Hawaii, USA, on 4-6 October 2016. His travel expenses were paid by the WPRFMC.

Dr. Martín A. Hall participated in a workshop, sponsored by the International Seafood Sustainability Foundation (ISSF), and organized by Dr. Gala Moreno of Azti-Tecnalia, Spain, at which a group of scientists and fishing captains discussed the options available for developing biodegradable fish-aggregating devices. The meeting took place in San Sebastian, Spain, on 3-4 November 2016. Dr. Hall's expenses were paid by the ISSF.

Mr. Kurt M. Schaefer participated in the Second Workshop of the U.S. National Marine Fisheries Service on Maturity Assessment, Reproductive Variability, and Life Strategies (MARVLS) held at the Southwest Fisheries Science Center in La Jolla, California, USA, on 3-5 November 2016. The participants included scientists of the U.S. National Marine Fisheries Service from its four regions (Southwest, Northwest, Southeast, and Northeast), state agencies, and academics who had conduct research on reproductive biology of fish for inclusion in stock assessments.

Dr. Daniel Margulies participated in the annual meeting of the North Pacific Marine Science Organization (PICES), which took place in San Diego, California, USA, on 7-10 November 2016. He made a presentation on behalf of the IATTC (an observer organization in PICES) to the Fishery Science (FIS) Committee; the presentation was entitled, "IATTC's Pre-recruit Research on Tunas in the Eastern Pacific, with an Emphasis on Hatchery-based Research with Yellowfin Tuna in Panama," co-authored with Mr. Vernon P. Scholey and Mss. Jeanne B. Wexler and Maria S. Stein. Dr. Margulies also presented a poster entitled "The IATTC's Research Program on the Reproductive Biology and Early Life History of Tunas in the Eastern

Pacific Ocean," also co-authored with Mr. Vernon P. Scholey and Mss. Jeanne B. Wexler and Maria S. Stein.

Dr. Martin A. Hall participated in meetings of the Developing World Working Group and of the Stakeholder Council, both of the Marine Stewardship Council (MSC) in Bali, Indonesia, on 8-10 November 2016. His expenses were paid by the MSC.

Dr. Alexandre Aires-da-Silva attended, as an observer, the 13th Regular Sessions of the Western and Central Pacific Fisheries Commission on Denarau Island, Nada, Fiji, on 5-9 December 2016.

RESEARCH

DATA COLLECTION AND DATABASE PROGRAM

There are two major fisheries for tunas in the eastern Pacific Ocean (EPO; the region east of 150ºW, south of 50ºN, and north of 50°S), the commercial surface fishery and the longline fishery. The catches by the commercial surface fishery are taken almost entirely by purse-seine and pole-and-line vessels based in ports of Western Hemisphere nations. The longline catches are taken almost entirely by vessels registered and based in Far Eastern nations. The staff of the IATTC collects data on the catches by purse-seine and pole-and-line vessels and samples the catches of these vessels at unloading facilities in Las Playas and Manta, Ecuador; Manzanillo and Mazatlán, Mexico; Panama, Republic of Panama; and Cumaná, Venezuela, where it has field offices, and also, to a lesser extent, at other ports. The governments of the nations in which the catches of the longliners that fish in the EPO are registered compile the catch and size data for those vessels and make the data, in aggregated form, available to the IATTC staff. The rest of this section deals almost entirely with the surface fisheries.

Compilation of data on the amounts of catch, and on species and length composition of the catches of the surface fisheries, is complicated. Observers accompany all trips of Class-6 purse seiners (vessels with fish-carrying capacities greater than 363 metric tons) that fish in the EPO. The data that they collect include the locations and dates of each set, the type of each set (dolphin, floating object, or unassociated), the approximate total weights of each species caught in each set, and the wells in which the fish caught in each set are stored. Similar data are obtained from the logbooks of smaller purse seiners and of pole-and-line vessels, although these data may be less accurate or less precise than those collected by the observers. Then, when a vessel unloads its catch, the weight of the contents of each well is made available to the IATTC staff. These "reported catch statistics"—catch statistics obtained from every possible source, including observer records, fishing vessel logbooks, unloading records, and data compiled by governmental agencies—are compiled to provide an estimate of the total amount of tropical tunas (yellowfin, bigeye, and skipjack combined) caught annually by the surface fisheries. In addition, sample data on the species and length composition of the catch are also obtained when a vessel unloads. The methods for collection of these sample data are described in the IATTC Annual Report for 2000 and in IATTC Stock Assessment Reports 2, 4, 10, 11, 12, and 13. Briefly, the fish in a well of a purse-seine or pole-and-line vessel are selected for sampling only if all of the fish in the well were caught in the same sampling area, during the same calendar month, and by the same type of gear (pole-and-line, or in the same type of set of a Class 1-5 or a Class-6 vessel). These data are then categorized by fishery (Figure 1).

The sample data on species and length composition of the catch are eventually combined with the reported catch statistics to make the "final" estimates of the catches by species and length- and weight-frequency distributions, by species, that appear in the IATTC's Stock Assessment Reports, Fishery Status Reports, and papers in outside journals, but this does not take place until two or more months after the end of the calendar year. (If additional information is acquired after the "final" estimates are calculated, that information is used to recalculate the estimates.) Most of the catch statistics that appear in the rest of this report are preliminary.

IATTC personnel stationed at its field offices collected 502 length-frequency samples from 243 wells and abstracted logbook information for 251 trips of commercial fishing vessels during the fourth quarter of 2016.

Reported fisheries statistics

The information reported herein is for the eastern Pacific Ocean (EPO: the region east of 150ºW, south of 50ºN, and north of 50°S), unless noted otherwise. The catches are reported in metric tons (t), vessel capacities in cubic meters (m^3), and effort in days fishing. Estimates of fisheries statistics with varying degrees of accuracy and precision are available. The most accurate and precise are those made after all available information has been entered into the data base, processed, and verified. While it may require a year or more to obtain some final information, much of the catch information is processed and available within two to three months of the return of a vessel from a fishing trip. Thus the estimates for the current week are the most preliminary, while those made a year later are much more accurate and precise. The statistics are developed using data from many sources, including scientific observers, fishing vessel logbooks, reports of landing, and data compiled by governmental agencies.

Fleet statistics for the purse-seine and pole-and-line fisheries

The lists of vessels authorized to fish for tunas in the EPO are given in the IATTC Regional Vessel Register (http://www.iattc.org/VesselListsENG.htm). The estimated total fish-carrying capacity of the purse-seine and pole-and-line vessels that have or were expected to fish in the EPO during 2016 was about 264,156 m^3 (Table 1). The average weekly at-sea capacity for the fleet, for the weeks ending 4 October through 31 December, was about 129,000 m^3 (range: 43,800 to 199,400 m^3).

Catch and catch-per-unit-of-effort statistics for the purse-seine and pole-and-line fisheries

Catch statistics

The estimated total retained catches, in metric tons, of tropical tunas from the EPO during the period of January-December 2016, and comparative statistics for 2011-2015, were:

Species	2016	2011-2015			Weekly average, 2016
		Average	Minimum	Maximum	
Yellowfin	235,500	223,600	203,500	246,100	4,500
Skipjack	329,800	278,800	258,400	327,000	6,300
Bigeye	57,000	51,200	44,100	61,300	1,100

Summaries of the estimated retained catches, by species and by flag of vessel, are shown in Table 2.

Catch-per-unit-of-effort statistics for purse-seine vessels

No adjustments in the catch-per-unit-of-effort (CPUE) data are included for factors, such as type of set or vessel operating costs and market prices, which might identify whether a vessel was directing its effort toward a specific species.

The measures of CPUE used in these analyses are based on data from fishing trips landing predominantly yellowfin, skipjack, bigeye, and bluefin tuna. The great majority of the purse-seine catches of yellowfin, skipjack, and bigeye are made by Class-6 vessels (vessels with fish-carrying capacities greater than 363 metric tons), and only data for these vessels are included in these analyses. There are now far fewer pole-and-line vessels than in previous years, so the data for these vessels are combined without regard to carrying capacity.

The estimated nominal catches per day of fishing for yellowfin, skipjack, and bigeye per day of fishing, in metric tons, by purse-seine (PS) and pole-and-line (LP) gear in the EPO during the third quarter of 2016 and comparative statistics for 2011-2015 were:

Region	Species	Gear	2016	2011-2015		
				Average	Minimum	Maximum
N of 5° N	Yellowfin	PS	12.2	13.8	12.5	15.2
S of 5° N			3.5	3.1	2.5	3.6
N of 5° N	Skipjack	PS	3.0	2.2	1.4	2.9
S of 5° N			14.9	10.6	9.4	11.9
EPO	Bigeye	PS	2.7	2.5	2.3	3.0
EPO	Yellowfin	LP	0	4.4	0	9.6
EPO	Skipjack	LP	0	0.7	0	1.7

Catch statistics for the longline fishery

The catches of bigeye by longline gear in the EPO are reported by flag states whose annual catches have exceeded 500 metric tons (C-13-01-Tuna-conservation-in-the-EPO-2014-2016.pdf). Preliminary estimates of the catches reported for January-December 2016 are shown in Table 3.

Size compositions of the surface catches of tunas

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 population. Samples of yellowfin, skipjack, bigeye, Pacific bluefin, and, occasionally, black skipjack from the catches of purse-seine and pole-and-line vessels in the EPO are collected by IATTC personnel at ports of landing in Ecuador, Mexico, Panama, and Venezuela. The catches of yellowfin and skipjack were first sampled in 1954, bluefin in 1973, and bigeye in 1975.

Data for fish caught during the third quarter of 2011-2016 are presented in this report. Two sets of length-frequency histograms are presented for each species; the first shows the data by stratum (gear type, set type, and area) for the third quarter of 2016, and the second shows data for the combined strata for the third quarter of each year of the 2011-2016 period. Samples from 216 wells were taken during the third quarter of 2016.

There are ten surface fisheries for yellowfin defined for stock assessments: four associated with floating objects, two with unassociated tuna schools, three associated with dolphins, and one pole-and-line (Figure 1). The last fishery includes all 13 sampling areas. Of the 216 wells sampled that contained fish caught during the third quarter of 2016, 193 contained yellowfin. The estimated size compositions of these fish are shown in Figure 2a. During the third quarter most of the larger sized (>110 cm) yellowfin was taken in sets on dolphins in the Northern and Inshore fisheries, with smaller amounts in the Northern and Southern unassociated and Southern dolphin fisheries. Smaller yellowfin <60 cm were taken in the Northern and Equatorial floating-object fisheries.

The estimated size compositions of the yellowfin caught by all fisheries combined during the third quarters of 2011-2016 are shown in Figure 2b. The average weight of yellowfin caught during the third quarter of 2016 (6.1 kg) was less than any of those of any of the previous 5 years, which ranged from 7.2 to 10.3 kg.

There are eight fisheries for skipjack defined for stock assessments: four associated with floating objects, two with unassociated tuna schools, one associated with dolphins, and one pole-and-line (Figure 1). Each of the last two fisheries includes all 13 sampling areas. Of the 216 wells sampled that contained fish caught during the third quarter of 2016, 128 contained skipjack. The estimated size compositions of these fish are shown in Figure 3a. Most of the smaller skipjack in the 35- to 50- cm range was caught in the Northern and Southern floating-object fisheries, with lesser amounts of smaller skipjack caught in the Ecuatorial floating-object fishery and the Southern unassociated fisheries. The highest catch of the largest skipjack greater than 70 cm were found in the Southern unassociated fishery.

The estimated size compositions of the skipjack caught by all fisheries combined during the third quarters of 2011-2016 are shown in Figure 3b. The average weight of skipjack caught during the third quarter of 2016 (1.9 kg) was similar to those of the previous 2 years, which ranged from 1.7 to 2.2 kg.

There are seven surface fisheries for bigeye defined for stock assessments: four associated with floating objects, one with unassociated tuna schools, one associated with dolphins, and one pole-and-line (Figure 1). Each of the last three fisheries includes all 13 sampling areas. Of the 216 wells sampled that contained fish caught during the third quarter of 2016, 56 contained bigeye. The estimated size compositions of these fish are shown in Figure 4a. Most of the third-quarter bigeye were caught in the Southern floating-object fishery, with lesser amounts in the Northern floating-object fishery. The bigeye in these areas fell into two general size groups with smaller bigeye in the 40- to 60- cm range, and larger bigeye in the 75- to 100-cm range.

The estimated size compositions of the bigeye caught by all fisheries combined during the third quarter of 2011-2016 are shown in Figure 4b. The average weight of bigeye caught during the third quarter of 2016 (4.6 kg) was greater than those of any of the previous 3 years, which ranged from 4.1 to 4.4 kg. however, it was still less than the 5.6 kg averages of 2011 and 2012.

The estimated retained purse-seine catch of bigeye less than 60 cm in length during the third quarter of 2016 was 4,900 metric tons (t), or about 41 percent of the estimated total retained purse-seine catch of bigeye during that period. The corresponding amounts for 2011-2015 ranged from 3,900 to 7,300 t, or 37 to 55 percent. These values may differ slightly from those given in previous Quarterly Reports due to changes in the estimation procedure.

BIOLOGY AND ECOSYSTEM PROGRAM

Early life history studies

Yellowfin broodstock

The yellowfin broodstock in Tank 1 (1,362,000 L) at the Achotines Laboratory spawned daily from October 10 to October 21, on October 31, from November 1-3, from November 7-16, from November 18-19, from November 21-29, and from December 6 to December 19 during the quarter. Spawning occurred between 10:15 p.m. and 11:30 p.m. The number of eggs collected ranged from 3,000 to 367,000 per day. During the quarter the water temperatures in the tank ranged from 27.5 to 28.7°C.

Twenty-two 4- to 14-kg yellowfin were transferred from Tank 2 to Tank 1 on December 21, 2016. With the group of large spawning fish in Tank 1 diminished due to normal attrition in the tank, the newly-transferred fish are expected to form the core of the spawning broodstock over the next 2-3 years. At the end of the quarter there were one 58-kg, four 35- to 38-kg, and twenty 5- to 15-kg yellowfin in Tank 1

. *Rearing of yellowfin eggs, larvae, and juveniles*

During the quarter, the following parameters were recorded for most spawning events: times of spawning, egg diameter, duration of egg stage, and hatching rate. The lengths of hatched larvae, duration of yolk-sac stage, weights of the eggs, yolk-sac larvae, and first-feeding larvae, and the lengths and selected morphometrics of these, were measured periodically.

Studies of snappers

The work on snappers (*Lutjanus* spp.) is carried out by the Autoridad de los Recursos Acuáticos de Panama (ARAP).

During 1996-2009, the ARAP staff had conducted full life cycle research on spotted rose snappers (*Lutjanus guttatus*) in captivity. The broodstock population of this species was rebuilt in recent years. During the second quarter of 2013, a major fishing effort was undertaken, and more than 100 spotted rose snappers were collected in local waters. At the end of December 2016, a small group of fish continued to be held in the broodstock snapper tank. These fish began spawning during 2015 (see IATTC Quarterly Report for July-September 2015) and have continued spawning sporadically throughout 2016.

Oceanography and meteorology

Easterly surface winds blow almost constantly over northern South America, which cause upwelling of cool, nutrient-rich subsurface water along the equator east of 160ºW, in the coastal regions off South America, and in offshore areas off Mexico and Central America. El Niño events are characterized by weaker-than-normal easterly surface winds, which cause above-normal sea-surface temperatures (SSTs) and sea levels and deeper-than-normal thermoclines over much of the tropical eastern Pacific Ocean (EPO). (The depth of the thermocline is a proxy for the depth of the upper edge of the oxygen-minimum zone, a thick layer of oxygen-poor water underlying the upper mixed layer. In locations where the thermocline is shallow, the habitat for tunas, especially yellowfin tuna, is vertically compressed near the surface of the ocean, where they are vulnerable to capture by surface gear.) In addition, the Southern Oscillation Indices (SOIs) are negative during El Niño episodes. (The SOI is the difference between the anomalies of sea-level atmospheric pressure at Tahiti, French Polynesia, and Darwin, Australia. It is a measure of the strength of the easterly surface winds, especially in the tropical Pacific in the Southern Hemisphere.) Anti-El Niño events, which are the opposite of El Niño events, are characterized by stronger-than-normal easterly surface winds, below-normal SSTs and sea levels, shallower-than-normal thermoclines, and positive SOIs. An additional index, the NOI* (Progress Ocean., 53 (2-4): 115-139) has recently been devised. The NOI* is the difference between the anomalies of sea-level atmospheric pressure at the North Pacific High (35°N-130°W) and Darwin, Australia. Ordinarily, the NOI* values are negative during El Niño events and positive during anti-El Niño events.

During the fourth quarter of 2015, the SSTs in the EPO were well above normal, with a broad band of water along the Equator with sea-surface temperatures (SSTs) 2º and 3º above normal (IATTC Quarterly Report for October-December 2015: Figure 5) During the first quarter of 2016, there were no SSTs north of 25º S that were more than 1º below normal, but there were extensive areas, especially between 10ºN and 10ºS with SSTs more than 2º above normal (Quarterly Report for January-March 2016: Figure 8). During the second quarter of 2016, the SSTs were much cooler, although there were scattered areas, both north and south of the Equator with SSTs more than 2º above normal (Quarterly Report for April-June 2016: Figure 5). However, there was a narrow band of cool water along the Equator with areas more than 2º below normal off Ecuador and west of 125ºW. During the third quarter of 2016, there were fewer areas with SSTs more than 2º above normal or more than 2º below normal. The latter occurred only along the Equator west of 125ºW. (Quarterly Report for July-September 2016: Figure 5). During the fourth quarter of 2016 there was a large area of warm water adjacent to the coast of South America that extended from about 10°S to south of 30°S and two areas of warm water offshore between about 20°S and 25°S. Also, there were a few scattered areas of warm and cool water scattered over other parts of the EPO (Figure 5).

According to the Climate Diagnostics Bulletin of the U.S. National Weather Service for December 2016, “A transition to ENSO-neutral is expected to occur by February 2017, with ENSO-neutral then continuing through the first half of 2017.”

Here is a copy of the abstract of an important article that appeared in Science, 354 (6319): 1591-1594 (December 23, 2016):

LARGE BENEFITS TO MARINE FISHERIES OF MEETING THE 1.5°C GLOBAL WARMING TARGET

William W.L. Cheung, Gabriel Reygondean, and Thomas L. Frölicher

Transferring the Paris Agreement to limit global warming to 1.5°C above preindustrial level into impact-related targets facilitates communication of the benefits of mitigating climate change to policymakers and stakeholders. Developing ecologically relevant impact-related targets for marine ecosystem services, such as fisheries, is an important step. Here, we use maximum catch potential and species turnover as climate-risk indicators for fisheries. We project that potential catches will decrease by more than 3 million metric tons per degree Celsius of warming. Species turnover is more than halved if lowered by more than 3.5° to 1.5°C above the preindustrial level. Regionally, changes in maximum catch potential and species turnover vary across ecosystems, with the biggest risk reduction in the Indo-Pacific and Arctic regions when the Paris Agreement target is achieved.

BYCATCH PROGRAM AND INTERNATIONAL DOLPHIN CONSERVATION PROGRAM

Observer program

Coverage

The Agreement on the International Dolphin Conservation Program (AIDCP) requires 100-percent coverage by observers on trips by Class-6 purse seiners (vessels with fish-carrying capacities greater than 363 metric tons) that fish for tunas in the eastern Pacific Ocean (EPO). This mandate is carried out by the IDCP On-Board Observer Program, made up of the IATTC's international observer program and the observer programs of Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, Venezuela, and the Regional Observer Program (ROP) under the umbrella of the WCPFC, based on a Memorandum of Cooperation (MOC) signed by representatives of the IATTC and the WCPFC.

In addition, Resolution C-12-08 of the IATTC indicates that "Any vessel [regardless of size class] with one or more of its wells sealed to reduce its well volume recorded on the Regional Vessel Register shall be required to carry an observer from the International Dolphin Conservation Program (IDCP) on board." Furthermore, Resolution C-13-01 allows Class-4 purse-seine vessels (vessels with fish-carrying capacities of 182 to 272 metric tons) to make a single fishing trip of up to 30 days duration during the specified closure periods, provided that such vessel carries an observer of the IDCP On-Board Observer Program.
The observers are biologists trained to collect a variety of data on the mortalities of dolphins associated with the fishery, sightings of dolphin herds, catches of tunas and bycatches of fish and other animals, oceanographic and meteorological data, and other information used by the IATTC staff to assess the conditions of the various stocks of dolphins, study the causes of dolphin mortality, and assess the effect of the fishery on tunas and other components of the ecosystem. The observers also collect data relevant to compliance with the provisions of the AIDCP and

data required for the tuna-tracking system established under the AIDCP, which tracks the "dolphin-safe" status of tuna caught in each set from the time it is captured until it is unloaded (and, after that, until it is canned and labeled).
During the fourth quarter of 2016 the observer programs of Colombia, the European Union, Mexico, Nicaragua, Panama, and Venezuela are to sample half, and that of Ecuador approximately one-third, of the trips by vessels of their respective fleets, while IATTC observers are to sample the remainder of those trips. Except as described in the next paragraph, the IATTC is to cover all trips by vessels registered in other nations that are required to carry observers.

At the fifth meeting of the Parties to the AIDCP in June 2001, observers from the international observer program of the South Pacific Forum Fisheries Agency (FFA) were approved to collect pertinent information for the IDCP On-Board Observer Program, pursuant to Annex II (9) of the AIDCP in cases for which the Director determines that the use of an observer from the IDCP On-Board Observer Program is not practical. In 2011, the IATTC and the WCPFC agreed on the MOC described above. As part of the implementation of the MOC, representatives of the two organizations put together a series of procedures to follow for the observers of the ROP under the umbrella of the WCPFC for tuna purse seiners, while observing fishing activity in the IATTC convention area. During the fourth quarter of 2016 one Party to both regional fisheries management organizations, and to the AIDCP, requested that one cross-endorsed observer be allowed to be deployed on a trip of a vessel of its flag, operating in both Convention areas. In addition, observers from the IDCP On-Board Observer Program departed on 135 fishing trips aboard purse seiners covered by that program during the fourth quarter of 2016, for a total of 136 sampled trips. Preliminary coverage data for these vessels during the quarter are shown in Table 5.

Observer Training

The IATTC staff conducted a regular observer training session during the fourth quarter of 2016, in Panama City, Panama, from November 21 to December 8, 2016 for ten attendees. Four of them for the Programa Nacional de Observadores de Panamá, and the rest for the IATTC observer program.

Gear project

During the fourth quarter of 2016 the IATTC staff carried out a dolphin safety-gear inspections and safety-panel alignment procedures for one Class-6 vessel participating in the fisheries of tuna associated with dolphins. In addition, members of the staff of the national observer program of Mexico, trained by the IATTC staff, conducted seven more such alignments.

Training and certification of fishing captains and crew

The IATTC has conducted dolphin mortality reduction seminars for tuna fishermen since 1980. Article V of the AIDCP calls for the establishment, within the framework of the IATTC, of a system of technical training and certification of fishing captains. Under the system, the IATTC staff is responsible for maintaining a list of all captains qualified to fish for tunas associated with dolphins in the EPO. The names of the captains who meet the requirements are to be supplied to the International Review Panel for approval and circulation to the Parties to the AIDCP.

One of the requirements for new captains is to attend a training seminar organized by the IATTC staff or by the pertinent national program in coordination with the IATTC staff. The fishermen and others who attend the seminars are presented with certificates of attendance.

During the fourth quarter of 2016 the IATTC staff did not conduct such seminars.

PUBLICATIONS

Capello, M., J.L. Deneubourg, M. Robert, K.N. Holland, K.M. Schaefer, and L.L. Dagorn. 2016. Population assessment of tropical tuna based on their associative behavior around floating objects. Sci. Rep. 6, 36415; doi: 10.1038/srep36415.

Pons, Maite, Trevor Branch, Michael Melnychuk, Olaf Jensen, Jon Brodziak, Jean M. Fromentin, Shelton J. Harley, Alan C. Haynley, Larie T. Kell, Mark N. Maunder, Ana M. Parma, Victor R. Restrepo, Rishi Sharma, Robert Ahrens, and Ray Hilborn. 2016. Effects of biological, economic and management factors on tuna and billfish stock status. Fish and Fisheries, doi:10.1111/faf.12163.

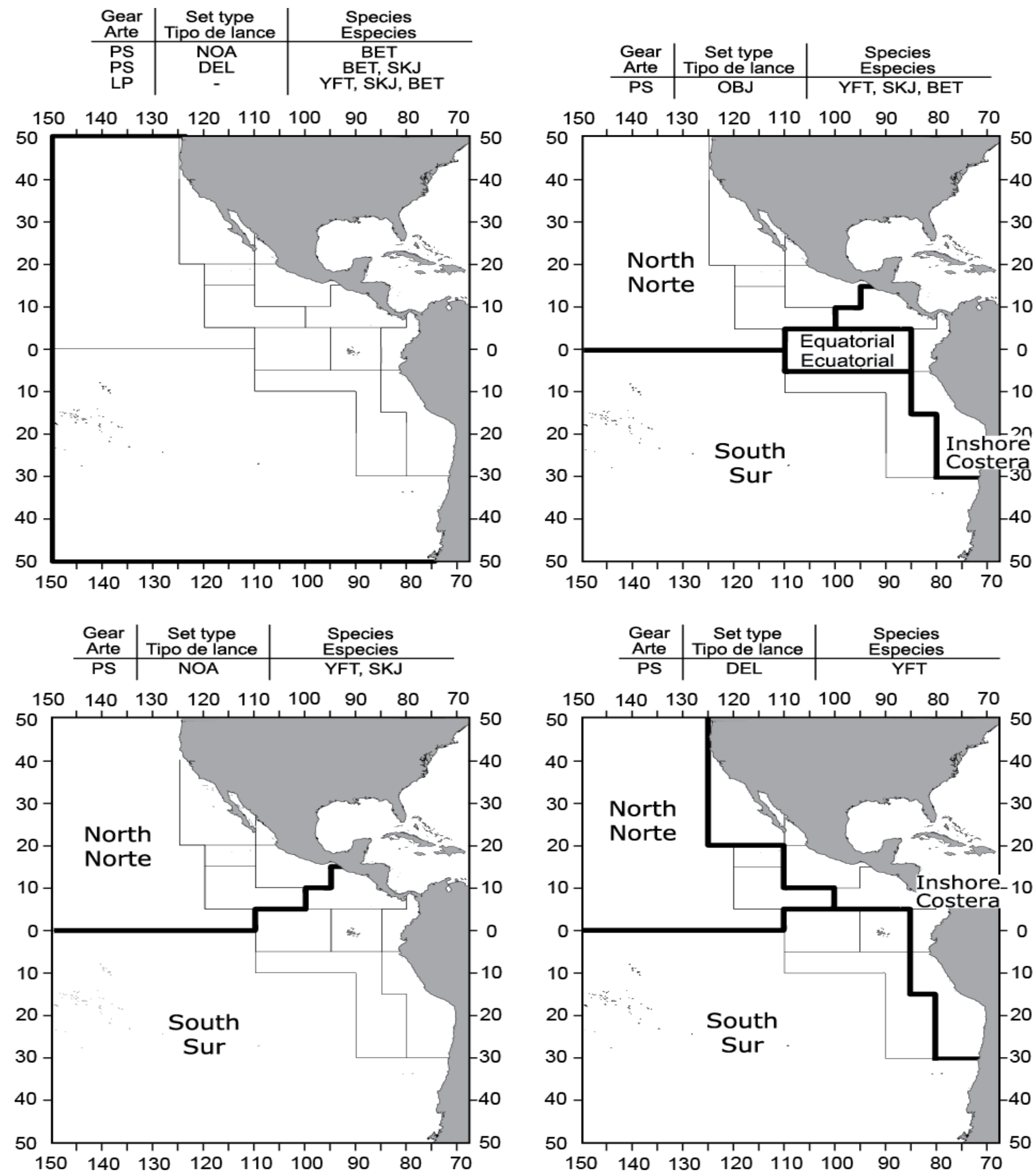

FIGURE 1. Spatial extents of the fisheries defined by the IATTC staff for stock assessment of yellowfin, skipjack, and bigeye in the EPO. The thin lines indicate the boundaries of the 13 length-frequency sampling areas, and the bold lines the boundaries of the fisheries. Gear: PS = purse seine, LP = pole and line; Set type: NOA = unassociated, DEL = dolphin, OBJ = floating object; Species: YFT = yellowfin, SKJ = skipjack, BET = bigeye.

FIGURA 1. Extensión espacial de las pesquerías definidas por el personal de la CIAT para la evaluación de las poblaciones de atún aleta amarilla, barrilete, y patudo en el OPO. Las líneas delgadas indican los límites de las 13 zonas de muestreo de frecuencia de tallas, y las líneas gruesas los límites de las pesquerías. Artes: PS = red de cerco, LP = caña; Tipo de lance: NOA = peces no asociados, DEL = delfín; OBJ = objeto flotante; Especies: YFT = aleta amarilla, SKJ = barrilete, BET = patudo.

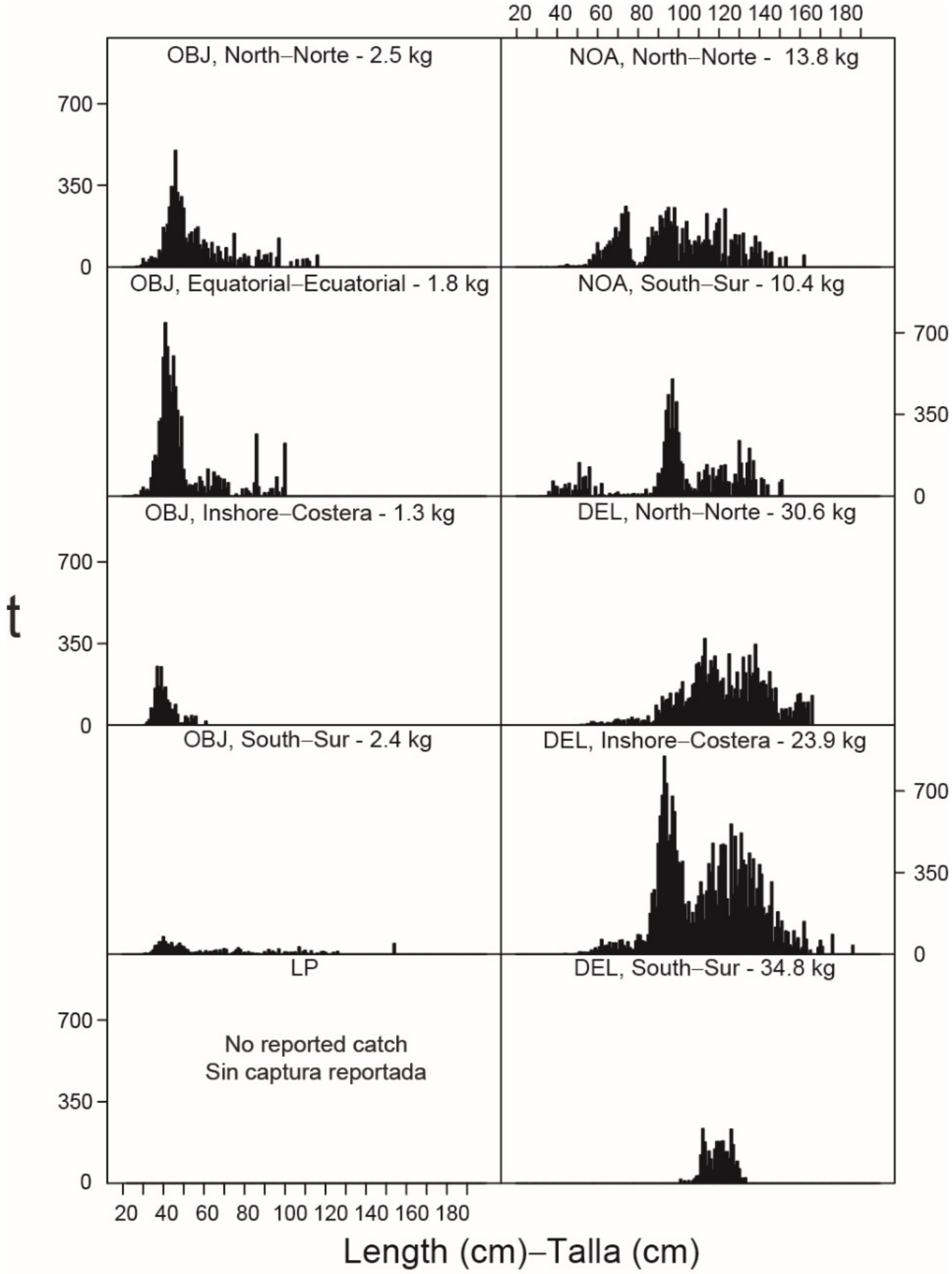

FIGURE 2a. Estimated size compositions of the yellowfin caught in each fishery of the EPO during the third quarter of 2016. The average weights of the fish in the samples are given at the tops of the panels. OBJ = floating object; LP = pole and line; NOA = unassociated; DEL = dolphin; t = metric tons.

FIGURA 2a. Composición por tallas estimada para el aleta amarilla capturado en cada pesquería del OPO durante el tercer trimestre de 2016. En cada recuadro se detalla el peso promedio de los peces en las muestras. OBJ = objeto flotante; LP = caña; NOA = peces no asociados; DEL = delfín; t = toneladas métricas.

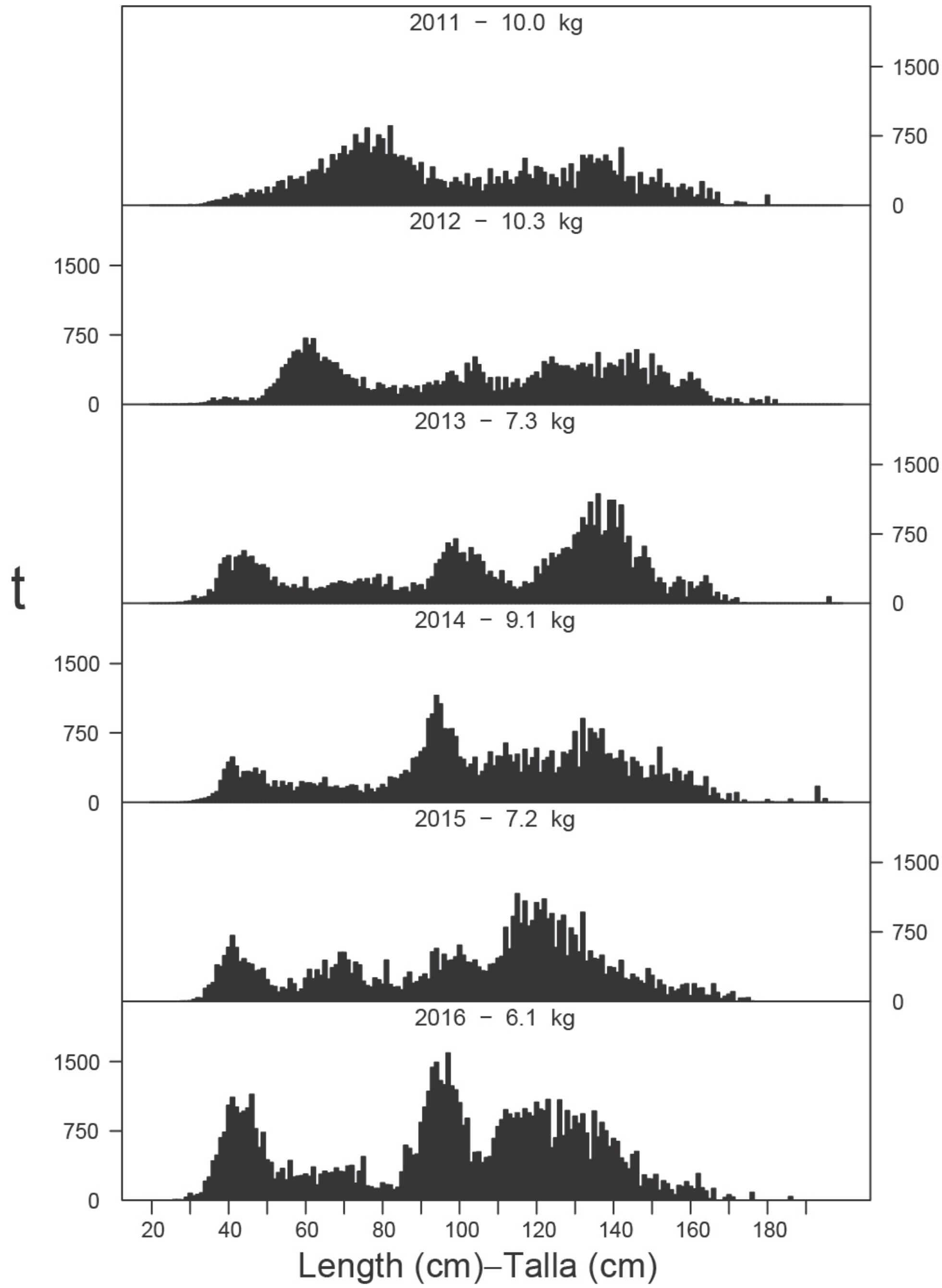

FIGURE 2b. Estimated size compositions of the yellowfin caught in the EPO during the third quarter of 2011-2016. The average weights of the fish in the samples are given at the tops of the panels. t = metric tons.

FIGURE 2b. Estimated size compositions of the yellowfin caught in the EPO during the tercer quarter of 2011-2016. The average weights of the fish in the samples are given at the tops of the panels. t = metric tons.

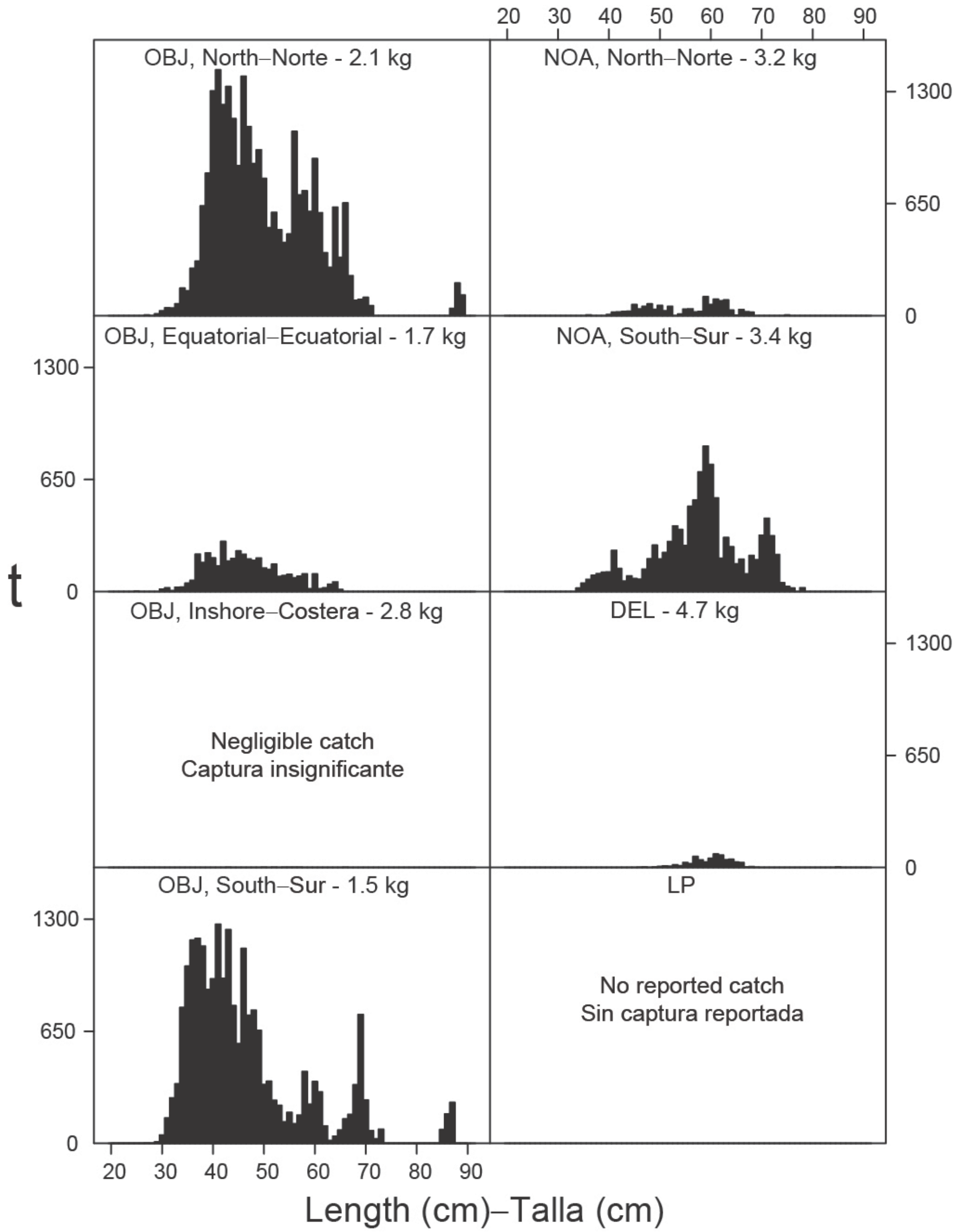

FIGURE 3a. Estimated size compositions of the skipjack caught in each fishery of the EPO during the third quarter of 2016. The average weights of the fish in the samples are given at the tops of the panels. OBJ = floating object; LP = pole and line; NOA = unassociated; DEL = dolphin; t = metric tons.

FIGURA 3a. Composición por tallas estimada para el barrilete capturado en cada pesquería del OPO durante el tercer trimestre de 2016. En cada recuadro se detalla el peso promedio de los peces en las muestras. OBJ = objeto flotante; LP = caña; NOA = peces no asociados; DEL = delfín; t = toneladas métricas.

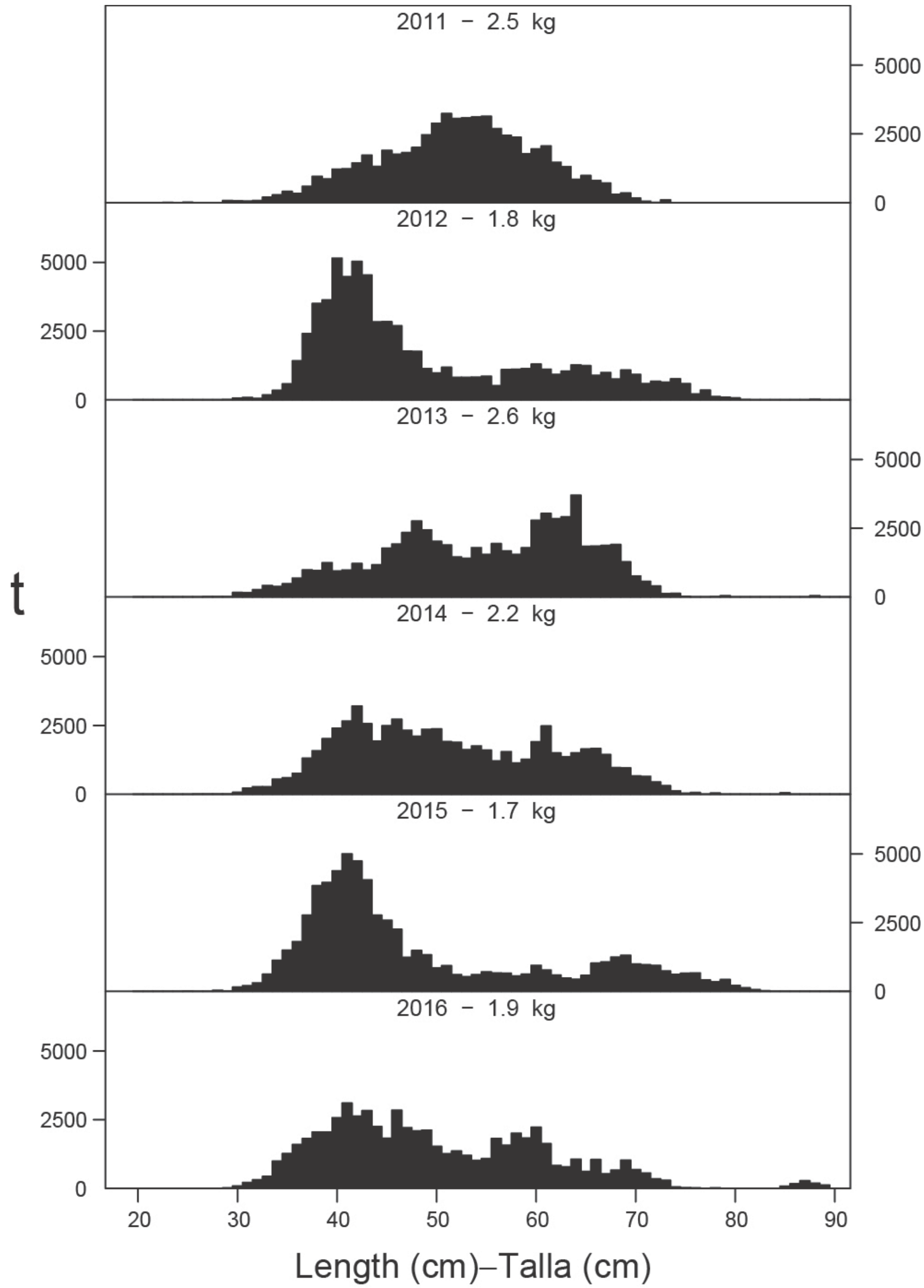

FIGURE 3b. Estimated size compositions of the skipjack caught in the EPO during the third quarter of 2011-2016. The average weights of the fish in the samples are given at the tops of the panels. t = metric tons.

FIGURA 3b. Composición por tallas estimada para el barrilete capturado en el OPO en el tercer trimestre de 2011-2016. En cada recuadro se detalla el peso promedio de los peces en las muestras. t = toneladas métricas.

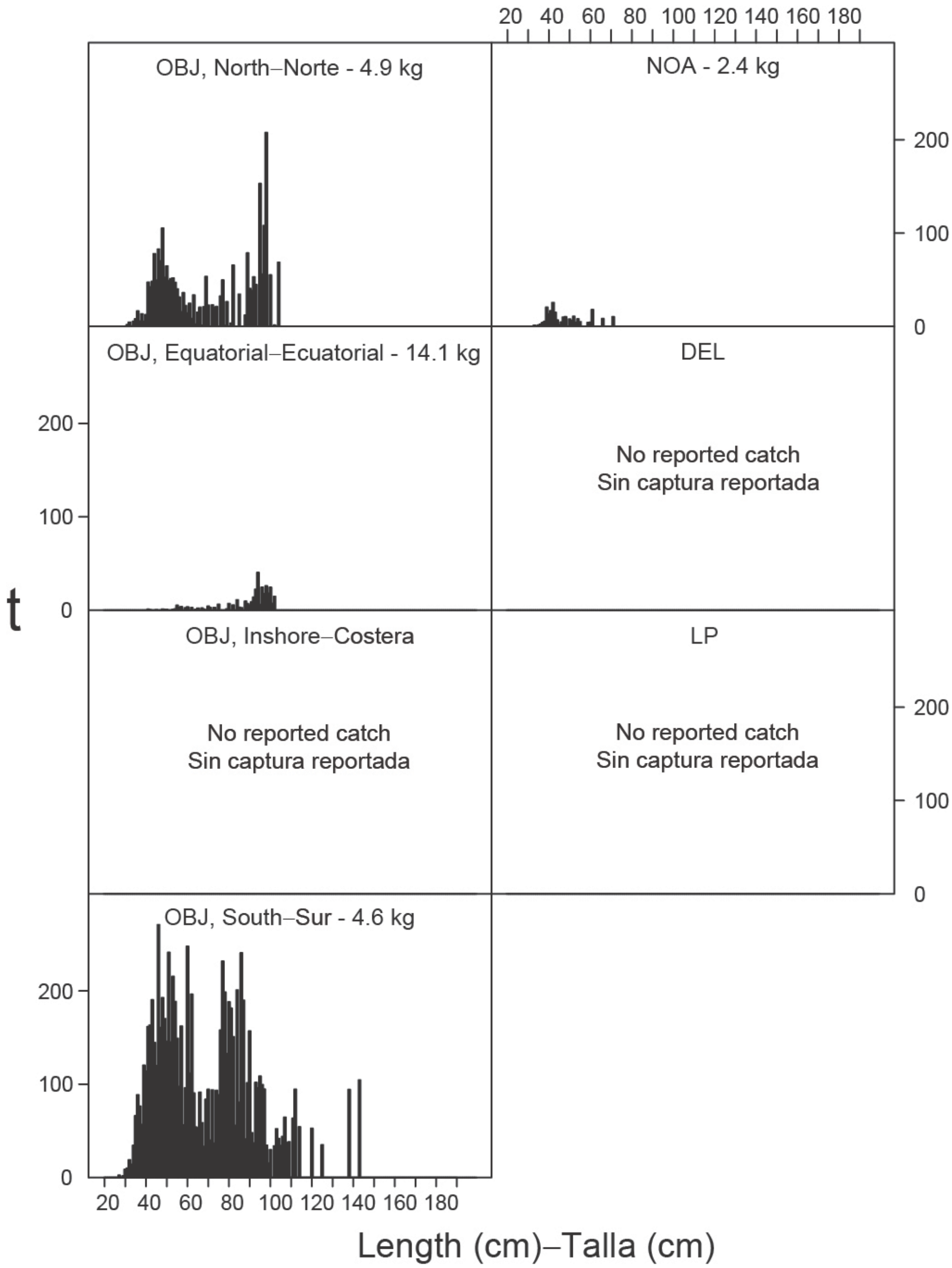

FIGURE 4a. Estimated size compositions of the bigeye caught in each fishery of the EPO during the third quarter of 2016. The average weights of the fish in the samples are given at the tops of the panels. OBJ = floating object; LP = pole and line; NOA = unassociated; DEL = dolphin; t = metric tons.

FIGURA 4a. Composición por tallas estimada para el patudo capturado en cada pesquería del OPO durante el tercer trimestre de 2016. En cada recuadro se detalla el peso promedio de los peces en las muestras. OBJ = objeto flotante; LP = caña; NOA = peces no asociados; DEL = delfín; t = toneladas métricas.

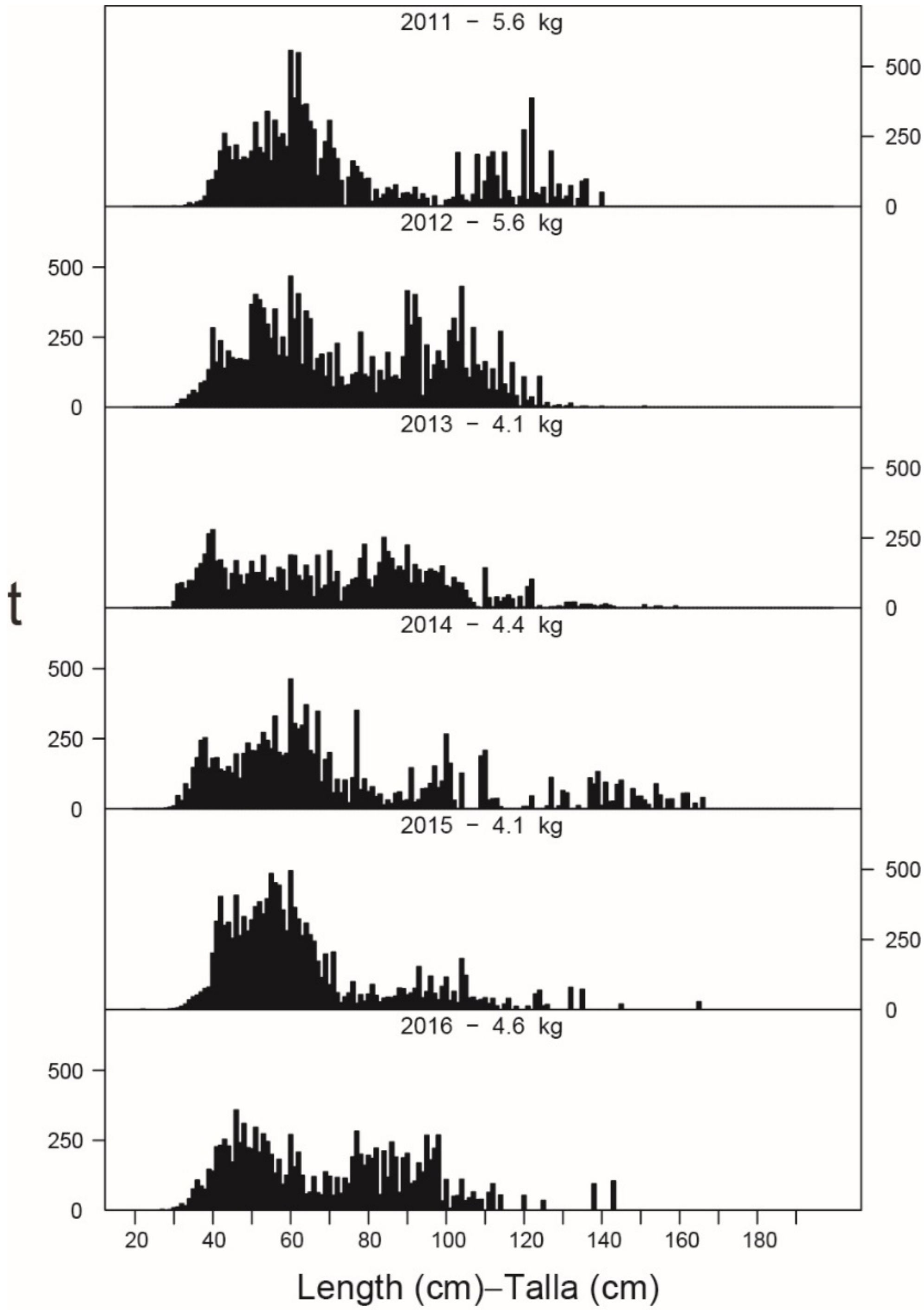

FIGURE 4b. Estimated size compositions of the bigeye caught in the EPO during the first quarter of 2011-2016. The average weights of the fish in the samples are given at the tops of the panels. t = metric tons.
FIGURA 4b. Composición por tallas estimada para el patudo capturado en el OPO en el tercer trimestre de 2011-2016. En cada recuadro se detalla el peso promedio de los peces en las muestras; t = toneladas métricas.

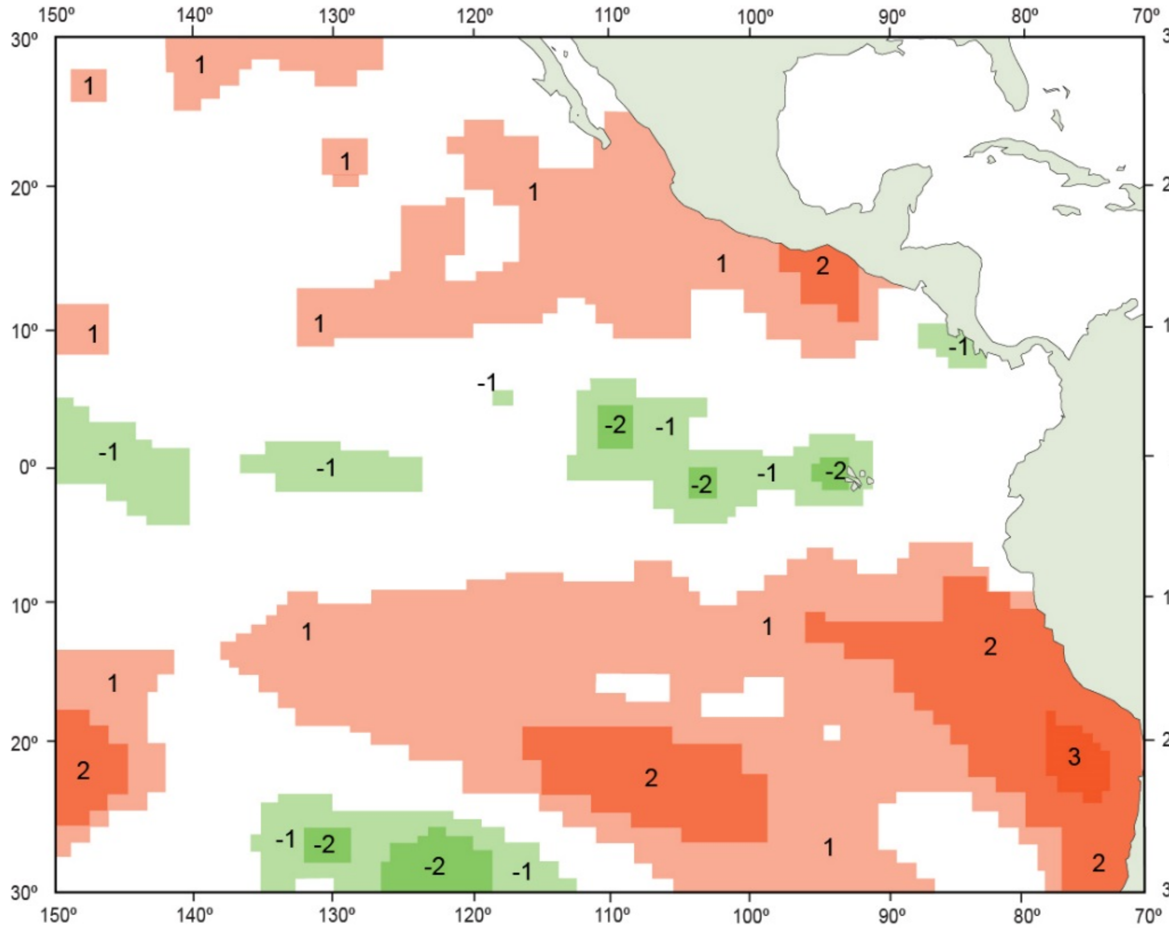

FIGURE 5. Sea-surface temperature (SST) anomalies (departures from long-term normals) for December 2016, based on data from fishing vessels and other types of commercial vessels.
FIGURA 5. Anomalías (variaciones de los niveles normales a largo plazo) de la temperatura superficial del mar (TSM) en diciembre de 2016, basadas en datos tomados por barcos pesqueros y otros buques comerciales.

TABLE 1. Estimates of the numbers and capacities, in cubic meters, of purse seiners and pole-and-line vessels operating in the EPO in 2016 by flag, gear, and well volume. Each vessel is included in the totals for each flag under which it fished during the year, but is included only once in the fleet total. Therefore the totals for the fleet may not equal the sums of the individual flag entries. PS = purse seine; LP = pole-and-line.

TABLA 1. Estimaciones del número de buques cerqueros y cañeros que pescan en el OPO en 2016 por bandera, arte de pesca, y volumen de bodega. Se incluye cada buque en los totales de cada bandera bajo la cual pescó durante el año, pero solamente una vez en el total de la flota; por consiguiente, los totales de las flotas no son siempre iguales a las sumas de las banderas individuales. PS = cerquero; LP = cañero.

Flag	Gear	Well volume–Volumen de bodega				Capacity
Bandera	Arte	1-900	901-1700	>1700	Total	Capacidad
			Number—Número			
Colombia	PS	4	10	-	14	14,860
Ecuador	PS	74	25	14	113	92,671
EU (España—Spain)	PS	-	-	2	2	4,120
Guatemala	PS	-	1	-	1	1,475
México	PS	10	38	1	49	60,146
Nicaragua	PS	-	5	2	7	10,648
Panamá	PS	2	9	4	15	21,174
Perú	PS	6	-	-	6	3,019
El Salvador	PS	-	-	2	2	4,473
USA—EE.UU.	PS	8	8	9	25	31,292
Venezuela	PS	-	13	2	15	21,448
All flags—	PS	104	108	36	248	
Todas banderas	LP	-	-	-	-	
	PS + LP	104	108	36	248	
			Capacity—Capacidad			
All flags—	PS	47,864	143,864	72,428	264,156	
Todas banderas	LP	-	-	-	-	
	PS + LP	47,864	143,864	72,428	264,156	

TABLE 2. Estimates of the retained catches of tunas in the EPO from 1 January through 31 December 2016, by species and vessel flag, in metric tons.

TABLA 2. Estimaciones de las capturas retenidas de atunes en el OPO del 1 de enero al 31 de diciembre de 2016, por especie y bandera del buque, en toneladas métricas**.**

Flag	**Yellowfin**	**Skipjack**	**Bigeye**	**Pacific Bluefin**	**Bonitos (*Sarda* spp.)**	**Albacore**	**Black skipjack**	**Other[1]**	**Total**	**Percentage of total**
Bandera	**Aleta amarilla**	**Barrilete**	**Patudo**	**Aleta azul del Pacífico**	**Bonitos (*Sarda* spp.)**	**Albacora**	**Barrilete negro**	**Otras[1]**	**Total**	**Porcentaje del total**
Ecuador	54,562	183,676	33,376	-	2,751	-	1,921	1,450	277,736	43.6
México	93,773	13,551	515	2,904	426	-	3,629	5	114,803	18.0
Nicaragua	10,900	2,102	589	-	-	-	-	-	13,591	2.1
Panamá	22,373	32,856	8,605	-	30	-	37	127	64,028	10.1
USA—EE.UU.	4,341	39,871	3,623	347	239	2	118	7	48,548	7.6
Venezuela	23,374	8,867	636	-	-	-	24	11	32,912	5.2
Other—Otros[2]	26,131	48,847	9,694	-	240	-	25	2	84,939	13.4
Total	235,454	329,770	57,038	3,251	3,686	2	5,754	1,602	636,557	

1 May include mackerel, other tunas, sharks, and miscellaneous fishes

1 Puede incluir caballas, otros túnidos, tiburones, y peces diversos

2 Includes Colombia, El Salvador, European Union (Spain), Guatemala and Peru; this category is used to avoid revealing the operations of individual vessels or companies.

2 Incluye Colombia, El Salvador, Guatemala, Perú y Unión Europea (España); se usa esta categoría para no revelar información sobre faenas de buques o empresas individuales.

TABLE 3. Reported catches of bigeye tuna in the EPO during 2016 by longline vessels.
TABLA 3. Capturas reportadas de atún patudo en el OPO durante 2016 por buques palangreros.

Flag	**Quarter**				**Month**			**Fourth quarter**	**Total**
	1	**2**	**3**	**1-3**	**10**	**11**	**12**		
Bandera	**Trimestre**				**Mes**			**Cuarto trimestre**	**Total**
	1	**2**	**3**	**1-3**	**10**	**11**	**12**		
China	1,779	1,328	2,005	5,112	734	867	563	2,164	7,276
Japan—Japón	3,548	2,036	2,111	7,695	1,102	1,298	1,112	3,512	11,207
Republic of Korea—República de Corea	2,238	789	1,005	4,032	908	1,096	995	2,999	7,031
Chinese Taipei—Taipei Chino	1,311	711	1,357	3,379	638	800	1,391	2,829	6,208
United States—Estados Unidos	-	-	-	-	-	-	-	-	-
Vanuatu	-	-	-	-	-	-	-	-	-
Total	8,786	4,864	6,478	20,218	3,382	4,061	4,061	11,504	31,722

TABLE 4. Oceanographic and meteorological data for the Pacific Ocean, January-December 2016. The values in parentheses are anomalies. SST = sea-surface temperature; SOI = Southern Oscillation Index; SOI* and NOI* are defined in the text.
TABLA 4. Datos oceanográficos y meteorológicos del Océano Pacífico, enero-diciembre 2016. Los valores en paréntesis son anomalías. TSM = temperatura superficie del mar; IOS = Índice de Oscilación del Sur; IOS* y ION* están definidas en el texto.

Month—Mes	**1**	**2**	**3**	**4**	**5**	**6**
SST—TSM (°C)						
Area 1 (0°-10°S, 80°-90°W)	25.9 (1.4)	26.8 (0.7)	27.6 (0.9)	25.8 (0.2)	24.6 (0.3)	23.2 (0.3)
Area 2 (5°N-5°S, 90°-150°W	28.2 (2.6)	28.4 (2.0)	28.7 (1.6)	28.3 (0.8)	27.1 (0.0)	26.3 (-0.1)
Area 3 (5°N-5°S, 120°-170°W)	29.2 (2.6)	29.1 (2.4)	28.9 (1.7)	28.9 (1.1)	28.2 (1.3)	27.5 (-0.1)
Area 4 (5°N-5°S, 150W°-160°E)	29.7 (1.4)	29.6 (1.5)	29.5 (1.3)	29.4 (0.9)	29.4 (0,6)	29.4 (0.5)
Thermocline depth—Profundidad de la termoclina, 0°-80°W	40	30	25	25	20	20
Thermocline depth—Profundidad de la termoclina, 0°-110°W	95	85	40	25	25	30
Thermocline depth—Profundidad de la termoclina, 0°-150°W	150	120	105	100	100	105
Thermocline depth—Profundidad de la termoclina, 0°-180°	115	80	75	130	140	150
SOI—IOS	-2.2	-2.0	-0.1	-1.2	0.4	0.6
NOI*—ION*	-6.94	0.82	-2.06	-1.14	0,27	1.56

TABLE 4. (continued)
TABLA 4. (continuación)

Month—Mes	**7**	**8**	**9**	**10**	**11**	**12**
SST—TSM (°C)						
Area 1 (0°-10°S, 80°-90°W)	21.8 (0.2)	2!.0 (0.4)	20.9 (0.5)	21.2 (0.4)	21.7 (0.1)	23.4 (0.5)
Area 2 (5°N-5°S, 90°-150°W	25.1 (-0.5)	24.5 (-0.5)	24.7 (-0.2)	24.5 (-0.4)	24.6 (-0.4)	24,8 (-0.4)
Area 3 (5°N-5°S, 120°-170°W)	26.7 (-0.5)	26.3 (-0.5)	26.1 (-0.6)	26.0 (-0.7)	26.1 (-0.6)	26.2 (-0.4)
Area 4 (5°N-5°S, 150W°-160°E)	29.1 (0.3)	28.7 (0.0)	28.5 (-0,2)	28.3 (-0.4)	28.3 (-0.4)	28.4 (-0.1)
Thermocline depth—Profundidad de la termoclina, 0°-80°W (m)	25	20	25	30	35	30
Thermocline depth—Profundidad de la termoclina, 0°-110°W (m)	25	40	30	55	45	50
Thermocline depth—Profundidad de la termoclina, 0°-150°W (m)	100	120	130	120	135	150
Thermocline depth—Profundidad de la termoclina, 0°-180° (m)	150	155	150	165	160	170
SOI—IOS	0.4	0.7	1.2	-0.3	-0.1	0.3
NOI*—ION*	1.75	0.40	3.80	-1.93	-0.49	2.52

TABLE 5. Preliminary data on the sampling coverage of trips of tuna purse seine vessels deployed by the observer programs of the IATTC, Colombia, Ecuador, the European Union, Mexico, Nicaragua, Panama, Venezuela, and under the MOC described above, departing during the fourth quarter of 2016. The numbers in parentheses indicate cumulative totals for the year.
TABLA 5. Datos preliminares de la cobertura de muestreo de viajes de buques atuneros de cerco asignados por los programas de observadores de la CIAT, Colombia, Ecuador, México, Nicaragua, Panamá, la Unión Europea, Venezuela y bajo el MDC descrito arriba, durante el cuarto trimestre de 2016. Los números entre paréntesis indican los totales acumulados para el año.

Flag	Trips		Class-6–Observed by program								Percentage observed	
Bandera	Viajes		Clase-6–Observado por programa								Porcentaje observado	
			IATTC CIAT		National Nacional		WCPFC		Not obs. No obs.			
Colombia	13	(45)	4	(21)	9	(24)					100.0	(100)
Ecuador	64	(350)	43	(231)	21	(119)					100.0	(100)
El Salvador	4	(14)	4	(14)							100.0	(100)
EU (Spain)—UE (España)	3	(13)	1	(6)	2	(7)					100.0	(100)
Guatemala	0	(4)	0	(4)							100.0	(100)
México	12	(212)	6	(102)	6	(110)					100.0	(100)
Nicaragua	5	(23)	2	(12)	3	(11)					100.0	(100)
Panamá	20	(76)	10	(38)	10	(38)					100.0	(100)
Perú	1	(21)	1	(20)					0	(1)	100.0	(95.2)
U.S.A.—E.U.A.	7	(54)	6	(40)			1	(12)	0	(2)	100.0	(93.3)
Venezuela	7	(45)	4	(26)	3	(19)					100.0	(100)
Total	136	(857)	81	(514)	54	(328)	1	(12)	0	(3)	100.0	(99.6)
Class – 4 – Clase												
Colombia	0	(1)	0	(1)	0	(0)					-	-
Ecuador	13	(18)	8	(12)	5	(6)					-	-
Total	13	(19)	8	(13)	5	(6)					-	-
Class – 5 – Clase												
Colombia	0	(3)	0	(1)	0	(2)					-	-
Perú	0	(4)	0	(4)							-	-
Total	0	(7)	0	(5)	0	(2)					-	-

PROBECUADOR Observed by program voluntarily sampling

							Class – 4 – Clase								
Ecuador	8	(10)	0	(0)	8	(10)								-	-
Total	8	(10)	0	(0)	8	(10)								-	-
							Class – 5 – Clase								
Ecuador	5	(9)	0	(0)	5	(9)								-	-
Total	5	(9)	0	(0)	5	(9)								-	-