

**INTER-AMERICAN TROPICAL TUNA COMMISSION**  
**WORKING GROUP ON ECOSYSTEMS AND BYCATCH**

**2<sup>ND</sup> MEETING**

La Jolla, California (USA)  
05-06 June 2024

**DOCUMENT EB-02-01**  
**ECOSYSTEM CONSIDERATIONS**

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**EXECUTIVE SUMMARY**

Over the past two decades, the scope of management of many fisheries worldwide has broadened to include the impacts of fishing on non-target species in particular, and the ecosystem more broadly. 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 society. In response to the increasing interest in EAFM by the IATTC with the adoption of the Antigua Convention, the staff has presented an *Ecosystem Considerations* report since 2003 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 eastern Pacific Ocean (EPO) ecosystem and its associated species. Specifically, information presented herein includes: (1) fisheries interactions (e.g., incidental catches of non-target species, generally termed “bycatch”, by broad taxonomic groups i.e., marine mammals, sea turtles, seabirds, elasmobranchs and teleosts), (2) a broad overview of the physical environment including short- (e.g., El Niño Southern Oscillation conditions) and long-term (e.g., Pacific Decadal Oscillation) environmental indicators, (3) tools for identifying potentially vulnerable species (e.g., the Ecological Assessment of Sustainable Impacts of Fisheries (EASI-Fish)), (4) ecosystem dynamics assessed through an eastern tropical Pacific Ocean (ETP) ecosystem model and corresponding ecological indicators, and (5) future developments for ecological research in the EPO to continue to guide science-based advice to the IATTC. It is important to note that data availability is poor for many bycatch taxa caught by fisheries other than the large vessel purse-seine fishery (class 6, >363 t), which has 100% observer coverage, such as the industrial longline fishery having a mandate of at least 5% observer coverage. Biological data is also lacking for many of these same species. This paucity in data has long been recognized by the staff (e.g., see [SAC-07-INF C\(d\)](#), [SAC-08-07b](#), [SAC-10 INF-B](#)). Consequently, recommendations by the staff for improvements in data collection and submission are underway (e.g., see [WSDAT-01](#) and [SAC-14 INF-Q](#) on longline data improvements, biological sampling ([SAC-14 INF-J](#)) and drafting an interim list of shark species under the purview of the IATTC (SAC-15-09)), which, if supported by the IATTC, will facilitate progress of science-based advice for guiding and implementing EAFM. Furthermore, a proposal to restructure the *Ecosystem Considerations* report into two ecosystem-advice products; an indicator-based ecosystem report card (“*EcoCard*”) and a complementary *Ecosystem Status Assessment* is presented in [EB-02-02](#) to improve IATTC’s communication of ecosystem status.

## 1. INTRODUCTION

The ecosystem approach to fisheries management (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 on 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 pertaining to tuna fishing activities, 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 IATTC’s inaugural 5-year Strategic Science Plan (SSP) implemented in 2019, the IATTC staff has conducted 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 (e.g., SAC-15 INF-E).

Assessing the ecological sustainability of EPO tuna fisheries is a significant challenge, given the wide range of species with differing life histories with which tuna fisheries interact. While relatively good information

is available for catches of tunas and tuna-like species throughout the Convention area, this is not the case for most non-target (i.e., “bycatch”) species, especially those that are less frequently encountered, 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 temporal 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 distributions of species to differing degrees, which in turn affects their potential to interact with tuna fisheries. At its 101<sup>st</sup> meeting, the IATTC adopted its first Resolution on climate change ([C-23-10](#)). As a result, a proposed workplan towards climate resilient fisheries will be presented at the 15<sup>th</sup> meeting of the Scientific Advisory Committee (SAC) to facilitate a better understanding of climate change and to prepare for potential predicted impacts on fisheries, target species, non-target species, and the broader EPO ecosystem (SAC-15-12).

Biological reference points, based on estimates of fishing mortality, spawning stock biomass, recruitment, and other biological parameters, have been used for conventional single-species management of target species, but the catch and/or biological data required for determining such reference points, or alternative performance measures, are unreliable or 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.

Due to the broadening array of ecological, environmental and fishery issues that are required to support EAFM of the EPO ecosystem, the length and complexity of this all-encompassing document has increased significantly in recent years to the extent that it is not optimal for succinctly conveying key messages to IATTC’s Cooperating Members and Non-members (CPCs), stakeholders and the wider public. Therefore, the staff now aim to restructure this report—considering ongoing work by the other tuna-Regional Fisheries Management Organizations (t-RFMOs)—into two complementary ecosystem-advice products: (1) an indicator-based Ecosystem Report Card or “EcoCard” highlighting a selected set of ‘key’ bycatch, ecosystem, and climate, indicators determined by the staff and through stakeholder consultation to best represent ecosystem status and (2) a complementary “Ecosystem Status Assessment” detailing the full suite of indicators considered to communicate the overall status of marine ecosystems and trends over time. A background paper ([EB-02-02](#)) details current efforts on EcoCards for the western and central Pacific Ocean by the Western and Central Pacific Fisheries Commission (WCPFC), the Atlantic Ocean by the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean by the Indian Ocean Tuna Commission (IOTC), along with a proposed workplan for IATTC to develop these ecosystem-advice products in support of EAFM. In the interim, the staff will continue to update the Ecosystem Considerations report.

## 2. DATA SOURCES

In this report, estimated total annual catches of bycatch species were obtained from observer data for the large-vessel purse-seine fishery<sup>1</sup>, nominal catches reported by the limited observer coverage onboard the small-vessel purse-seine fishery<sup>2</sup>, and gross annual removals by the longline fishery were obtained from annual summary reports (TASK I data, see [SAC-12-09](#), [WSDAT-01-01](#), [specifications for data provision](#)) submitted to the IATTC by CPCs. Minimum catches in 2022 reported by observers on longline vessels are also included as an interim measure until observer coverage increases from the mandated 5% to at least 20%—as recommended to the Commission by the scientific staff—that may allow total annual catches for some bycatch species to be reliably estimated. Currently, observer coverage for CPCs is not considered by staff to be representative of the activities of their longline fleets (see section 2.2. below and [BYC-10 INF-D](#)). Longline data were available through 2022 as the deadline for data reporting for the

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<sup>1</sup> Size class 6 purse-seine vessels with a carrying capacity > 363 t

<sup>2</sup> Vessels with a carrying capacity ≤363 t

previous year occurs after the annual SAC meeting (see Resolutions [C-03-05](#); [C-19-08](#)). However, some CPCs temporarily suspended their longline observer programs due to the COVID-19 pandemic, and therefore data for 2022 are not available for these CPCs, although data are expected for 2023 as observer programs resumed. Purse-seine data were available through 2023, with data from the last 2 years considered preliminary as of March 2024. Each data source and their associated data gaps is described in detail below. Additional information on bycatch data available by fishery can be found in, for example, documents [SAC-07-INF-C\(d\)](#) and [SAC-12-09](#).

## 2.1. Purse-seine

Data from the purse-seine fishery is compiled from 3 data sources: 1) IATTC and National Program observer programs, 2) vessel logbooks that are obtained by staff at the Commission’s field offices in Latin American tuna ports, and 3) canneries. 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 onboard for all trips for Class- 6 vessels since 1993. An historical perspective of bycatch data collection from the observer programs is described in [IATTC Special Report 25](#). Observers working in 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 exact fishing positions. 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 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 from this form is currently of little use for the purposes of the ecosystem considerations 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 purse-seine 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 these vessels to fish 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-11-11](#)), 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 J-8](#)) to provide rudimentary 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 2023, most trips (56%) made by smaller vessels were unobserved, 34% were from the voluntary TUNACONS observer program, 6% from the Ecuadorian National observer program, and 4% from the IATTC 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))<sup>3</sup>. The numbers of sets for each type made in the EPO during 2008–2023 are shown in Table A-7 of Document [SAC-15-01](#).

Despite the observer requirement for 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<sup>3</sup> to account for such instances.

## 2.2. Longline

The considerable variability in reporting formats of longline data has hindered the staff's ability to estimate EPO-wide catches for bycatch species ([SAC-08-07b](#), [SAC-08-07d](#), [SAC-08-07e](#), [BYC-10 INF-D](#)). Bycatch data for longline fisheries reported herein were obtained using data of gross annual removals estimated by each CPC and reported to the IATTC in summarized form (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 1993–2022. A staff-wide collaboration is underway to provide recommendations for updating 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, especially those explicitly listed as being under the purview of the IATTC (SAC-15-09). 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](#)). The workshop report has also been posted to the IATTC website ([WSDAT-01-RPT](#)) and a series of staff recommendations were revised based on participant feedback (see [SAC-14 INF-Q](#)). In 2023, the SAC, in general terms, endorsed the recommendations on tunas presented by the staff in [SAC-14-14](#) (see [SAC-14-16](#), paragraph 1d, paragraph) as well as a recommendation that the Commission review and update Resolution C-03-05 on "Data Provision", taking into consideration document [SAC-14 INF-Q](#) ([SAC-14-16](#), paragraph 7.1 Resolution C-03-05). Therefore, the importance of updating this resolution is reiterated in SAC-15-13 and encourages CPCs to update C-03-05 to better align data provision and submission requirements with the Antigua Convention's mandate to include non-target, dependent and associated species, and the effects of the fishery on the ecosystem.

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<sup>3</sup> The observed data is aggregated by species, year, flag and set type. The number of known unobserved sets is taken from logbooks and other sources. Additionally, there are known EPO trips for which the staff do not know the number and type of sets made. Therefore, known bycatch-per-day from observer data is calculated by species, year, flag and set type, and applied to the number of days-at-sea for each trip to estimate the bycatch.

In some instances, there may be unobserved sets or days-at-sea data by a flag that have no equivalent observer data for that year to facilitate a reliable estimation of catch. For these trips, yearly data from a proxy flag is used. The proxy flag is determined by subsequent 5 trips made by the vessel where an observer was onboard, and adopting the predominant flag used for those trips as the proxy flag. Then the bycatch-per-set or day of the known proxy flag for the year in question is applied to the data for the unrepresented flag.

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. 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, attributing the catch 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, but under coverage by observers was exacerbated by the challenges many CPCs had in placing observers during the COVID-19 pandemic, which continued to impact at least one longline observer program in 2022. The program resumed in 2023 and observer data is expected to be included in next year’s *Ecosystem Considerations* report once data for 2023 become available. The IATTC staff, the Ecosystems and Bycatch Working Group (EBWG) and the Scientific Advisory Committee (SAC) have continued to recommend that the longline observer coverage requirement should be increased to at least 20%. IATTC staff discussed the inadequacy of 5% coverage for scientific purposes and the representativeness of the data to adequately describe the activities of longline fleets in the EPO ([BYC-10 INF-D](#)). Although CPCs have made a tremendous effort to improve 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 considerably less reliable given that less data are available for these species. 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](#), [SAC-14 INF-Q](#)) 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-15-01](#). The staff has developed [stock assessments](#)—including benchmark assessments for bigeye tuna (SAC-15-02), yellowfin tuna (SAC-15-03) and skipjack tuna (SAC-15-04)—and/or stock status indicators (SSIs) for tropical tunas ([SAC-15 INF-F](#)). An evaluation of current conservation and management measures (CMMs) is provided in SAC-15-05 while proposed CMMs are provided in SAC-15-06. Additionally, harvest strategy work and initial results for the management strategy evaluation (MSE) for bigeye tuna (SAC-15-08) will be presented at the 15<sup>th</sup> meeting of the SAC and an investigation of fishing strategies related to the individual vessel threshold (SAC-15 INF-K) will be available. An investigation on environmental effects on the 2022–2023 tropical tuna catches will be provided (SAC-15 INF-L). The staff has also collaborated on the assessments of [Pacific bluefin](#) (2022 and 2023) and north Pacific [albacore](#) (2023) 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](#) (2023), western and central North Pacific [striped marlin](#) (2023), [blue marlin](#) (2021), and shortfin mako (2022–2024). 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*), frequently co-occur 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 using this method 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](#); [Figure J-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. Additionally, the staff has co-organized a 2<sup>nd</sup> workshop on methods to monitor the status of dolphins in the EPO in May 2024 (see details [here](#)).

Estimates of incidental mortality of dolphins in the purse-seine fishery of large vessels during 1993–2023 are shown in [Table J-1a](#). In 2023, the stock of dolphins with the highest incidental mortality was the eastern spinner (n=274), followed by the western-southern spotted (n=195), the whitebelly spinner (n=178), and northeastern spotted dolphins (n=115). Common dolphins were least impacted by the fishery, with mortalities of 26 central, 7 southern, and 29 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 2022 ([Table J-1b](#)). Interactions and mortalities were defined by subjective classification of fate (injured, discarded, released, or not reported) and release condition (alive, alive and healthy, alive and injured, dead, or not reported) as recorded by observers. Dispositions not reported or reported as discarded were precautionarily assumed to represent mortalities. Under these assumptions, 61 of the 67 marine mammals reported by observers in 2022 for the EPO were considered to be mortalities. Unidentified dolphins (Delphinidae) were reported to have interacted the most (39 interactions, 34 mortalities), followed by the bottlenose dolphin (18 interactions, 17 mortalities), while ≤2 marine mammal interactions were reported for the remaining 8 taxa, all resulting in 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, although the impact of this is expected to be low due to improved FAD construction and design requirements ([C-23-04](#) and [C-23-05](#)).

The number of estimated sea turtle mortalities and interactions recorded by observers on large purse-seine vessels, by set type, from 1993–2023 is shown in [Figure J-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 21,974 interactions and 951 mortalities (~4%) during 1993–2023, but only 124 interactions and no mortalities occurred in 2023 ([Table J-2a](#)). In 2023, there were 21 interactions recorded with eastern Pacific green, 14 loggerhead, 4 hawksbill, 5 leatherback, and 101 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](#)), but has been improving since 2019 with the submission of operational-level observer data 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 2022 are considered minimum numbers of interactions and mortalities ([Table J-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. Observers reported 58 interactions of sea turtles in the EPO (26 Olive Ridley, 13 black/green turtles, 9 loggerhead, 7 leatherback and 3 hawksbill) for 2022 and 15 of these interactions (mostly loggerhead, 60%) 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 13<sup>th</sup> 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 11<sup>th</sup> Bycatch Working Group meeting in May 2022, the 1<sup>st</sup> EBWG meeting in May 2023 and are expected to continue at the 2<sup>nd</sup> EBWG meeting in May 2024.

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 conservation and 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 the fishing effort dynamics of all EPO fisheries do not change. 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 a successful collaboration between two international 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](#)) and draft guidelines for best handling and release practices (BHRP) of seabirds were presented to the 1<sup>st</sup> EBWG meeting in 2023 ([EB-01-01](#), Annex 1). 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.

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 2022 are available ([Table J-3](#)) (but see section 2.2 for uncertainties and data gaps in reported data).

The observer data submitted by CPCs for 2022 contained 70 interactions (69 mortalities) with seabirds in the EPO with dispositions recorded as “discarded”, “injured”, “released” or not recorded. Dispositions not recorded were precautionarily presumed to indicate a mortality due to incomplete disposition data. With these limited data, boobies and gannets in the family Sulidae were reported to have interacted the most with the gear (n=31; 44% of all interactions), followed by the black-footed albatross, *Phoebastria nigripes* (n=19; 27%), and the grey petrel, *Procellaria cinerea* (n=4; 6%) with the other seabird interactions (9 taxa) being <5% of all interactions. 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. To mitigate the impacts of fishing on sharks, guidelines for best handling and release practices (BHRP) in IATTC fisheries are presented in SAC-15-11, as requested under Resolution [C-23-07](#). Recommendations based upon measurable improvements to post release survival rates include: avoiding shark interactions, releasing entangled sharks promptly, and minimizing handling time onboard for purse-seine fisheries, and leaving sharks in the water, removing trailing gear, and minimizing handling stress to improve post-release survival for longline fisheries. A workplan towards the adoption of BHRP guidelines for all vulnerable taxa will be presented at the 2<sup>nd</sup> EBWG meeting (EB-02-03).

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-A](#), [EBWG-01 INF-A](#)), blue (*Prionace glauca*) ([ISC Shark Working Group](#)), shortfin mako (*Isurus oxyrinchus*) ([ISC Shark Working Group](#)), and common thresher (*Alopias vulpinus*) ([NMFS](#)). As part of the [FAO Common Oceans Tuna Project](#), Pacific-wide assessments of the porbeagle shark (*Lamna nasus*) in the southern hemisphere (Clarke 2017) and the bigeye thresher shark (*Alopias superciliosus*) (Fu *et al.* 2018) were completed in 2017, and for the silky shark (Clarke 2018a) in 2018, as well as a risk assessment for the Indo-Pacific whale shark population (Clarke 2018b), also in 2018. Whale shark interactions with the tuna purse-seine fishery in the EPO are summarized in document [BYC-08 INF-A](#).

The 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](#)). 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 staff 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](#)). At its 101<sup>st</sup> meeting, the IATTC adopted Resolution [C-23-07](#), which includes a provision for IATTC staff to draft, in collaboration with the EBWG and the SAC, an interim list of shark species for the consideration by Members to be under the purview of the Commission. A list of 49 species documented to interact with pelagic fisheries in the EPO was used in combination with other available species lists, ecological characteristics and conservation classifications by international instruments (e.g., IUCN Red List of Threatened Species) to provide potential recommendations from the staff for an interim list of shark species (see SAC-15-09).

Catches (t) of sharks in the large-vessel purse-seine fishery (1993–2023) and minimum reported catch estimates<sup>4</sup> by longline fisheries (1993–2022) are provided in [Table J-4a](#), while catches of the most frequently caught species, discussed below, are shown in [Figure J-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). For purse seiners, the majority of the shark catch is from floating object sets. Silky shark (family Carcharhinidae) is the most commonly caught shark species in the purse-seine fishery with annual catches averaging 555 t—primarily from sets on floating objects ([Figure J-3a](#))—and being 514 t in 2023. In contrast, minimum reported annual catch in the longline sample data for 2006–2022 averaged 10,057 t while only 37 t were reported in 2022. Annual catch of the oceanic whitetip shark (Carcharhinidae) in the purse-seine fishery averaged 55 t (also primarily from sets on floating objects) and was 13 t in 2023. The minimum reported annual catch in the longline fishery from 2006–2018 averaged 165 t and none were reported in 2019–2022. 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 J-3](#)). Minimum annual reported catch of blue shark in the longline fishery from 1993–2022 averaged 6,368 t and was 10,052 t in 2022. By contrast, the annual catch in the purse-seine fishery averaged only 2 t, with 1 t caught in 2023. Some anomalies in the reporting of longline data are likely related to the COVID-19 pandemic or variability in reporting certain species or information, although it’s important to note the reporting of bycatch data

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<sup>4</sup> 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](#)).

is not compulsory according to the data provision resolution ([C-03-05](#)) and the corresponding [specifications](#) (see [SAC-12-09](#), [WSDAT-01-01](#), [SAC-14 INF-Q](#)). Additionally, a list of shark species under the purview of the Commission has not yet formally been established (see SAC-15-09), which contributes to the variability in reporting for fisheries other than the large purse-seine fishery. The staff reiterate the importance of updating C-03-05 to adapt to mandates set forth in the Antigua Convention and encourage CPCs to draft a revised resolution based on input from the staff and workshop participants in [SAC-14 INF-Q](#) (see SAC-15-13). These efforts are expected to reduce variability in data reporting.

Other important species of sharks caught in the purse-seine and longline fisheries include the smooth hammerhead (*Sphyrna zygaena*), the pelagic thresher (*Alopias pelagicus*), and mako sharks (*Isurus* spp.) ([Table J-4a](#), [Figure J-3a](#)). Catch estimates for the smooth hammerhead shark in the purse-seine fishery averaged 25 t (primarily caught in floating-object sets) and was 16 t in 2023, while in the longline fishery minimum annual reported catch averaged 848 t (2006–2022) and was 7 t in 2022. In contrast, the pelagic thresher was caught primarily in unassociated tuna school sets by the purse-seine fishery with the estimated annual catch averaging 4 t and was 3 t in 2023. Minimum annual reported catch of the pelagic thresher by the longline fishery averaged 1,808 t (2007–2022) and only 4 t was reported in 2022. Catch estimates for the mako sharks by the purse-seine fishery were lower than the aforementioned shark species averaging 3 t and was 1 t in 2023. However, in the longline fishery the minimum annual reported catch averaged 1,439 t (1993–2022) and was 1,324 t in 2022.

Complementary to the shark catches presented in [Figure J-3a](#) and similar to the purse-seine based SSIs reported by set type for the tropical tunas ([SAC-15 INF-F](#)), catch by set type was scaled so that their average equals 1 during the 1993–2023 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 J-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 whitetip shark, a decreasing trend in relative catches is apparent for all set types with the highest relative catches occurring prior to 2000. The relative catches of smooth hammerhead sharks were variable, particularly in dolphin and unassociated sets; about 4 and 5 times greater than the mean in dolphin sets and in unassociated sets in 2004, respectively.

The spatial distribution (in 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 J-3c](#) to provide an indication of current (i.e., 2023) and past (average of the last 5 years; 2018–2022) spatial catch dynamics. Catches of silky shark were widely distributed across the EPO, but primarily in the 10°N to 10°S latitudinal band, occurred mostly in floating-object sets and catches were slightly higher east of about 120°W in 2023 compared to the 5-year average between the equator and 10°N. Catches of oceanic whitetip shark and smooth hammerhead shark were negligible (i.e., primarily <1 t) in both time periods and their catch distributions were reduced in 2023 compared to the 5-year average. Minimal catches of oceanic whitetip were observed south of the equator and west of 140°W in 2023, primarily in floating object sets, with no catches >1 t in the 5-year average. For the smooth hammerhead shark, minimal catches were observed east of 100°W along the equator and off South America in 2023 while only two locations (~7°S and 87°W; ~2°N and 97°W) had catches slightly above 1 t during the 5-year average.

The limited observer data from small purse-seine vessels showed 30 t of silky shark, 3 t of scalloped hammerhead and 3 t of smooth hammerhead were caught in floating-object sets in 2023, while catches of other shark species or species groups (7 taxa) were minimal (≤ 1 t) ([Table J-8](#)).

The minimum catches derived only from observer data for sharks caught by longline in 2022 are presented

in [Table J-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 nearly 17,000 interactions in 2022 (98% of interactions resulted in mortalities), followed by silky shark with nearly 3,000 animals (99% resulting in mortalities). Under the disposition criteria described in [Table J-4b](#), 97% of 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 Acuicola 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 the 14<sup>th</sup> meeting of the SAC ([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-GEF 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.

### 3.6. RAYS

To better represent estimated annual catches of manta rays (Mobulidae) and stingrays (Dasyatidae), these taxa are now reported in numbers of individuals by the large-vessel purse-seine fishery (1993–2023) in [Table J-5a](#), while catches of key species are shown in [Figure J-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 J-5b](#)). The largest average catches in the purse-seine fishery were observed for unidentified mobulid rays (Mobulidae spp., average 1993–2023: 1,198 individuals; number of individuals in 2023: 214), followed by the pelagic stingray (average: 874; 2023: 549), the smoothtail manta (average: 340; 2023: 127), the spinetail manta (average: 242; 2023: 68), unidentified stingrays (Dasyatidae spp., average: 207; 57) and the giant manta ray (average: 115; 2023: 10 individuals). 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 J-4a](#)).

Similar to 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 are provided in [Figure J-4b](#). As with the reported observed catch ([Figure J-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 cells) was greatest for pelagic stingray with most catches occurring primarily in floating-object sets south of ~5°N and east of 120°W and in dolphin sets north of 5°N for 2023, while catches for the 5-year average (2018–2022) by set type were variable ([Figure J-4c](#)). Minimal catches of the spinetail manta, smoothtail manta and giant manta were observed across space and time with most catches being less than 5 individuals per spatial area.

For the small purse-seine vessel fishery, the limited observer data available for 2023 showed floating-object sets contained the largest numbers of individual ray species, including the pelagic stingray (n=30), followed by the Chilean devil ray (n=13) and the spinetail manta (n=6), while the number of other rays were <5 ([Table J-8](#)).

The minimal data available from the reported longline observer dataset for 2022 (see section 2.2. for data gaps and [BYC-10 INF-D](#)) showed that the most interactions were with the pelagic stingray (*Pteroplatytrygon violacea*) (4,327 individuals) with 3,936 (91%) of these interactions resulting in mortalities, followed by unidentified manta rays (*Mobula* spp.) with 74 interactions (73 mortalities, 99%), giant manta with 41 interactions (36 mortalities, 88%), and the spinetail manta (2 interactions, no mortalities) ([Table J-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  $F/F_{40\%}$  and  $SBR/SBR_{40\%}$  biological reference points, leading to a vulnerability 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 of catches vary between purse-seine and longline fisheries. Large pelagic fishes caught by the large-vessel purse-seine fishery, primarily in floating-object sets, (1993–2023) and longline (1993–2022) fisheries are shown in [Table J-6a](#), with time series of catches of key species presented in [Figure J-5](#). The most commonly-caught pelagic fish in both fisheries is dorado (Coryphaenidae) with the estimated average annual catch for the purse-seine fishery being 1,359 t (1,472 t in 2023) and the minimum reported annual catch for the longline fishery averaging 5,643 t (725 t in 2022). 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 the 10<sup>th</sup> meeting of the SAC ([SAC-10-11](#)). Additionally, a Resolution ([C-23-09](#)) on the research for the management of dolphinfish was adopted at IATTC’s 101<sup>st</sup> Commission meeting in 2023.

Other key species caught by the purse-seine fishery include wahoo (Scombridae) and rainbow runner (Carangidae). Wahoo had an estimated average annual catch of 359 t for the purse-seine fishery, although catches have declined from a peak of 1,025 t in 201 to 267 t in 2023 ([Figure J-5](#)). Minimum reported annual catch of wahoo by the longline fishery have averaged 170 t and was 177 t in 2022. 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 46 t, with the peak catch in 2007 at 158 t and declining thereafter to 44 t in 2023 ([Figure J-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 364 t (1993–2022), 360 t (2006–2022), and 53 t (1993–2022), respectively. Catches of all these taxa have increased after the mid-2000s ([Figure J-5](#)) but note the uncertainty and data gaps in this dataset (section 2.2). For the most recent year (2022), there were 223 t, 194 t, and 53 t of opah, snake mackerels, and pomfrets reported, respectively ([Table J-5a](#)).

The limited observer data available for 2023 for the small purse-seine fishery included 268 t of dorado and 36 t of wahoo caught in floating-object sets, while the remaining species or species groups of large fishes (7 taxa) had <5 t reported ([Table J-8](#)).

For 2022, the minimal available data from longline observers (see section 2.2. and [BYC-10 INF-D](#)) is provided in [Table J-6b](#). These data show the most frequently caught species in this dataset was the long snouted lancetfish (*Alepisaurus ferox*) with nearly 14,000 interactions (13,599 mortalities), followed by escolar (*Lepidocybium flavobrunneum*) with 6,110 interactions (6,036 mortalities), dorado (Corpyhaenidae) with 4,439 interactions (all resulted in mortalities), opah (3,169 interactions, 3,166 mortalities), snake mackerel (2,967 interactions, 2,923 mortalities), and pomfrets (2,036 interactions, 2,033 mortalities). The remaining 13 taxa had <2000 interactions. Most interactions with large fishes resulted in mortalities (99%).

### 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 J-7](#) with key species as identified by catch data presented in [Figure J-6](#) for the large-vessel purse-seine fishery.

Bullet and frigate tunas (Scombridae) are by far the most commonly reported forage species with estimated annual catches averaging 1,008 t from 1993–2023. However, their catches have declined from 1,921 in 2005 to 597 t in 2023 ([Figure J-6](#)). Triggerfishes (Balistidae) and filefishes (Monacanthidae) are the second most commonly reported forage group with annual estimated catches averaging 271 t and totaling 522 t in 2023. Combined catches for these two groups peaked in 2004 at 922 t but have otherwise been variable. Annual catches of sea chubs (Kyphosidae) have averaged 16 t and have remained minimal with 12 t in 2023. Lastly, annual catches of the various species in the category ‘epipelagic forage fishes’ averaged 7 t with 8 t estimated to be caught in 2023.

A total of 253 t of bullet and frigate tunas and 122 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 2023. Catches of all other species or species groups (4 taxa) of small fishes were minimal ( $\leq 2$  t) ([Table J-8](#)).

## 4. PHYSICAL ENVIRONMENT

Environmental conditions affect marine ecosystems and therefore impact species distributions and abundance, the dynamics and catchability of target and bycatch species, and the activities of fishers<sup>5</sup> (e.g., [SAC-10 INF-D](#)). At IATTC’s 101<sup>st</sup> meeting in 2023, a resolution on climate change was adopted ([C-23-10](#)), and correspondingly, a proposed workplan towards climate resilient fisheries will be presented at the 2<sup>nd</sup> EBWG meeting and the 15<sup>th</sup> meeting of the SAC (SAC-15-12). 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, 2023.

### 4.1. Environmental indicators

The ocean environment changes on a variety of time scales, from seasonal to inter-annual, decadal, and longer “regimes”. Longer-term climate-induced changes are typically decadal at intervals of around 10–

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<sup>5</sup> 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.

30 years and are characterized by relatively stable average conditions and patterns in physical and biological variables. 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 alternate phase is commonly called La Niña and 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 of commercially-important tunas and billfishes to capture by tuna fleets 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](#)). Analyses on the potential effects of environment on tuna catches are underway (SAC-15 INF-L).

The [Climate Diagnostics Bulletin](#) of the US National Weather Service reported that in 2023 anomalies—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 in January, ENSO neutral conditions from February through April and El Niño conditions from May through December.

Indices of variability in such conditions are commonly used to monitor the direction and magnitude of ENSO events in the Pacific Ocean. The Oceanic Niño Index (ONI) is 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 J-7a](#)). Therefore, the ONI is used in this report 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 J-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. “Strong” to “very strong” El Niño conditions persisted for the latter half of 2023 with values ranging from 0.8 to 2.0 during this time period ([Figure J-7b](#)).

The Pacific Decadal Oscillation (PDO; [Figure J-8](#)) index is used to describe longer-term environmental fluctuations in the Pacific Ocean. In the EPO, it has been used to explain the influence of environmental drivers on the vulnerability of some species, such as the silky shark, to capture by tuna fleets (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 2023, cool conditions persisted with values ranging from -2.47 to -0.95 (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 J-9](#)) in the eastern tropical Pacific (ETP) from 5°N to 5°S—the same latitudinal band used in the ONI—was developed to explore the variability in these variables across space and time using time-longitude Hovmöller diagrams. The SST time series show mean monthly values from 1993–2023, while monthly CHL-a concentrations covers data for 2003–2023 due to limitations with data availability. The SST plot ([Figure J-9, top panel](#)) clearly shows the extension of warmer waters during the extreme El Niño events of 1997–1998, 2015–2016, and for the latter half of 2023 while cooler waters are observed during the strong La Niña events in 1999–2000, 2007–2008 and 2010–2011 across the ETP. The CHL-a plot ([Figure J-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 strongly influence the habitat and distributions of oceanic animals (Hobday and Hartog 2014).

[Figures J-10 and J-11](#) show quarterly mean SSTs and CHL-a concentrations, respectively, to: 1) provide a general indication of seasonal environmental variability for 2023, 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 2023. In future, the staff plans to incorporate catch distributions for 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 vulnerable bycatch species, including oceanic whitetip, silky and hammerhead sharks.

Warm waters prevailed over much of the EPO during 2023, with the exception of the northern and southern extremities of the Convention Area where cooler waters occurred ([Figure J-10](#)). A warm pool off Central America was observed in quarter 1 that extended westwards during quarters 2 and 3 and retracted slightly 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 with minimal contraction in quarters 3 and 4.

[Figure J-11](#) shows CHL-a concentrations were highest along the equator and the coast of the Americas year-round. The oligotrophic<sup>6</sup> South Pacific Gyre—located between 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. J-10](#)), where CHL-a concentration was high ([Fig. J-11](#)). Yellowfin tuna was the predominant tuna species in the catch primarily north of the equator during these same quarters; yellowfin catches were present in the warmer waters (~29°C) off central America in quarter 2 but were low in this region of warmer water during quarters 3 and 4. Bigeye tuna catches mostly occurred south of 10°N with greater catches taken west of ~110°W, particularly in quarters 2 and 3. No tuna catches were recorded in the

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<sup>6</sup> An area of low productivity, nutrients, and surface chlorophyll, often referred to as an “oceanic desert”.



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 required for single-species assessments are lacking. An alternative for such data-limited situations, reflected in [Goal L](#) of the SSP, are Ecological Risk Assessments (ERAs), assessments that are designed to identify and prioritize potentially vulnerable 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 instantaneous 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.,  $F_{MSY}$ ,  $SPR_{40\%}$ ).

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’ assessment 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 East Pacific regional management unit (RMU) of the Critically Endangered leatherback turtle (*Dermochelys coriacea*) ([BYC-10 INF-B](#), [BYC-11-02](#)). Therefore, EASI-Fish will be used in future to assess the vulnerability of all species groups (e.g., elasmobranchs, sea turtles, teleosts) impacted by EPO tuna fisheries. In 2022, EASI-Fish was used to assess the vulnerability of the East Pacific leatherback turtle RMU and shark bycatch species in EPO tuna fisheries and the results were presented at BYC-11 ([BYC-11-02](#)) and SAC-13, respectively ([SAC-13-11](#)). An EASI-Fish assessment for silky shark and hammerheads was presented at SAC-14, where the potential efficacy of 43 different conservation and management measures was simulated ([SAC-14-12](#)). The simulations showed that almost all CMMs were effective in reducing vulnerability, such as banning wire traces, imposing a 100 cm total length minimum retention length for all sharks, and prohibiting landing of all sharks. However, the positive effects of these measures were negated in most scenarios due to high post-release mortality of these species. These results highlighted that the most effective conservation measure for sharks is to avoid interaction with EPO fisheries.

## 6. ECOSYSTEM DYNAMICS

Although vulnerability assessments (e.g., EASI-Fish) are useful for assessing the ecological impacts of fishing by assessing the populations of individual species, ecosystem models are required to detect changes in the structure and internal dynamics of an ecosystem. These models are generally data- and labor-intensive to construct, and consequently, few fisheries worldwide have access to a reliable ecosystem model to guide conservation and management. 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 J-12](#).

The model was calibrated to time series of biomass and catch data for yellowfin and bigeye tunas 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 (“ETP-8”). 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 ( $TL_{2.0}$ ),  $\geq 3.25$ –4.0 ( $TL_{3.5}$ ), and  $> 4.0$  ( $TL_{4.0}$ ). A full description of these indicators is provided in [SAC-10-14](#).

ETP-21 was updated in 2024 (named ETP-24) using annual catch estimates by species for 1993–2022 assigned to the relevant functional groups, which was then rebalanced to provide an updated ecosystem status for 2022.

Ecological indicators showed that values for  $TL_c$  and MTI decreased from their peak of 4.77 and 4.83 in 1991 to 4.66 and 4.69 in 2022, respectively, as the purse-seine fishing effort on floating objects (OBJ) significantly increased ([Figure J-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 0.170 of a trophic level in the subsequent 30 years, or 0.057 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  $TL_{MC4.0}$  community was at one of its highest values (4.493) in 1986 but has continued to decline to 4.467 in 2022 ([Figure J-13](#)). As a result of changes in predation pressure on lower trophic levels, between 1993 and 2022 the biomass of the  $TL_{MC3.25}$  community increased from 3.801 to 3.829, while interestingly, the biomass of the  $TL_{MC2.0}$  community also increased

from 3.092 to 3.107.

Together, these indicators show that the ecosystem structure has likely changed over the 43-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 floating-object 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 increasing beyond pre-pandemic levels in 2022 when the number of floating-object sets increased significantly to 17,699 ([Figure J-13](#)). These results suggest that the increase in floating-object sets are 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 caught by IATTC tuna fisheries. 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, which will be considered when developing a new SSP for the IATTC:

- 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 was used to explore the potential efficacy of hypothetical conservation and management measures for silky and hammerhead sharks in 2023 ([SAC-14-12](#)). This assessment is expected to be resumed in the near future with a potential external review of the EASI-Fish assessment and the collaboration of the shark technical workshops of the IATTC.
- 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 expanded 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-24 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 2018–2024 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-24 model is that it describes only the tropical component of the EPO ecosystem, and results cannot be reliably extrapolated to other regions of the EPO. Therefore, after updated diet information is collected, future work will aim to develop a spatially-explicit model that covers the entire EPO and calibrate the model with available time series of catches, ideally for species representing different trophic levels, and effort data for key fisheries in the EPO.
- Environmental variables can have a profound influence on the catches of target and bycatch species, as has been shown previously by IATTC staff and now undertaken annually in this report, with a dedicated workplan on climate resilient fisheries resulting from Resolution [C-23-10](#) being proposed at SAC-15 (SAC-15-12). 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, is described in [SAC-14 INF-Q](#).

- In preparation for the 2<sup>nd</sup> data improvement workshop the staff will analyze currently available small purse seine data to better understand its representativeness and make the necessary recommendations based on science.
- 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. Furthermore, the staff has co-organized a 2<sup>nd</sup> workshop on methods to monitor the status of dolphins in 2024.
- The staff aim to restructure this *Ecosystem Considerations* report into two ecosystem-advice products: 1) an indicator-based ecosystem report card (“*EcoCard*”) and corresponding *Ecosystem Status Assessment* to detail indicator selection, calculation, and validation, and validation, with a main goal of improving IATTC’s communication of ecosystem status (see [EB-02-02](#)).

## ACKNOWLEDGMENTS

We would like to thank Sylvain Caillot, Nick Vogel, and Joydelee Marrow 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 8<sup>th</sup> Meeting of the Working Group to Review Stock Assessments in 2007 ([SAR-8-17 J](#)) and has been updated annually.

## LITERATURE CITED

- Bayliff, W.H. 1989. Inter-American Tropical Tuna Commission, Annual Report for 1988. IATTC, La Jolla, CA USA. 270 pp.
- Chassot, E., S. Bonhommeau, G. Reygondeau, K. Nieto, J.J. Polovina, M. Huret, N.K. Dulvy, and H. Demarcq. 2011. Satellite remote sensing for an ecosystem approach to fisheries management. *ICES Journal of Marine Science* 68(4): 651-666.
- Clarke, S. 2017. Southern Hemisphere porbeagle shark (*Lamna nasus*) stock status assessment. WCPFC-SC13-2017/SA-WP-12 (rev. 2). Pages 75. *Western and Central Pacific Fisheries Commission. Scientific Committee Thirteenth Regular Session*, Rarotonga, Cook Islands.
- Clarke, S. 2018a. Pacific-wide silky shark (*Carcharhinus falciformis*) Stock Status Assessment. WCPFC-SC14-2018/SA-WP-08. Pages 137. *Western and Central Pacific Fisheries Commission*, Busan, Korea.
- Clarke, S. 2018b. Risk to the Indo-Pacific Ocean whale shark population from interactions with Pacific Ocean purse-seine fisheries. WCPFC-SC14-2018/SA-WP-12 (rev. 2). Pages 55. *Western and Central Pacific Fisheries Commission, Scientific Committee Fourteenth Regular Session*, Busan, Korea.
- Dahlman, L. 2016. Climate Variability: Oceanic Niño Index. <https://www.climate.gov/news-features/understanding-climate/climate-variability-oceanic-ni%C3%B1o-index>. National Oceanic and Atmospheric Administration.
- Druon, J.-N., S. Campana, F. Vandeperre, F. Hazin, H. Bowlby, R. Coelho, N. Queiroz, F. Serena, F. Abascal, D. Damalas, M. Musyl, J. Lopez, B. Block, P. Afonso, H. Dewar, P.S. Sabarros, B. Finucci, A. Zanzi, P. Bach, I. Senina, F. Garibaldi, D. Sims, J. Navarro, P. Cermeño, A. Leone, G. Diez, M. Teresa, M. Deflorio, E. Romanov, A. Jung, M. Lapinski, M. Francis, H. Hazin, and P. Travassos. 2022. Global-scale environmental

niche and habitat of blue shark (*Prionace glauca*) by size and sex: a pivotal step to improving stock management. *Frontiers in Marine Science* 9

Duffy, L.M., and S.P. Griffiths. 2019. Assessing attribute redundancy in the application of productivity-susceptibility analysis to data-limited fisheries. *Aquatic Living Resources* 32(20): 1-11.

Duffy, L.M., C.E. Lennert-Cody, R. Olson, C.V. Minte-Vera, and S.P. Griffiths. 2019. Assessing vulnerability of bycatch species in the tuna purse-seine fisheries of the eastern Pacific Ocean. *Fisheries Research* 219: 105316

Fiedler, P., and M. Lavín. 2017. Oceanographic Conditions of the Eastern Tropical Pacific. In P. W. Glynn, D. P. Manzanillo, and I. C. Enochs (eds.), *Coral Reefs of the Eastern Tropical Pacific: Persistence and Loss in a Dynamic Environment*, p. 59-83. Springer, Netherlands.

Fiedler, P.C. 2002. Environmental change in the eastern tropical Pacific Ocean: review of ENSO and decadal variability. Administrative Report LJ-02-16. Southwest Fisheries Science Center. Pages 38. National Marine Fisheries Service, NOAA, La Jolla, CA.

Fu, D., M.-J. Roux, S. Clarke, M. Francis, A. Dunn, S. Hoyle, and C. Edwards. 2018. Pacific-wide sustainability risk assessment of bigeye thresher shark (*Alopias superciliosus*). WCPFC-SC13-2017/SA-WP-11. Rev 3 (11 April 2018). *Western and Central Pacific Fisheries Commission. Scientific Committee Thirteenth Regular Session*, Rarotonga, Cook Islands.

Griffiths, S.P., and N. Lezama-Ochoa. 2021. A 40-year chronology of the vulnerability of spinetail devil ray (*Mobula mobular*) to eastern Pacific tuna fisheries and options for future conservation and management. *Aquatic Conservation: Marine and Freshwater Ecosystems* 31(10): 2910-2925.

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

Hobday, A.J., and J.R. Hartog. 2014. Derived Ocean Features for Dynamic Ocean Management. *Oceanography* 27(4): 134-145.

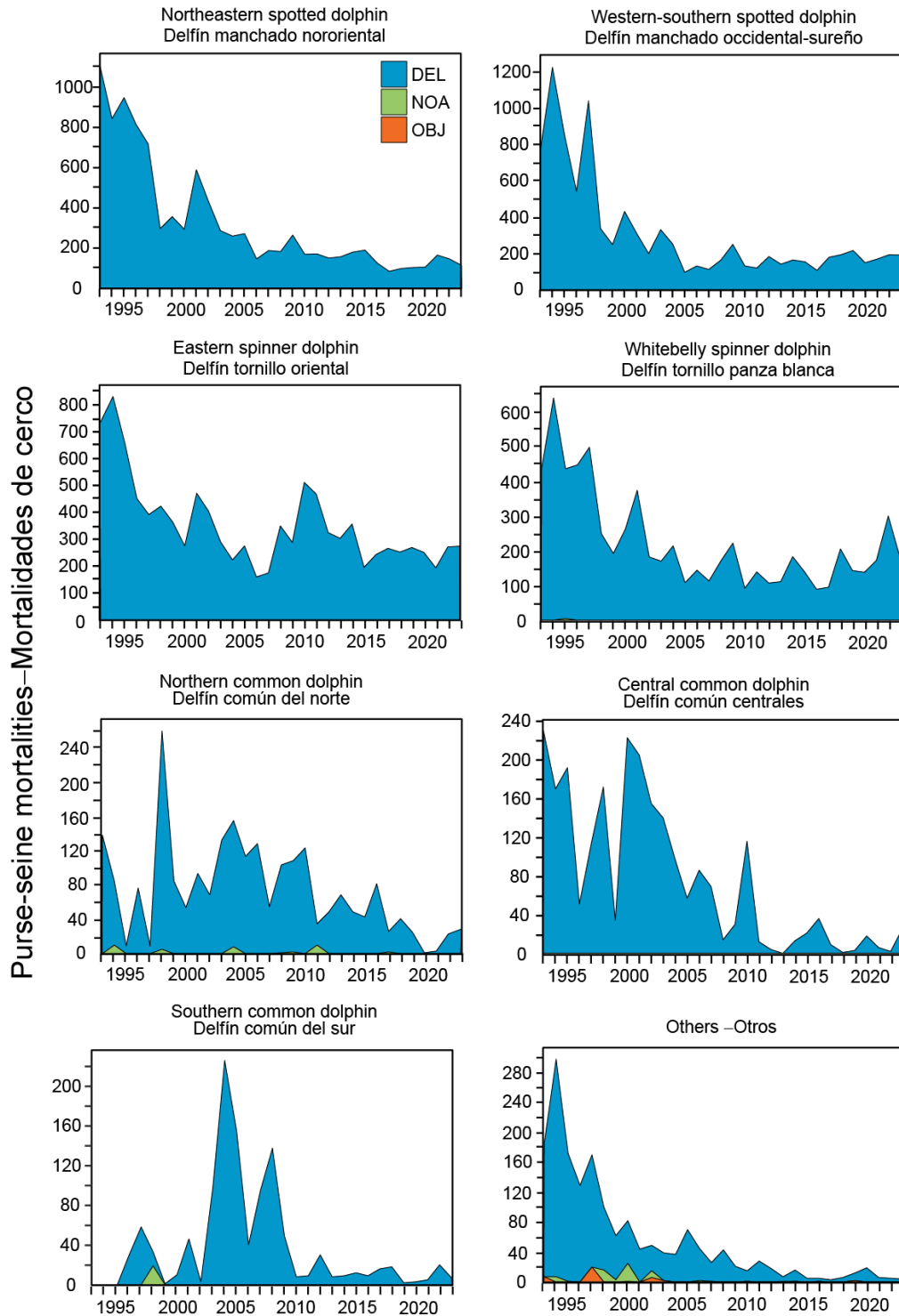
Lennert-Cody, C.E., S.C. Clarke, A. Aires-da-Silva, M.N. Maunder, P.J.S. Franks, M.H. Román, A.J. Miller, and M. Minami. 2018. The importance of environment and life stage on interpretation of silky shark relative abundance indices for the equatorial Pacific Ocean *Fisheries Oceanography*: 1-11

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

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

Pons, M., J.T. Watson, D. Ovando, S. Andracka, S. Brodie, A. Domingo, M. Fitchett, R. Forselledo, M. Hall, E.L. Hazen, J.E. Jannot, M. Herrera, S. Jiménez, D.M. Kaplan, S. Kerwath, J. Lopez, J. McVeigh, L. Pacheco, L. Rendon, K. Richerson, R. Sant'Ana, R. Sharma, J.A. Smith, K. Somers, and R. Hilborn. 2022. Trade-offs between bycatch and target catches in static versus dynamic fishery closures. *Proceedings of the National Academy of Sciences* 119(4): e2114508119.

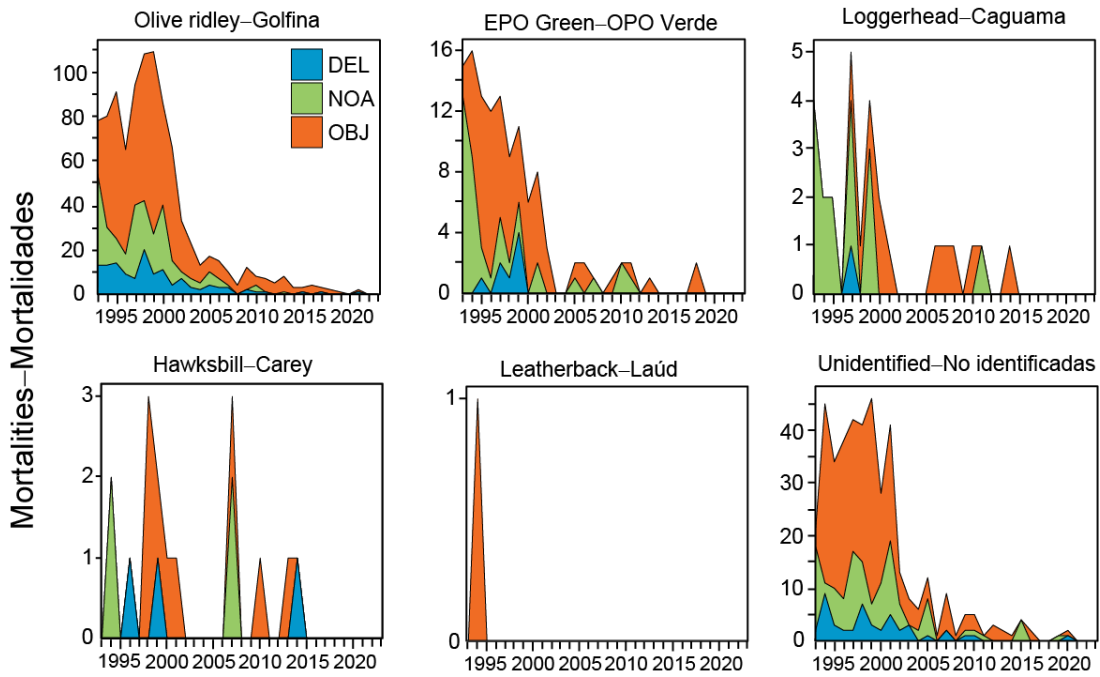
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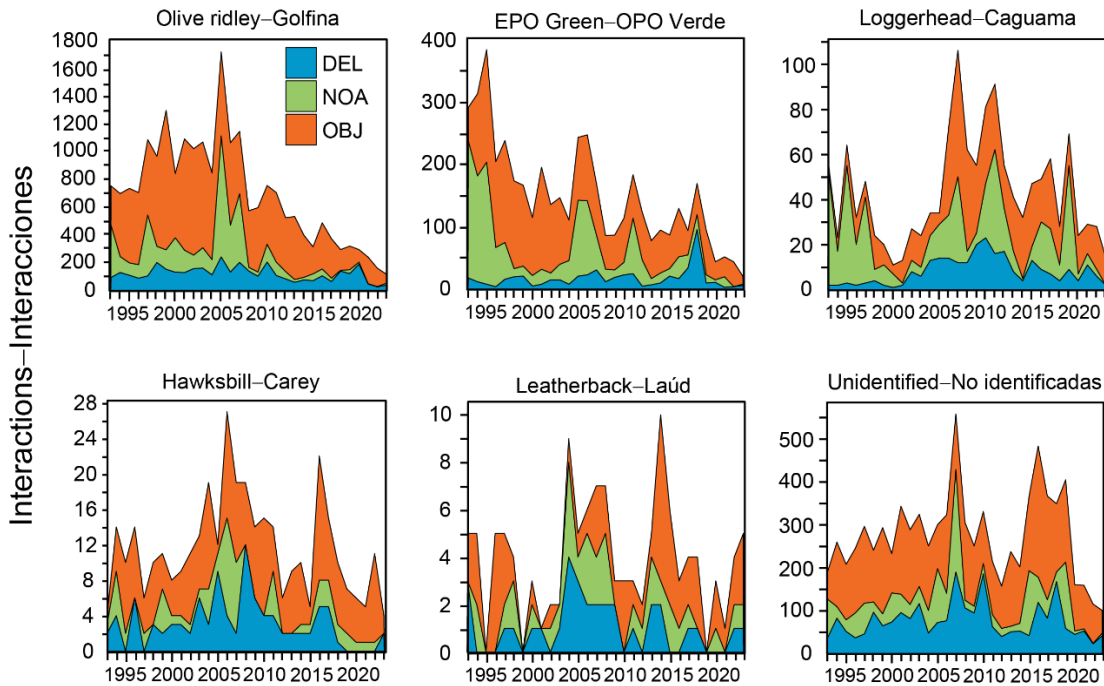
**FIGURE J-1.** Estimated number of incidental dolphin mortalities by observers onboard purse-seine vessels, 1993–2023.

**FIGURA J-1.** Número estimado de mortalidades incidentales de delfines por observadores a bordo de buques cerqueros grandes, 1993–2023.

a.



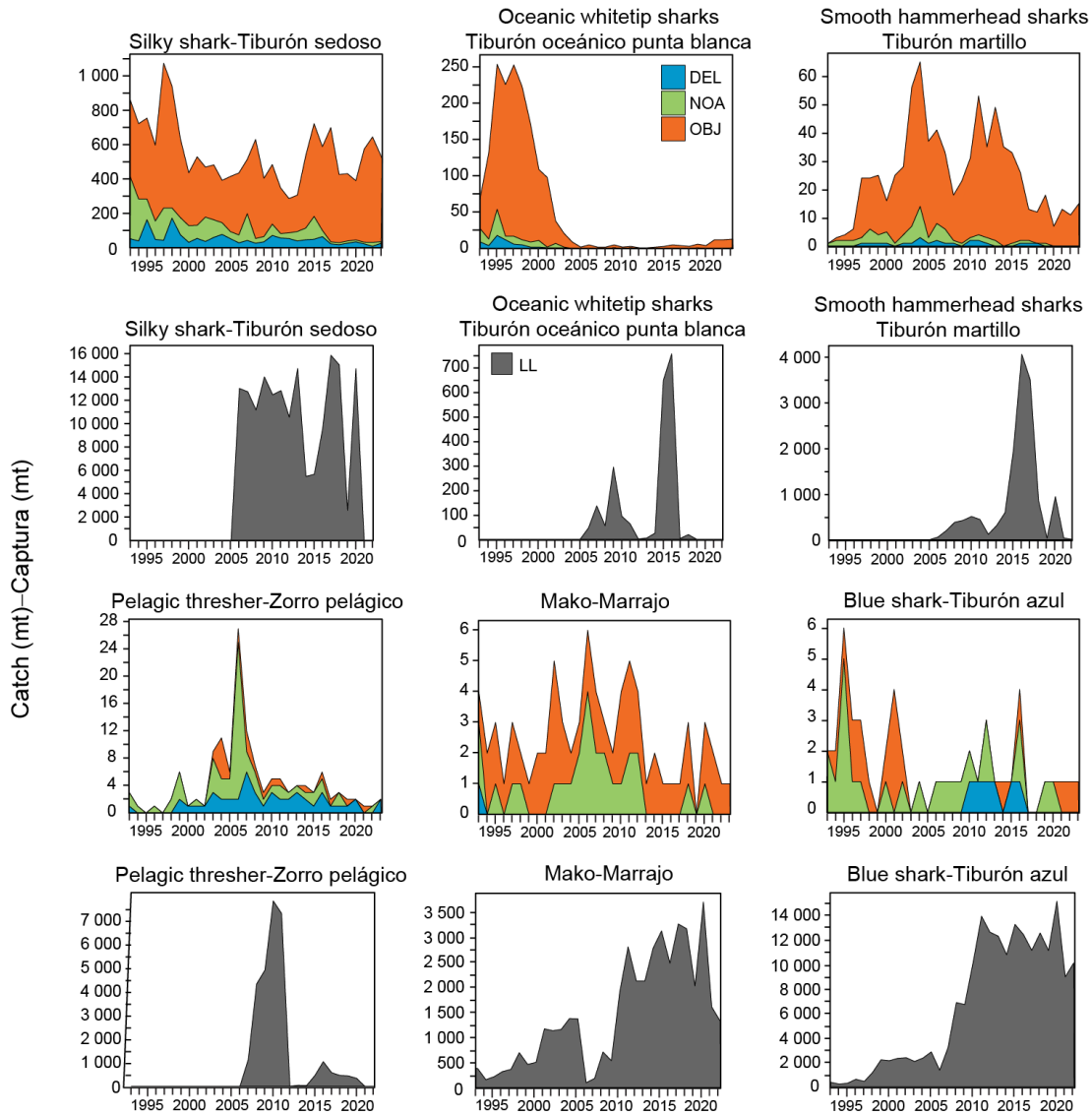
b.



**FIGURE J-2.** Estimated number of sea turtle a) mortalities and b) interactions by observers onboard large purse-seine vessels, 1993–2023, by set type (dolphin (DEL), unassociated (NOA), floating object (OBJ)).

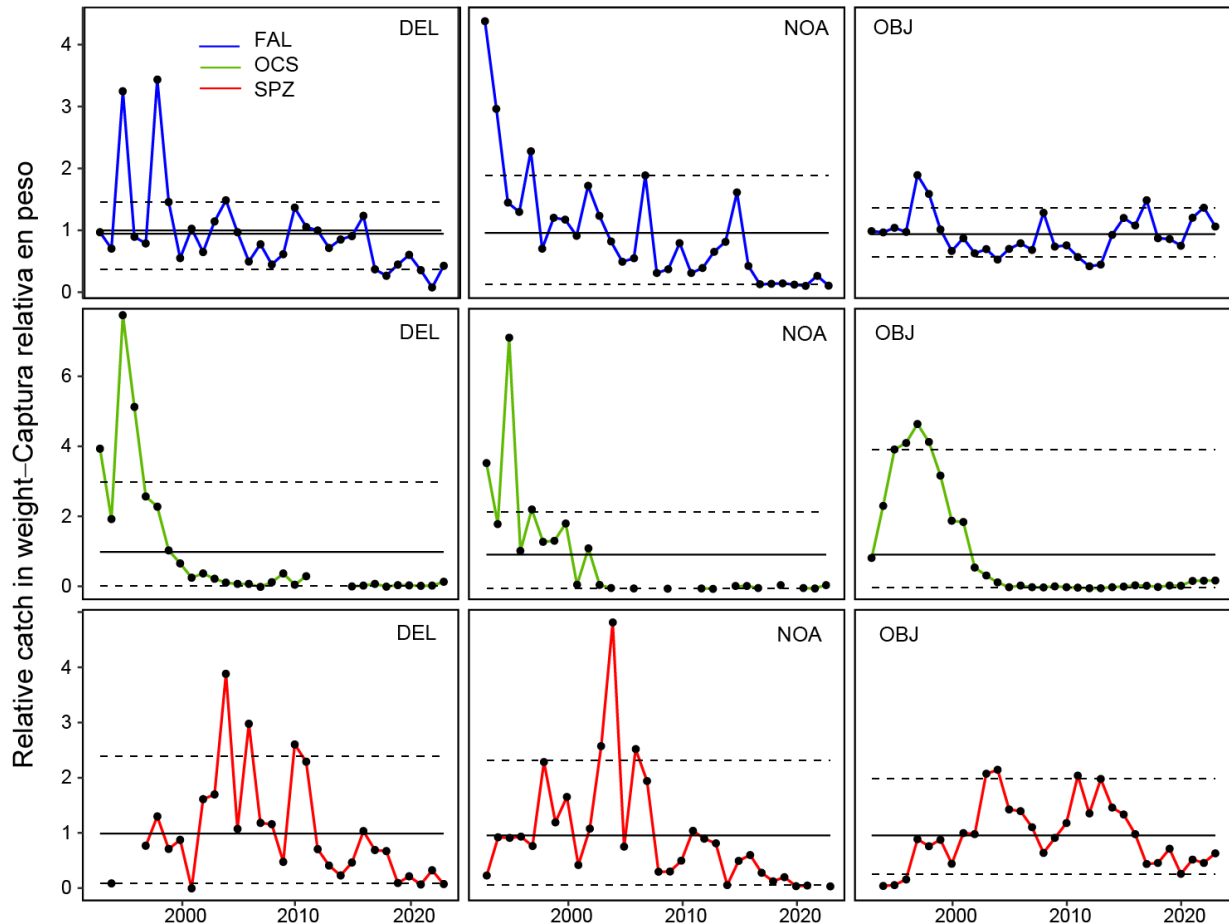
**FIGURA J-2.** Número estimado de a) mortalidades y b) interacciones de tortugas marinas por observadores a bordo de buques cerqueros grandes, 1993-2023, por tipo de lance (delfín (DEL), no asociado (NOA), objeto flotante (OBJ)).





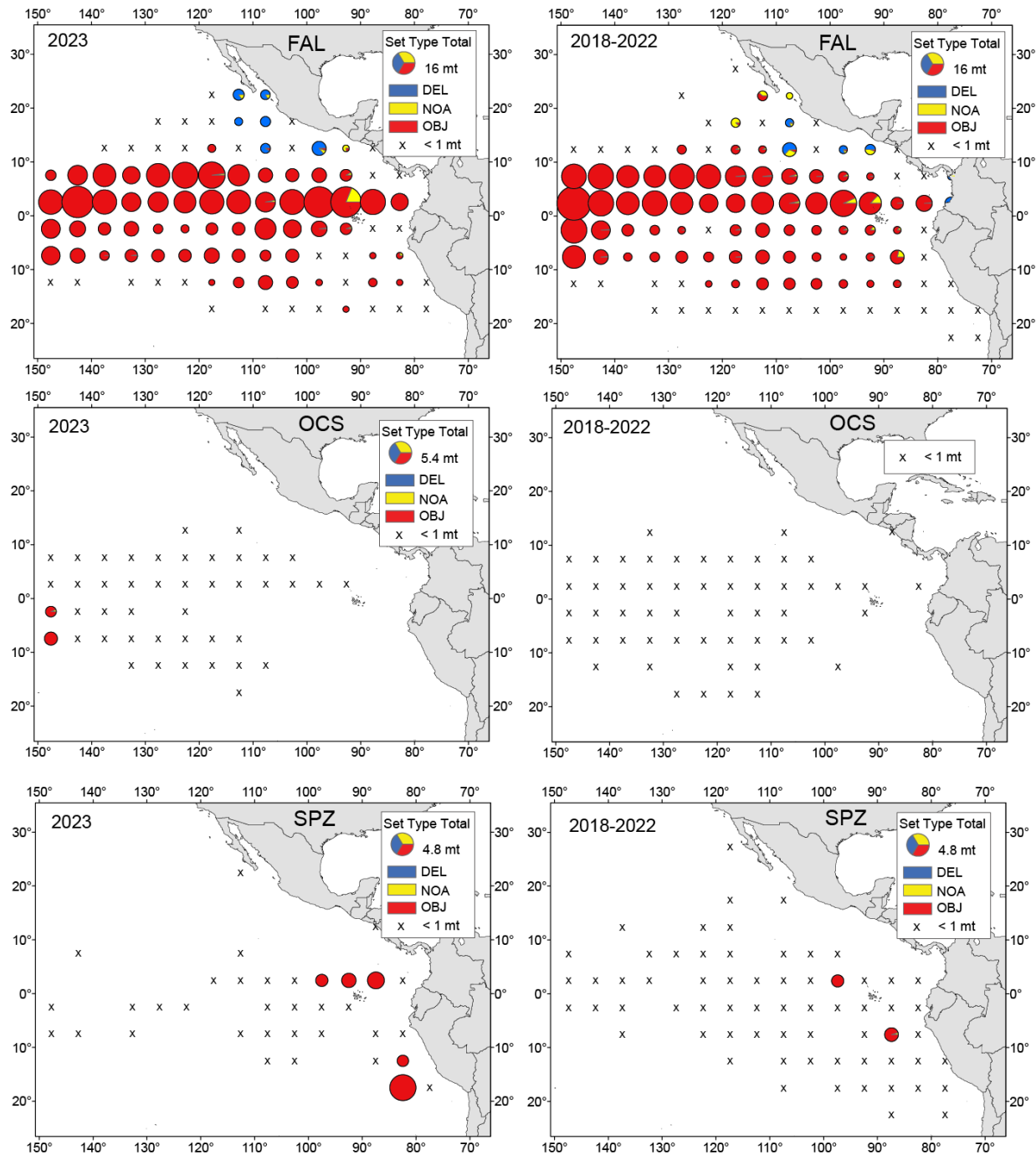
**FIGURE J-3a.** Estimated catches in metric tons (t) of key shark species in the eastern Pacific Ocean recorded by observers onboard large purse-seine vessels and minimum longline (LL) estimates of gross annual removals reported by CPCs (see section 2.2. for uncertainty and data gaps in reporting of bycatch species caught by longline). Purse-seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2023) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline catches (1993–2022) 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 J-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 (1993–2023) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras (1993–2022) 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).



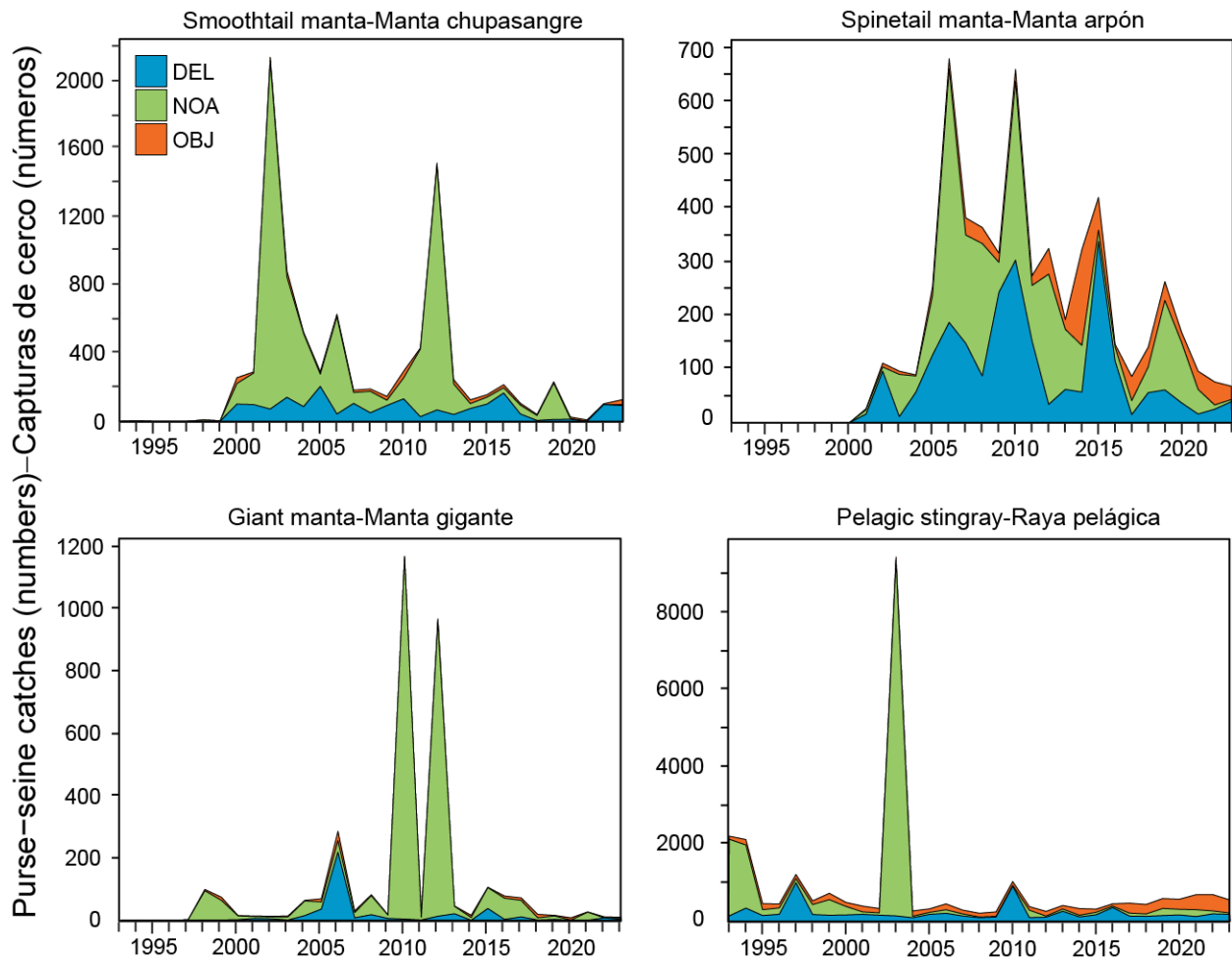
**FIGURE J-3b.** Indicators of relative catch of key shark species reported by observers onboard large purse-seine vessels (Class 6, carrying capacity > 363 t) by set type: dolphins (DEL), unassociated tuna schools (NOA) and floating object (OBJ). The solid line is the average equal to 1 and the dashed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

**FIGURA J-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*).



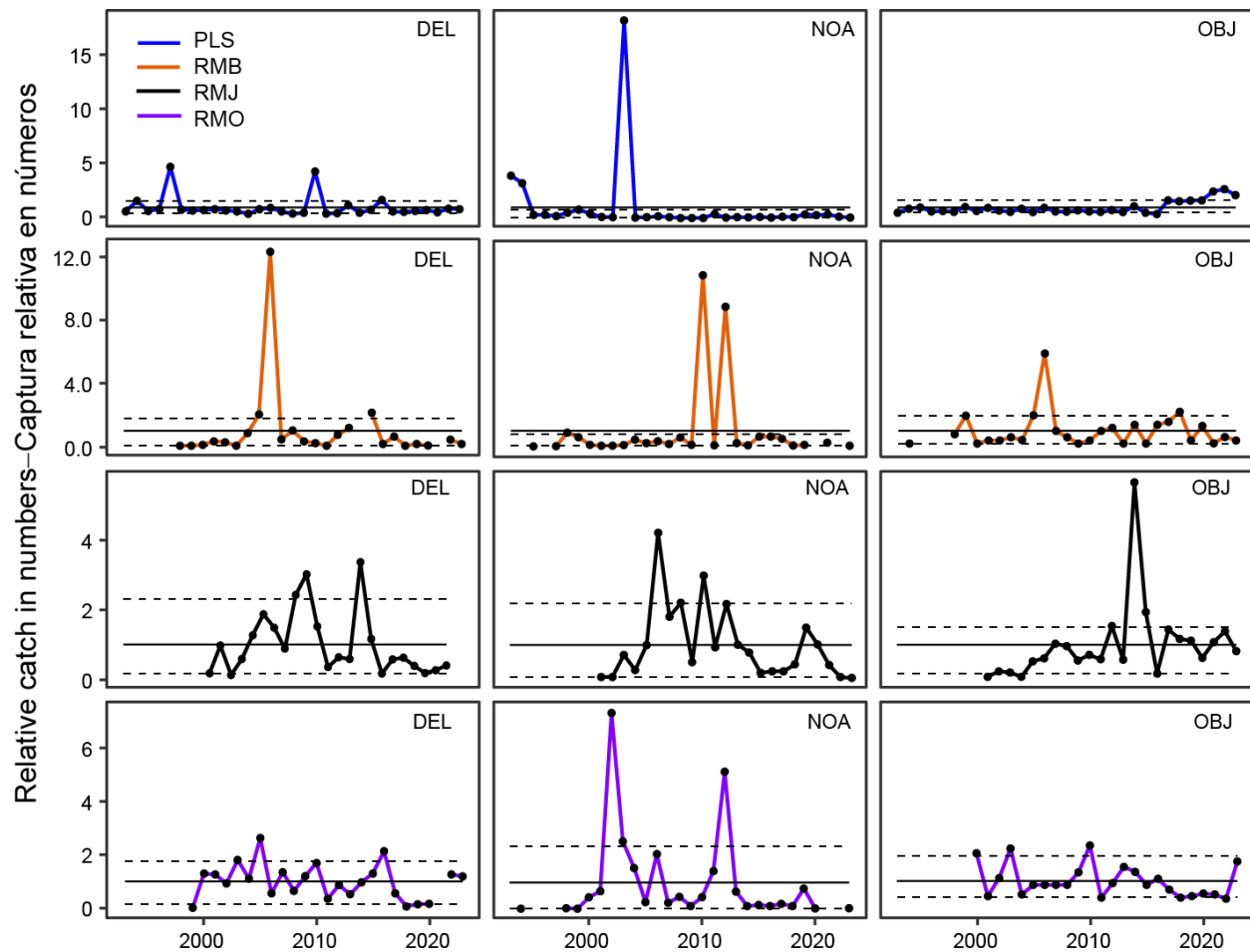
**FIGURE 3c.** Purse-seine catches (Class 6, carrying capacity > 363 t) (at 5°x5° resolution) of key species of sharks by set type: floating object (OBJ) unassociated tuna schools (NOA) and dolphins (DEL), for 2023 (left panel) and the 2018–2022 averages (right panel). FAL: silky shark (*Carcharhinus falciformis*), OCS: oceanic whitetip shark (*Carcharhinus longimanus*), SPZ: smooth hammerhead shark (*Sphyrna zygaena*).

**FIGURA 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 2023 (panel izquierdo) y los promedios de 2018–2022 (panel derecho). FAL: tiburón sedoso (*Carcharhinus falciformis*), OCS: tiburón oceánico punta blanca (*Carcharhinus longimanus*), SPZ: cornuda cruz (*Sphyrna zygaena*).



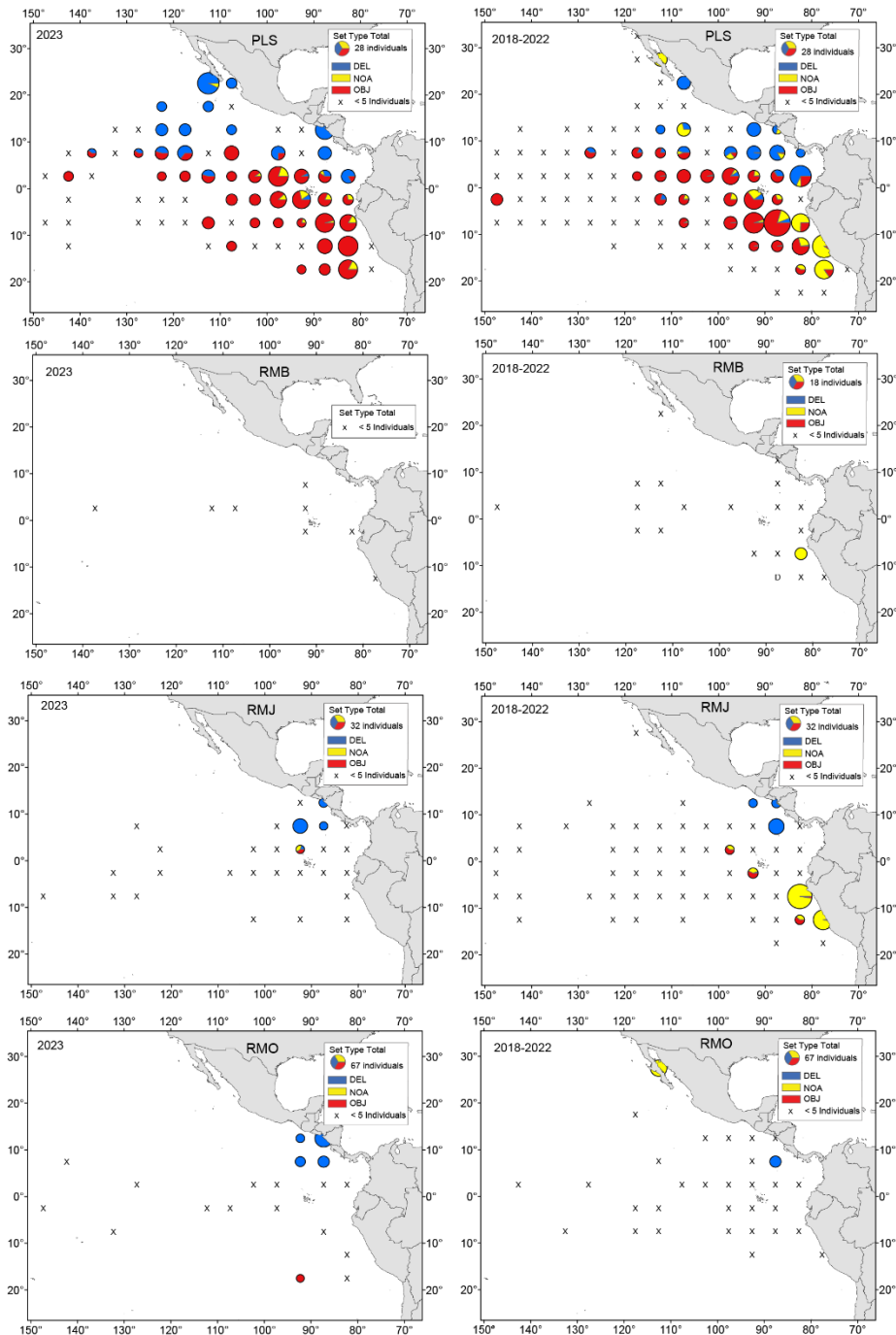
**FIGURE J-4a.** Estimated purse-seine catches in numbers of individuals of key species of rays in the eastern Pacific Ocean. Purse seine catches are provided for size-class 6 vessels with a carrying capacity >363 t (1993–2023) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL).

**FIGURA J-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 (1993-2023) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y del-fines (DEL).



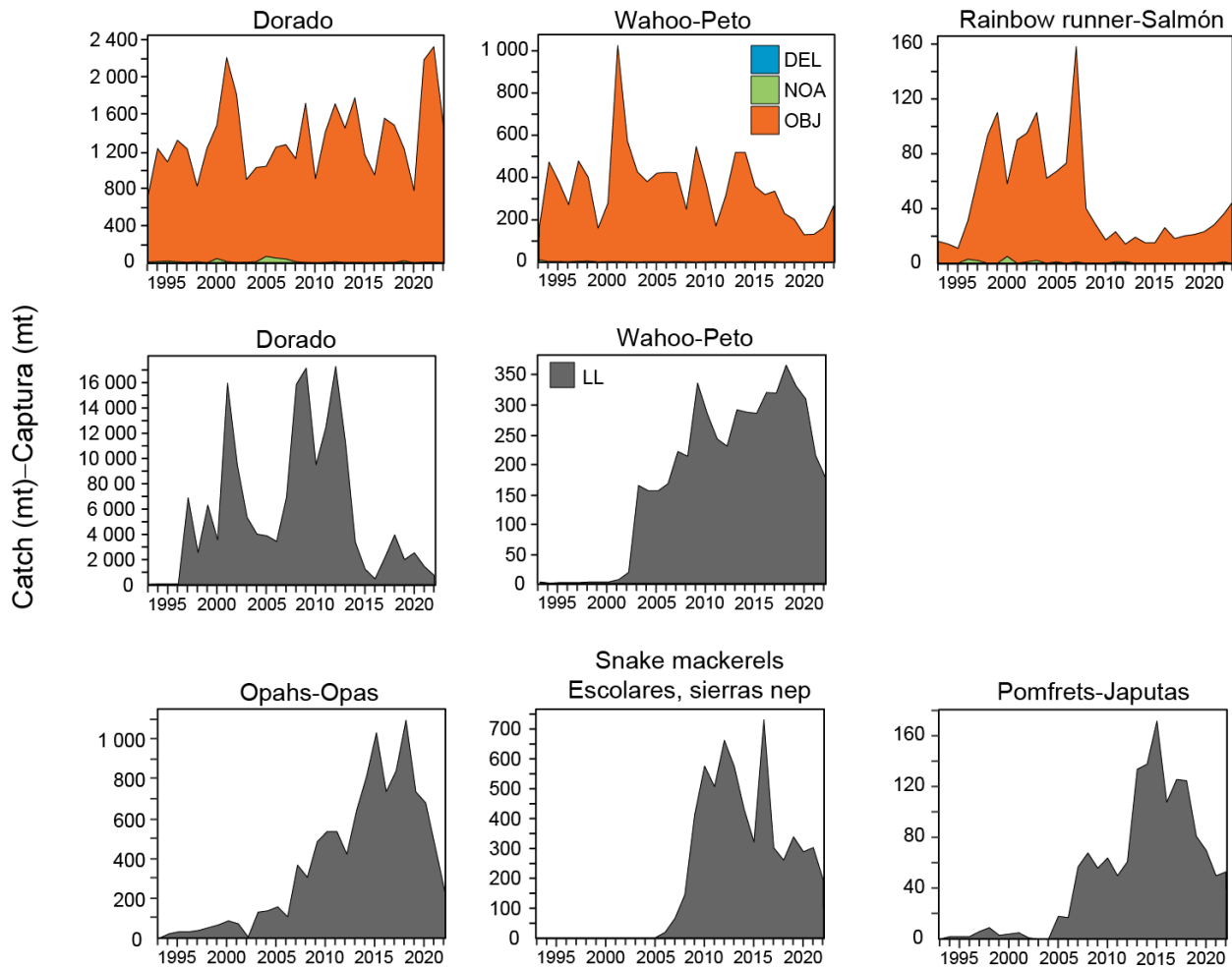
**FIGURE J-4b.** Indicators of relative number of individuals of rays reported by observers onboard large purse-seine vessels (Class 6, carrying capacity > 363 t) by set type: dolphins (DEL), unassociated tuna schools (NOA) and floating object (OBJ). The solid line is the average equal to 1 and the dashed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

**FIGURA J-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*).



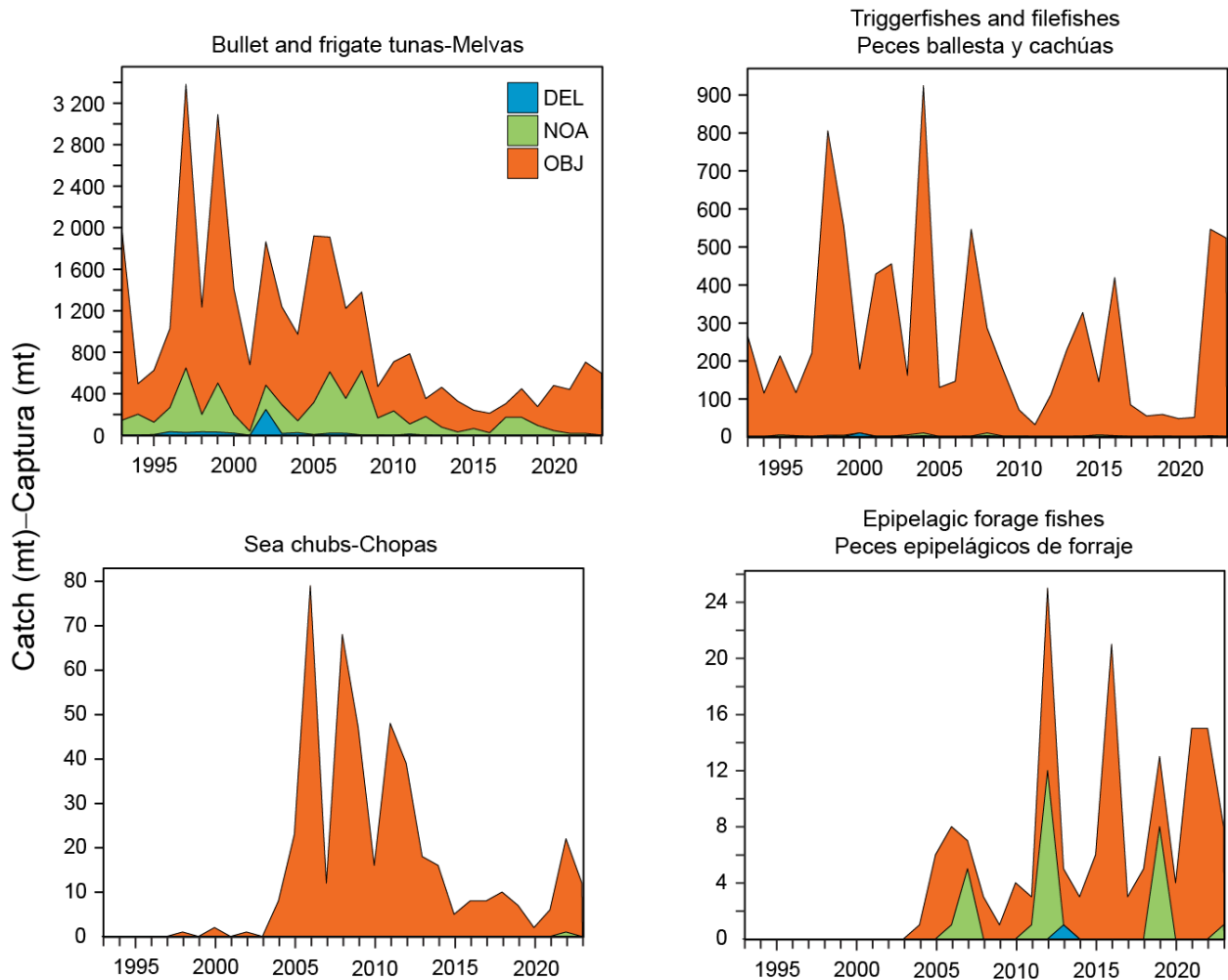
**FIGURE J-4c.** Purse-seine catches (Class 6, carrying capacity > 363 t) (at 5°x5° resolution) of key species of rays by set type: floating object (OBJ) unassociated tuna schools (NOA) and dolphins (DEL), for 2023 (left panel) and the 2018-2022 averages (right panel). PLS: pelagic stingray (*Pteroplatytrygon violacea*), RMB: giant manta (*Mobula birostris*), RMJ: spinetail manta (*Mobula mobular*), RMO: smoothtail manta (*Mobula thurstoni*).

**FIGURA J-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 2023 (panel izquierdo) y los promedios de 2018-2022 (panel derecho). PLS: raya pelágica (*Pteroplatytrygon violacea*), RMB: manta gigante (*Mobula birostris*), RMJ: manta mobula (*Mobula mobular*), RMO: manta diablo (*Mobula thurstoni*).



**FIGURE J-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 (1993–2023) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Longline (LL) catches (1993–2022) are minimum reported gross-annual removals (see section 2.2. for uncertainty and data gaps in reporting of bycatch species caught by longline).

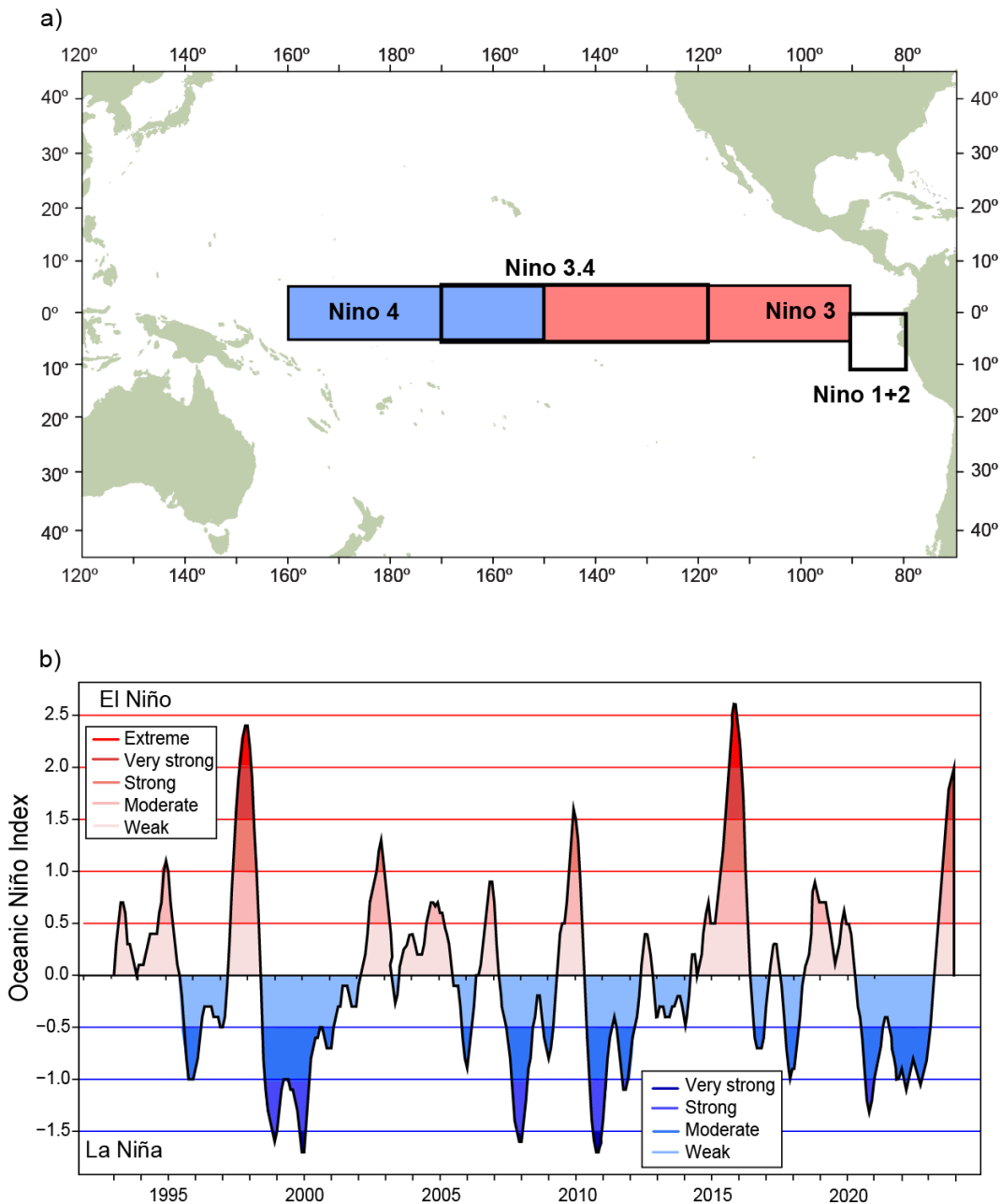
**FIGURA J-5.** Capturas cerqueras y palangreras estimadas en toneladas (t) de especies clave de peces grandes en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993-2023) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Las capturas palangreras (LL) (1993–2022) 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 J-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 (1993–2023) by set type: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL).

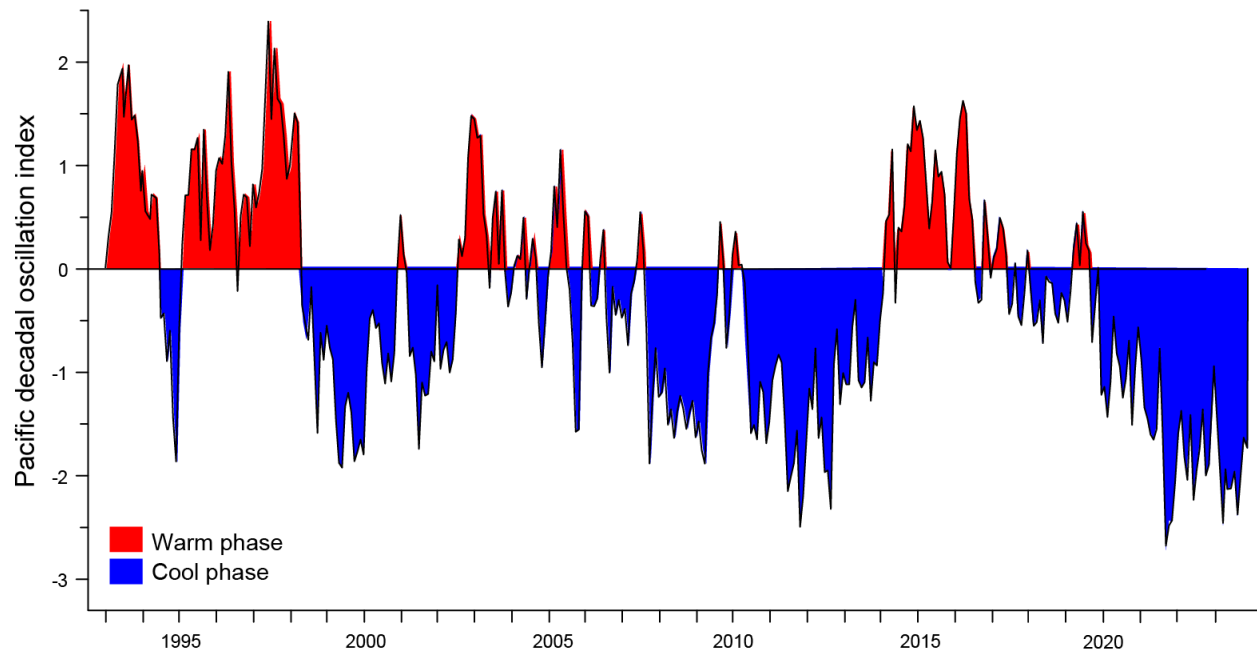
**FIGURA J-6.** Capturas cerqueras estimadas en toneladas (t) de especies clave de peces pequeños en el Océano Pacífico oriental. Se presentan las capturas cerqueras para buques de clase 6 con una capacidad de acarreo >363 t (1993–2023) por tipo de lance: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL).





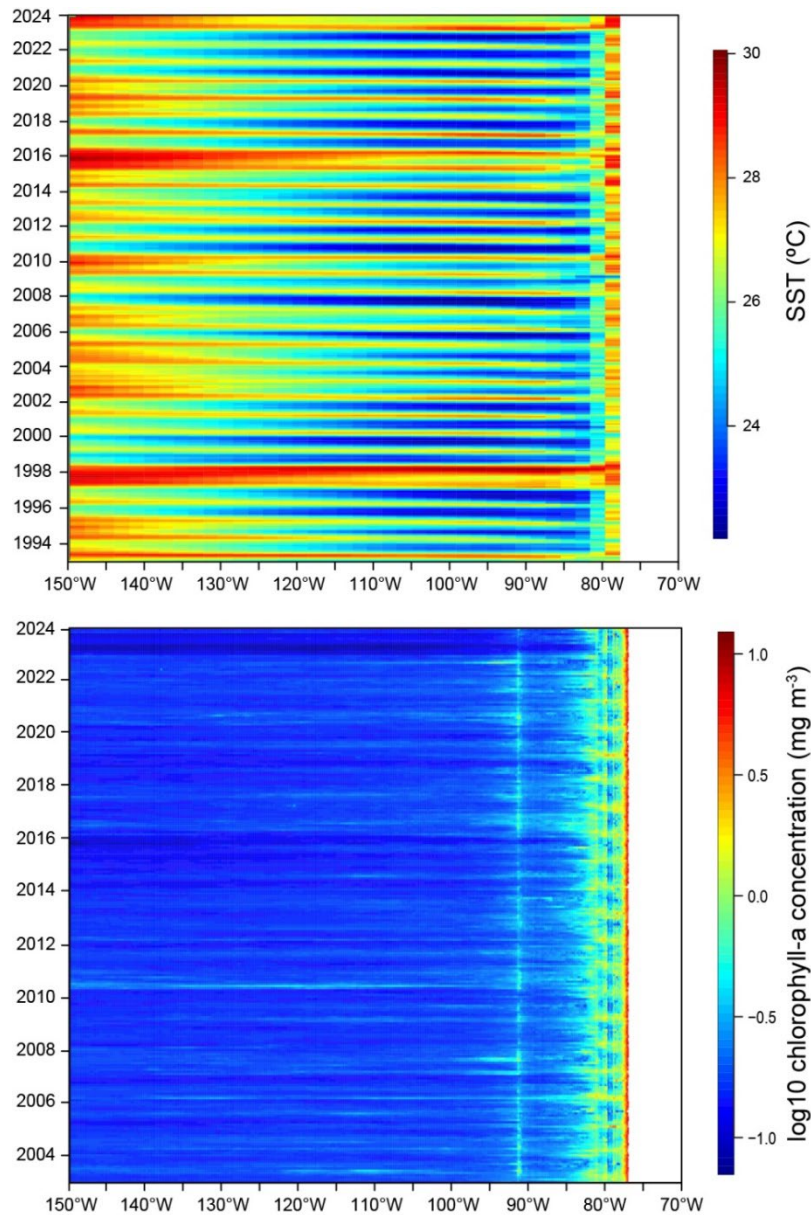
**FIGURE J-7.** El Niño regions used as indicators of El Niño Southern Oscillation (ENSO) events in the Pacific Ocean (top panel), and the Oceanic Niño Index (ONI) used to monitor ENSO conditions in Niño region 3.4 from 5°N to 5°S and 120°W to 170°W (bottom panel). Time series shows the running 3-month mean ONI values from the start of the IATTC observer program through December 2023. ONI data obtained from: [http://origin.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ONI\\_v5.php](http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php)

**FIGURA J-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 2023. Datos del ONI obtenidos de: [http://origin.cpc.ncep.noaa.gov/products/analysis\\_monitoring/ensostuff/ONI\\_v5.php](http://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php)



**FIGURE J-8.** Monthly values of the Pacific Decadal Oscillation (PDO) Index, January 1993–December 2023. ERSST V5 PDO Time Series data obtained from: <https://psl.noaa.gov/pdo/>

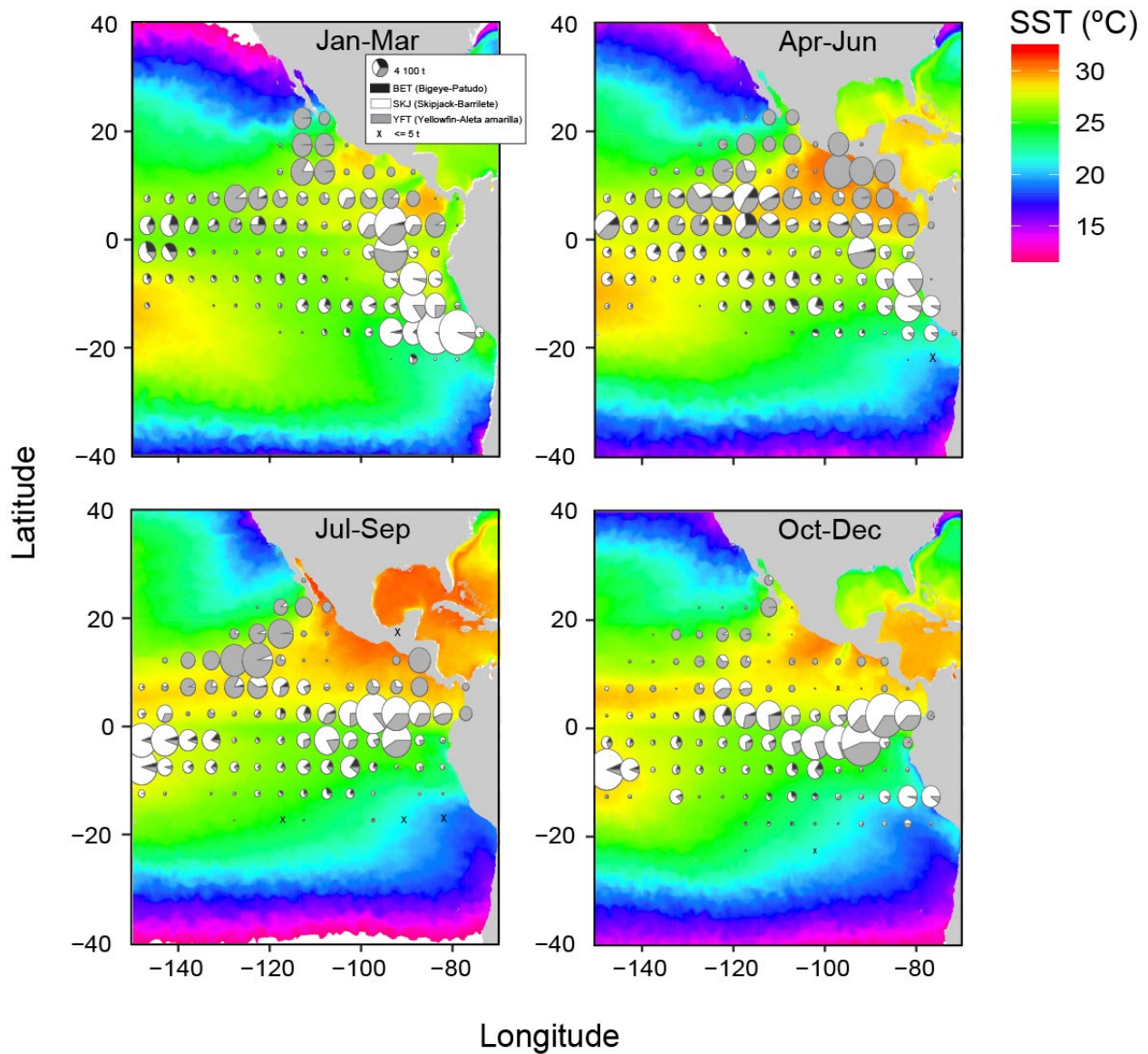
**FIGURA J-8.** Valores mensuales del índice de Oscilación Decadal del Pacífico (PDO), enero de 1993–diciembre de 2023. Datos de la serie de tiempo ERSST V5 PDO obtenidos de: <https://psl.noaa.gov/pdo/>



**FIGURE J-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 2023 (top panel) ([https://coastwatch.pfeg.noaa.gov/erddap/griddap/nceiErsstv5\\_LonPM180.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/nceiErsstv5_LonPM180.html)) and mean monthly chlorophyll-a concentration for January 2003–December 2023 (bottom panel)

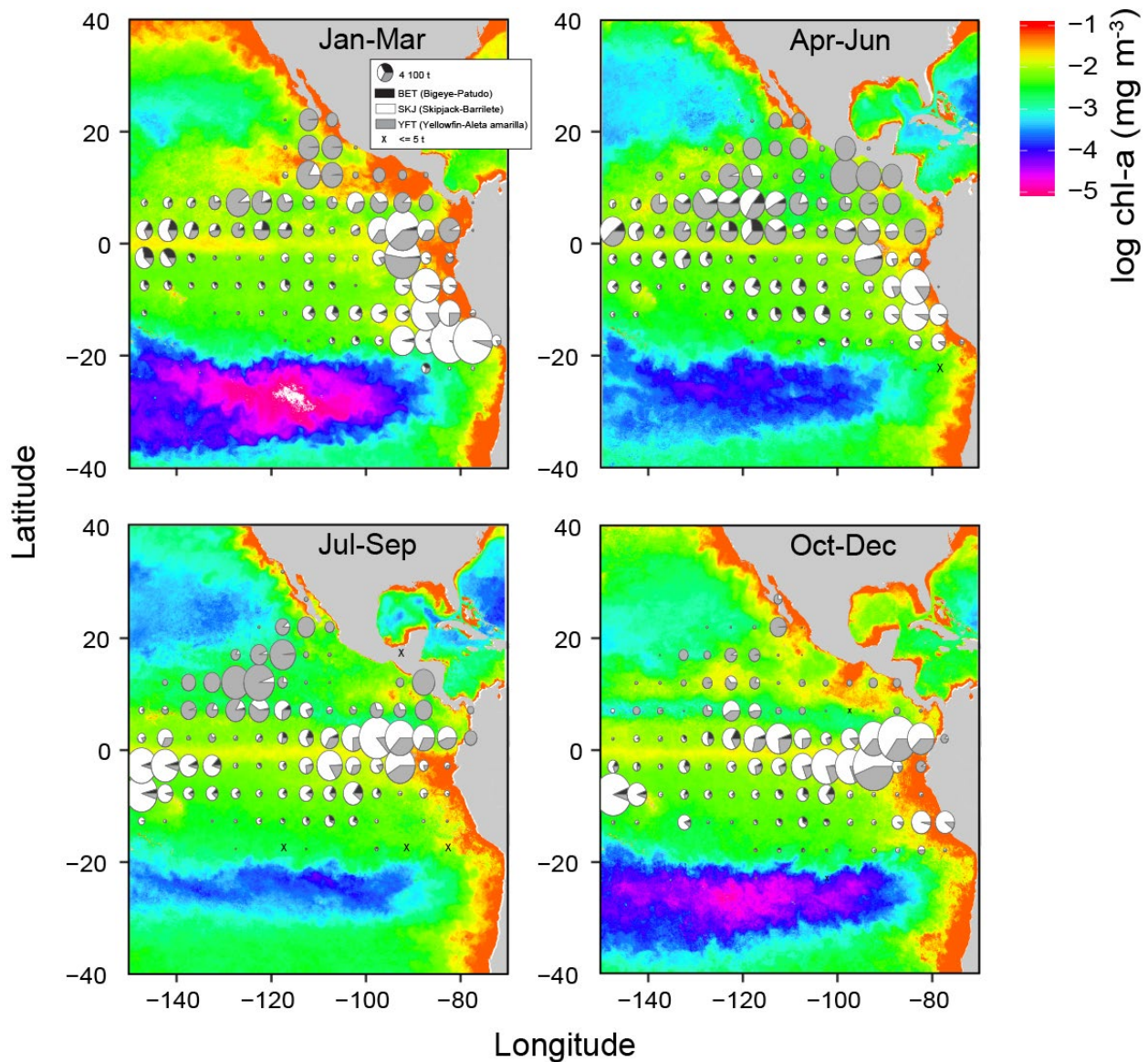
([https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday\\_R2022SQ/index.html](https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html)); ([https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday\\_R2022NRT.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday_R2022NRT.html)).

**FIGURA J-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 2023 (panel superior) ([https://coastwatch.pfeg.noaa.gov/erddap/griddap/nceiErsstv5\\_LonPM180.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/nceiErsstv5_LonPM180.html)) y concentración promedio mensual de clorofila-a de enero de 2003 a diciembre de 2023 (panel inferior) ([https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday\\_R2022SQ/index.html](https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html)); ([https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday\\_R2022NRT.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday_R2022NRT.html)).



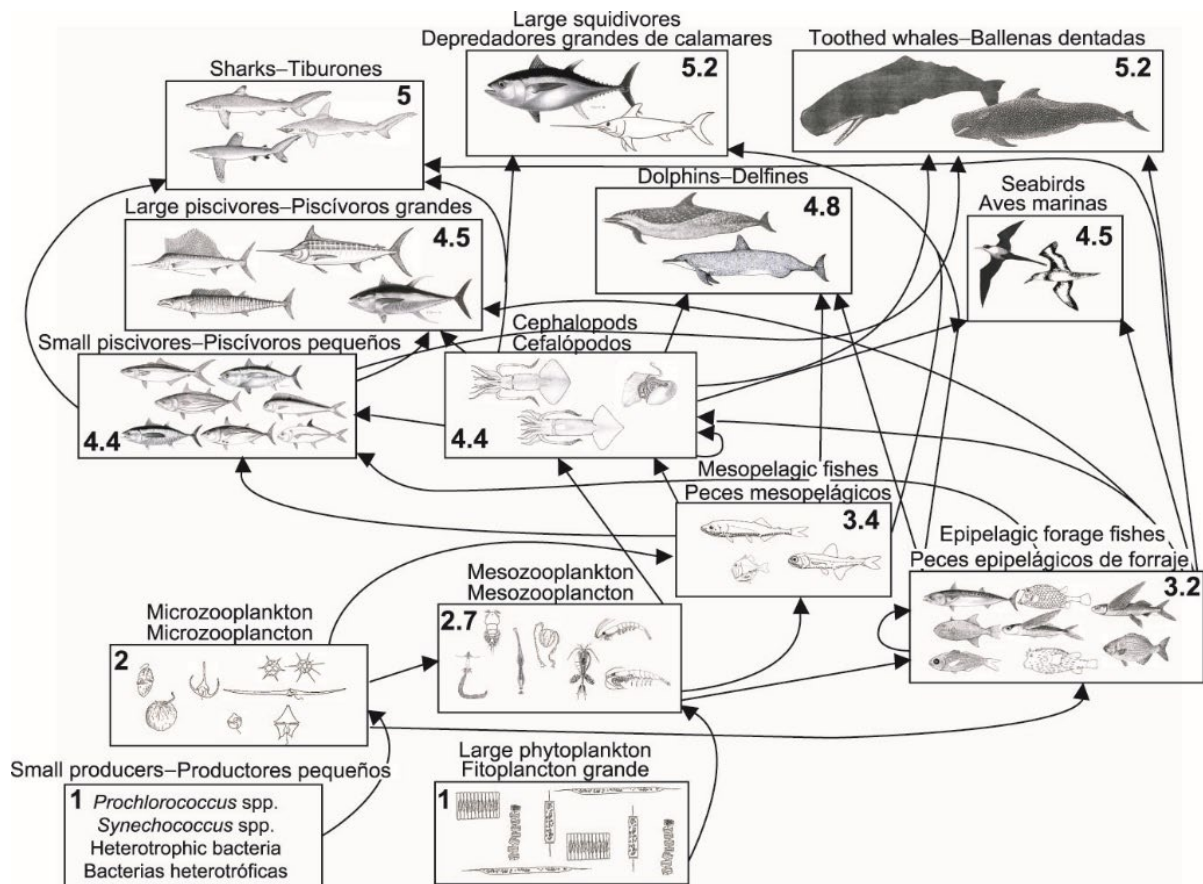
**FIGURE J-10.** Mean sea surface temperature (SST) for each quarter during 2023 with catches of tropical tunas overlaid. SST data obtained from NOAA NMFS SWFSC ERD on January 9, 2024, “Multi-scale Ultra-high Resolution (MUR) SST Analysis fv04.1, Global, 0.01°, 2002–present, Monthly”, <https://coastwatch.pfeg.noaa.gov/erddap/info/jplMURSST41mday/index.html>.

**FIGURA J-10** Temperatura superficial del mar (TSM) promedio para cada trimestre de 2023 con las capturas de atunes tropicales superpuestas. Datos de TSM obtenidos de NOAA NMFS SWFSC ERD el 9 de enero de 2024, “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>.



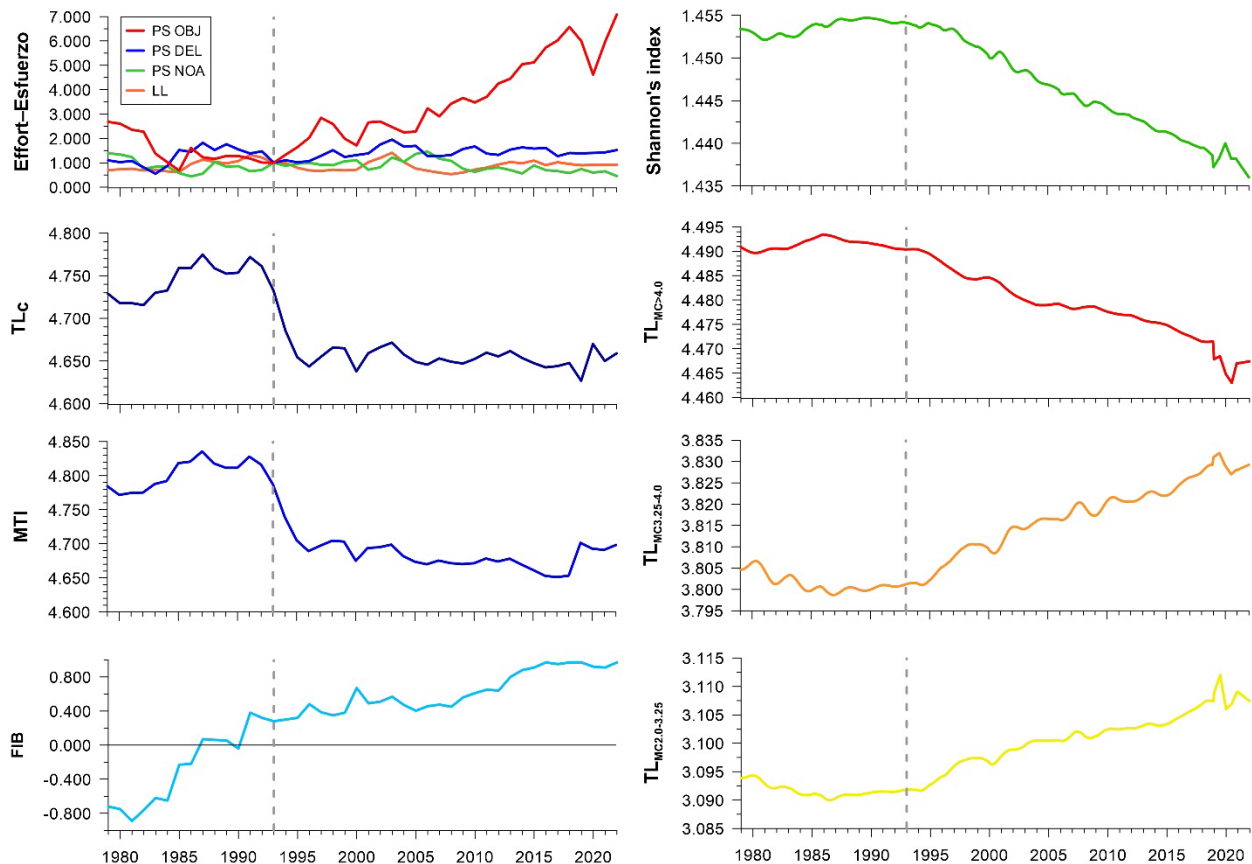
**FIGURE J-11.** Mean log chlorophyll-a concentration (in  $\text{mg m}^{-3}$ ) for each quarter during 2023 with catches of tropical tunas overlaid. Chlorophyll data obtained from NOAA CoastWatch on February 7, 2024, “Chlorophyll-a, Aqua MODIS, NPP, L3SMI, Global, 4km, R2022 SQ, 2003-present (Monthly Composite)”, NOAA NMFS SWFSC ERD, [https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday\\_R2022SQ/index.html](https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html) and [https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday\\_R2022NRT.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday_R2022NRT.html).

**FIGURA J-11.** Concentración promedio de clorofila-a (en  $\text{mg m}^{-3}$ ) para cada trimestre de 2023 con las capturas de atunes tropicales superpuestas. Datos de clorofila obtenidos de NOAA CoastWatch el 7 de febrero de 2024, “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](https://coastwatch.pfeg.noaa.gov/erddap/info/erdMH1chlamday_R2022SQ/index.html) and [https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday\\_R2022NRT.html](https://coastwatch.pfeg.noaa.gov/erddap/griddap/erdMH1chlamday_R2022NRT.html).



**FIGURE J-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 J-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 J-13.** Annual values for seven ecological indicators of changes in different components of the tropical EPO ecosystem, 1979–2022 (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 J-13** Valores anuales de siete indicadores ecológicos de cambios en diferentes componentes del ecosistema del OPO tropical, 1979–2022 (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 J-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 1993-2023. Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Data for 2022–2023 are considered preliminary.

**Tabla J-1a.** Número estimado de individuos de mortalidades incidentales de delfines por la pesquería de cerco durante 1993-2023, 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 2022–2023 se consideran preliminares.

Year	Northeastern spotted Purse seine			Western-southern spotted Purse seine			Eastern spinner Purse seine			Whitebelly spinner Purse seine		
	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	-	-
2023	115	-	-	195	-	-	274	-	-	178	-	-
<b>Total</b>	<b>10,005</b>	<b>3</b>	<b>-</b>	<b>9,705</b>	<b>-</b>	<b>-</b>	<b>10,913</b>	<b>-</b>	<b>-</b>	<b>6,945</b>	<b>5</b>	<b>-</b>



**Table J-1a** continued

Year	Northern common Purse seine			Central common Purse seine			Southern common Purse seine			Other dolphins Purse seine		
	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	-	-
2023	29	-	-	26	-	-	7	-	-	4	-	-
<b>Total</b>	<b>2,243</b>	<b>38</b>	<b>-</b>	<b>2,306</b>	<b>-</b>	<b>-</b>	<b>1,115</b>	<b>19</b>	<b>-</b>	<b>1,616</b>	<b>64</b>	<b>41</b>

**Table J-1b.** Minimum number of marine mammal interactions and mortalities in the eastern Pacific Ocean (EPO) in 2022 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 EPO. Reported marine mammal interactions were precautionarily presumed to be mortalities (i.e., disposition was either not reported or a detailed disposition was not provided e.g., “discarded”, “injured”) unless release condition was reported as “alive”, “alive and healthy”, or “released”. 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 J-1b.** Número mínimo de interacciones con mamíferos marinos y mortalidades en el Océano Pacífico oriental (OPO) en 2022 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 OPO. Se supuso precautoriamente que las interacciones con mamíferos marinos reportadas resultaron en mortalidades (es decir, no se reportó la disposición o no se proporcionó una disposición detallada, por ejemplo, "descartado", "herido", a menos que la condición de liberación fuera reportada como "vivo", "vivo y sano" o "liberado"). 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)

Common name	Scientific name	Interactions	Mortalities
Dolphin, nei	Delphinidae	39	34
Bottlenose dolphin	<i>Tursiops truncatus</i>	18	17
Guadalupe fur seal	<i>Arctocephalus townsendi</i>	2	2
Risso's dolphin	<i>Grampus griseus</i>	2	2
False killer whale	<i>Pseudorca crassidens</i>	1	1
Mesoplodon, nei	<i>Mesoplodon</i> spp.	1	1
Offshore spotted dolphin	<i>Stenella attenuata</i>	1	1
Seals and sea lions nei	Otariidae, Phocidae	1	1
Shortfin pilot whale	<i>Globicephala macrorhynchus</i>	1	1
Unidentified spinner dolphin	<i>Stenella longirostris</i>	1	1
Total numbers		67	61

**Table J-2a.** Estimated number of turtle interactions and mortalities by observers onboard purse-seine size-class 6 vessels with a carrying capacity >363 t (1993–2023). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Data for 2022–2023 are considered preliminary.

**Tabla J-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 (1993–2023). Tipos de lances cerqueros: objeto flotante (OBJ), atunes no asociados (NOA) y delfines (DEL). Los datos de 2022–2023 se consideran preliminares.

Year	<i>Lepidochelys olivacea</i> , Olive ridley (LKV)						<i>Chelonia agassizii</i> , <i>Chelonia mydas</i> , eastern Pacific green (TUG)						<i>Caretta caretta</i> , loggerhead (TTL)					
	Purse seine						Purse seine						Purse seine					
	interactions			mortality			interactions			mortality			interactions			mortality		
	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	-	-	-
2023	64	14	46	-	-	-	13	2	6	-	-	-	12	-	2	-	-	-
Total	13,622	4,398	3,954	606	215	130	2,633	1,487	528	73	38	8	591	507	253	11	14	1

Table J-2a continued

Year	<i>Eretmochelys imbricata</i> , hawksbill (TTH)						<i>Dermochelys coriacea</i> , leatherback (DKK)						Unidentified turtles					
	Purse seine						Purse seine						Purse seine					
	interactions			mortality			interactions			mortality			interactions			mortality		
	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	-	-	-
2023	2	-	2	-	-	-	3	1	1	-	-	-	53	6	42	-	-	-
Total	199	64	96	9	4	3	57	33	32	1	-	-	4,620	1,577	2,407	264	103	46

**Table J-2b.** Minimum number of sea turtle interactions and mortalities in the eastern Pacific Ocean (EPO) in 2022 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 EPO. Dispositions considered to indicate a survival event are those reported by observers as “Alive and Healthy”, “Light injuries”, “Released” 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. 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 J-2b.** Número mínimo de interacciones con tortugas marinas y mortalidades en el Océano Pacífico oriental (OPO) en 2022 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 OPO. Las disposiciones que se considera que indican un evento de supervivencia son las reportadas por los observadores como “Viva y sana”, “Heridas leves”, “Liberada” 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. 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).

Common name	Scientific name	Interactions	Mortalities
Olive ridley turtle	<i>Lepidochelys olivacea</i>	26	1
Black/Green turtle	<i>Chelonia mydas</i>	13	2
Loggerhead turtle	<i>Caretta caretta</i>	9	9
Leatherback turtle	<i>Dermochelys coriacea</i>	7	3
Hawksbill turtle	<i>Eretmochelys imbricata</i>	3	-
Total numbers		58	15

**Table J-3.** Minimum number of seabird interactions in the eastern Pacific Ocean (EPO) in 2022 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 EPO. All reported seabird interactions are precautionarily presumed to be mortalities (i.e., disposition was reported as “discarded”, “injured”, or not reported), with the exception of one light-mantled albatross reported as “released”, which was presumed to be alive. 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 J-3.** Número mínimo de interacciones con aves marinas en el Océano Pacífico oriental (OPO) en 2022 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 OPO. Se supone precautoriamente que todas las interacciones con aves marinas reportadas son mortalidades (es decir, la disposición fue reportada como "descartada", "herida" o no fue reportada), a excepción de un albatros de manto claro declarado "liberado", que se supuso que estaba vivo. 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).

Common name	Scientific name	Interactions	Mortalities
Boobies and gannets nei	Sulidae Fam.	31	31
Black-footed albatross	<i>Phoebastria nigripes</i>	19	19
Grey petrel	<i>Procellaria cinerea</i>	4	4
Laysan albatross	<i>Phoebastria immutabilis</i>	3	3
Petrels	<i>Procellaria spp.</i>	3	3
Albatross nei	<i>Diomedea spp.</i>	2	2
Cape petrel	<i>Daption capense</i>	2	2
Wandering albatross	<i>Diomedea exulans</i>	2	2
Light-mantled sooty albatross	<i>Phoebetria palpebrata</i>	1	-
Petrels or shearwaters nei	Procellariidae	1	1
Terns nei	<i>Sterna spp.</i>	1	1
Wilson's storm petrel	<i>Oceanites oceanicus</i>	1	1
Total numbers		70	69

**Table J-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 (1993–2023) and minimum reported longline (LL) catches of sharks (gross-annual removals in t) (1993–2022, \*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 2018–2022 (longline) and 2022–2023 (purse-seine) are considered preliminary.

**Tabla J-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 (1993–2023) y capturas palangreras (LL) mínimas reportadas de tiburones (extracciones anuales brutas en t) (1993–2022, \*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 2018–2022 (palangre) y 2022–2023 (cerco) se consideran preliminares.

Year	Carcharhinidae															
	<i>Carcharhinus falciformis</i> , silky shark				<i>Carcharhinus longimanus</i> , oceanic whitetip				<i>Prionace glauca</i> , blue shark				Other Carcharhinidae, requiem sharks			
	Purse seine				Purse seine				Purse seine				Purse seine			
	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	8,935	30	<1	<1	-
2022	614	23	7	37	12	<1	<1	-	1	<1	-	10,052	30	2	2	-
2023	480	10	24	*	12	<1	<1	*	1	<1	-	*	26	<1	2	*
<b>Total</b>	<b>13,205</b>	<b>2,473</b>	<b>1,532</b>	<b>170,972</b>	<b>1,517</b>	<b>112</b>	<b>65</b>	<b>2,143</b>	<b>22</b>	<b>25</b>	<b>9</b>	<b>191,055</b>	<b>584</b>	<b>131</b>	<b>133</b>	<b>28,694</b>

Table J-4a Continued

Year	Sphyrnidae															
	<i>Sphyrna zygaena</i> , smooth hammerhead				<i>Sphyrna lewini</i> , scalloped hammerhead				<i>Sphyrna mokarran</i> , great hammerhead				<i>Sphyrna</i> spp., hammerheads, nei			
	Purse seine				Purse seine				Purse seine				Purse seine			
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	7	47	<1	<1	<1	<1	-	-	-	9	<1	<1	-
2023	15	<1	<1	*	19	<1	<1	*	<1	<1	-	*	8	<1	<1	*
<b>Total</b>	<b>691</b>	<b>69</b>	<b>22</b>	<b>14,412</b>	<b>489</b>	<b>98</b>	<b>27</b>	<b>814</b>	<b>62</b>	<b>4</b>	<b>5</b>	<b>-</b>	<b>749</b>	<b>147</b>	<b>52</b>	<b>3,123</b>



Table J-4a Continued

Year	Alopiidae															
	<i>Alopias pelagicus</i> , pelagic thresher				<i>Alopias superciliosus</i> , bigeye thresher				<i>Alopias vulpinus</i> , thresher shark				<i>Alopias</i> spp., thresher shark, nei			
	Purse seine			LL	Purse seine			LL	Purse seine			LL	Purse seine			LL
	OBJ	NOA	DEL		OBJ	NOA	DEL		OBJ	NOA	DEL		OBJ	NOA	DEL	
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	4	<1	<1	<1	85	<1	<1	<1	-	<1	<1	<1	3
2023	<1	<1	2	*	<1	<1	6	*	-	<1	<1	*	<1	<1	<1	*
<b>Total</b>	23	66	47	28,929	17	108	61	7,581	5	29	13	5,115	15	70	48	3,816

Table J-4a Continued

Year	Lamnidae								Triakidae				Other sharks				All sharks			
	<i>Isurus</i> 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			
	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	44,179
2021	2	<1	-	1,604	-	-	-	8	-	-	-	2	6	<1	<1	33	646	12	24	10,637
2022	1	<1	-	1,324	-	-	-	5	-	-	-	-	2	<1	<1	9	729	27	11	11,527
2023	1	-	<1	*	-	-	-	*	-	-	-	*	1	<1	<1	*	566	14	36	*
<b>Total</b>	<b>51</b>	<b>28</b>	<b>4</b>	<b>43,178</b>	<b>-</b>	<b>&lt;1</b>	<b>-</b>	<b>655</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>16,414</b>	<b>943</b>	<b>319</b>	<b>288</b>	<b>94,663</b>	<b>18,374</b>	<b>3,677</b>	<b>2,306</b>	<b>611,561</b>

**Table J-4b.** Minimum number of shark interactions and mortalities in the eastern Pacific Ocean (EPO) in 2022 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 EPO. 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 J-4b.** Número mínimo de interacciones con tiburones y mortalidades en el Océano Pacífico oriental en 2022 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 OPO. 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.

Common name	Scientific name	Interactions	Mortalities
Blue shark	<i>Prionace glauca</i>	16,689	16,344
Silky shark	<i>Carcharhinus falciformis</i>	2,757	2,731
Crocodile shark	<i>Pseudocarcharias kamoharai</i>	2,526	2,350
Pelagic thresher shark	<i>Alopias pelagicus</i>	1,330	1,316
Bigeye thresher shark	<i>Alopias superciliosus</i>	923	870
Short fin mako shark	<i>Isurus oxyrinchus</i>	777	776
Oceanic whitetip shark	<i>Carcharhinus longimanus</i>	765	751
Velvet dogfish	<i>Scymnodon squamulosus</i>	365	279
Scalloped hammerhead shark	<i>Sphyrna lewini</i>	179	179
Smooth hammerhead shark	<i>Sphyrna zygaena</i>	150	150
Longfin mako shark	<i>Isurus paucus</i>	113	112
Sharks, rays, skates, etc. nei	Elasmobranchii	53	53
Thresher shark	<i>Alopias vulpinus</i>	29	19
Thresher shark, nei	<i>Alopias spp.</i>	28	12
Kitefin shark	<i>Dalatias licha</i>	19	19
Various sharks nei	Euselachii	18	-
Great hammerhead	<i>Sphyrna mokarran</i>	13	13
Other sharks*		6	6
Total numbers		26,740	25,980

\*"Other sharks" include those with ≤3 interactions from 3 taxa in 2022

**Table J-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 (1993–2023). Purse-seine set types: floating object (OBJ), unassociated tuna schools (NOA) and dolphins (DEL). Species highlighted bold are discussed in main text. Data for 2022–2023 are considered preliminary.

**Tabla J-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 (1993–2023). 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 2022–2023 se consideran preliminares.

Year	Mobulidae														
	<b><i>Mobula thurstoni</i>, smoothtail manta</b>			<b><i>Mobula mobular</i>, spinetail manta</b>			<i>Mobula munkiana</i> , munk's devil ray			<i>Mobula tarapacana</i> , Chilean devil ray			<b><i>Mobula birostris</i>, giant manta</b>		
	Purse seine			Purse seine			Purse seine			Purse seine			Purse seine		
	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	5	-	98	43	8	25	12	-	4	23	-	12	3	-	8
2023	29	6	92	25	4	39	5	8	226	79	8	10	2	5	3
Total	397	6,911	1,864	720	2,553	2,281	130	847	723	277	710	902	137	2,782	425

Table J-5a Continued

Year	Mobulidae			Dasyatidae						Other rays			All rays		
	Mobulidae spp., mobulid rays, nei			<i>Pteroplatytrygon violacea</i> , pelagic stingray			Dasyatidae spp., stingrays, nei								
	Purse seine			Purse seine			Purse seine			Purse seine			Purse seine		
	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	422	76	187	34	9	7	-	-	-	671	116	437
2023	115	19	80	338	36	175	39	12	5	1	-	20	633	99	650
Total	2,358	25,119	9,681	4,887	15,707	6,514	443	3,471	631	4	3,409	729	9,353	61,509	23,750

**Table J-5b.** Minimum number of ray interactions and mortalities in the eastern Pacific Ocean (EPO) in 2022 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 EPO. 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”, “Alive” and “Escaped”, 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 J-5b.** Número mínimo de interacciones con rayas y mortalidades en el Océano Pacífico oriental en 2022 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 OPO. 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", "Viva" y "Escapada", 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.

Common name	Scientific name	Total interactions	Mortalities
Pelagic stingray	<i>Pteroplatytrygon violacea</i>	4,327	3,936
Manta ray, nei	<i>Mobula</i> spp.	74	73
Giant manta	<i>Mobula birostris</i>	41	36
Spinetail manta	<i>Mobula mobular</i>	2	-
Total numbers		4,444	4,045

**Table J-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 (1993–2023) and minimum reported longline (LL) catches of large fishes (gross-annual removals in t) (1993–2022, \*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 2018–2022 (longline) and 2022–2023 (purse-seine) are considered preliminary.

**Tabla J-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 (1993–2023) y capturas palangreras (LL) mínimas reportadas de peces grandes (extracciones anuales brutas en t) (1993–2022, \*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 2018–2022 (palangre) y 2022–2023 (cerco) se consideran preliminares.

Year	Coryphaenidae				Scombridae				Carangidae											
	<b>Coryphaenidae spp., dorado</b>				<b>Acanthocybium solandri, wahoo</b>				<b>Elagatis bipinnulata, rainbow runner</b>				<b>Seriola spp., amberjacks, nei</b>				<b>Caranx spp., jacks, crevalles, nei</b>			
	Purse seine		LL		Purse seine		LL		Purse seine		LL		Purse seine		LL		Purse seine		LL	
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	-	
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	3,926	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	2,505	130	<1	<1	309	23	-	<1	-	9	1	-	<1	3	<1	<1	
2021	2,183	13	<1	1,413	132	<1	<1	214	28	<1	<1	-	81	3	-	-	3	<1	-	
2022	2,325	12	2	725	164	<1	<1	177	35	<1	-	-	25	4	-	-	6	<1	-	
2023	1,466	4	2	*	267	<1	<1	*	44	<1	<1	*	9	<1	-	*	3	-	-	
<b>Total</b>	<b>41,572</b>	<b>554</b>	<b>36</b>	<b>169,292</b>	<b>11,073</b>	<b>42</b>	<b>10</b>	<b>5,103</b>	<b>1,419</b>	<b>20</b>	<b>&lt;1</b>	<b>-</b>	<b>468</b>	<b>183</b>	<b>&lt;1</b>	<b>2</b>	<b>104</b>	<b>360</b>	<b>9</b>	<b>1</b>

Table J-6a Continued

Year	Carangidae				Molidae				Lobotidae				Sphyraenidae				Lampridae			
	<i>Seriola, Caranx spp., amberjacks, jacks, crevalles, nei</i>				<i>Molidae spp., molas, nei</i>				<i>Lobotes surinamensis, tripletail</i>				<i>Sphyraenidae spp., barracudas</i>				<i>Lampris spp., opahs</i>			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine			
	OBJ	NOA	DEL	LL	OBJ	NOA	DEL	LL	OBJ	NOA	DEL	LL	OBJ	NOA	DEL	LL	OBJ	NOA	DEL	LL
1993	13	35	<1	-	-	20	<1	-	<1	<1	-	-	-	-	-	-	-	-	-	1
1994	19	6	<1	-	1	3	2	-	<1	-	-	-	<1	34	-	-	-	-	-	23
1995	17	19	-	-	2	4	<1	-	<1	<1	-	-	<1	3	-	-	-	-	-	33
1996	29	153	-	-	5	6	<1	-	<1	-	-	-	<1	<1	-	-	-	-	-	33
1997	68	16	3	-	5	4	3	-	1	<1	<1	-	<1	<1	-	-	-	-	-	40
1998	72	7	<1	-	2	2	1	-	16	<1	-	-	<1	<1	-	-	-	-	-	54
1999	52	46	-	-	2	5	1	-	8	<1	-	-	-	-	-	-	-	-	-	68
2000	29	19	<1	4	2	4	1	-	4	<1	-	-	<1	-	<1	-	-	-	-	88
2001	70	<1	<1	18	6	2	1	-	<1	-	-	-	<1	<1	-	-	-	-	-	73
2002	26	9	<1	15	6	2	1	-	3	-	-	-	<1	-	-	-	-	-	-	6
2003	43	<1	<1	54	<1	4	<1	-	3	<1	-	-	<1	-	-	-	-	-	-	132
2004	8	7	<1	-	6	<1	1	-	1	<1	-	-	<1	-	-	-	-	-	-	139
2005	1	<1	-	-	2	9	2	-	7	<1	<1	-	<1	-	<1	-	-	-	-	159
2006	29	-	-	-	26	14	2	-	9	<1	<1	-	<1	-	-	-	-	-	-	109
2007	2	2	-	6	9	8	2	-	3	<1	<1	-	<1	1	-	-	-	-	-	370
2008	4	-	-	5	9	6	4	-	2	<1	-	-	<1	-	<1	-	-	-	-	308
2009	3	<1	<1	10	6	5	1	-	7	<1	<1	-	1	<1	-	-	-	-	-	488
2010	<1	4	-	8	9	44	1	-	<1	-	-	-	<1	-	<1	-	-	<1	-	539
2011	<1	4	-	7	4	113	<1	-	3	<1	-	-	<1	2	<1	8	-	-	-	539
2012	7	1	-	1	9	12	<1	-	3	<1	-	-	<1	<1	-	-	-	<1	-	425
2013	2	<1	-	<1	9	28	2	-	2	-	<1	-	<1	-	<1	-	-	<1	-	648
2014	2	2	-	11	3	9	1	-	2	-	<1	-	<1	<1	-	-	-	<1	-	818
2015	2	-	<1	11	6	12	1	87	2	<1	-	-	<1	-	-	-	-	-	-	1,039
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	-	-	-	-	-	1,102
2019	3	<1	-	-	2	6	<1	-	2	-	<1	-	<1	-	-	-	-	-	<1	740
2020	<1	1	-	-	1	<1	<1	-	2	<1	-	-	<1	-	-	-	-	-	-	684
2021	2	<1	-	-	<1	2	<1	-	1	<1	-	-	1	<1	-	-	-	-	-	449
2022	4	<1	-	-	2	2	<1	-	4	<1	<1	-	<1	-	-	-	-	-	-	223
2023	1	-	-	*	2	<1	<1	*	2	-	<1	*	2	-	<1	*	-	-	-	*
Total	523	341	5	162	161	339	35	362	100	<1	<1	-	13	41	<1	8	-	<1	<1	10,922



**Table J-6a Continued**

Year	<i>Gempylidae</i> spp., snake mackerels, nei				<i>Bramidae</i> spp., pomfrets, nei				Other large fishes				Unidentified fishes				All fishes			
	Purse seine			LL	Purse seine			LL	Purse seine			LL	Purse seine			LL	Purse seine			LL
OBJ	NOA	DEL	OBJ		NOA	DEL	OBJ		NOA	DEL	OBJ		NOA	DEL	OBJ		NOA	DEL	OBJ	
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	6,116
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	5,303
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	3,752
2020	-	-	-	288	-	-	-	70	<1	-	-	213	<1	<1	<1	462	953	9	<1	4,532
2021	-	-	-	302	-	-	-	50	<1	<1	-	<1	<1	<1	-	1,153	2,432	19	1	3,607
2022	-	-	-	194	<1	-	-	53	<1	<1	-	<1	<1	-	-	1,864	2,564	19	3	3,236
2023	-	-	-	*	<1	<1	-	*	<1	-	-	*	-	-	-	*	1,796	5	3	*
<b>Total</b>	<b>&lt;1</b>	<b>-</b>	<b>-</b>	<b>6,121</b>	<b>&lt;1</b>	<b>&lt;1</b>	<b>-</b>	<b>1,480</b>	<b>57</b>	<b>298</b>	<b>&lt;1</b>	<b>629</b>	<b>75</b>	<b>24</b>	<b>13</b>	<b>30,640</b>	<b>55,565</b>	<b>2203</b>	<b>108</b>	<b>224,721</b>

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**Table J-6b.** Minimum number of interactions and mortalities of large fishes in the eastern Pacific Ocean (EPO) in 2022 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 EPO. 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 J-6b.** Número mínimo de interacciones y mortalidades de peces grandes en el Océano Pacífico oriental en 2022 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 OPO. 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.

Common name	Scientific name	Interactions	Mortalities
Long snouted lancetfish	<i>Alepisaurus ferox</i>	13,613	13,599
Escolar	<i>Lepidocybium flavobrunneum</i>	6,110	6,036
Dorado, mahi mahi, dolphin fish, nei	<i>Coryphaena</i> spp.	4,439	4,439
Opah	<i>Lampris guttatus</i>	3,169	3,166
Snake mackerel	<i>Gempylus serpens</i>	2,967	2,923
Pomfrets, ocean breams nei	Bramidae	2,036	2,033
Wahoo	<i>Acanthocybium solandri</i>	1,693	1,693
Sickle pomfret	<i>Taractichthys steindachneri</i>	1,511	1,321
Common dolphinfish	<i>Coryphaena hippurus</i>	1,426	1,420
Oilfish	<i>Ruvettus pretiosus</i>	661	649
Pompano dolphinfish	<i>Coryphaena equiselis</i>	528	528
Snake mackerels, escolars nei	Gempylidae	84	84
Mackerels nei	Scombridae	51	51
Ocean sunfish, Mola	<i>Mola mola</i>	43	35
Rough pomfret	<i>Taractes asper</i>	31	23
Barracudas nei	<i>Sphyrna</i> spp.	30	30
Slender tuna	<i>Allothunnus fallai</i>	27	27
Butterfly kingfish	<i>Gasterochisma melampus</i>	23	23
Other large fishes*		109	97
Total numbers		38,551	38,177

\*"Other large fishes" includes those with <15 interactions from 19 taxa in 2022.

**Table J-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 (1993–2023) and minimum reported longline (LL) catches of small forage fishes (gross-annual removals in t) (1993–2022, \*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 2018–2022 (longline) and 2022–2023 (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 J-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 (1993–2023) y capturas palangreras (LL) mínimas reportadas de peces forrajeros pequeños (extracciones anuales brutas en t) (1993–2022, \*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 2018–2022 (palangre) y 2022–2023 (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*).

Year	<b>Auxis spp., bullet and frigate tunas</b>				<b>Balistidae, Monacanthidae spp., triggerfishes and file- fishes</b>				<b>Kyphosidae, sea chubs</b>				<b>Epipelagic forage fishes</b>				<b>Small Carangidae spp., carangids, nei</b>				<b>Other small fishes</b>			
	Purse seine				Purse seine				Purse seine				Purse seine				Purse seine							
	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	687	17	<1	-	543	2	<1	-	21	1	-	-	15	-	<1	-	<1	<1	-	-	1	3	<1	-
2023	596	<1	<1	*	522	<1	<1	*	12	-	-	*	7	<1	<1	*	3	<1	<1	*	1	12	<1	*
Total	24,694	6,047	496	-	8,325	48	16	-	457	2	<1	-	125	29	<1	<1	26	6	<1	<1	1,185	111	51	78

**Table J-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 2023 for size-class 1–5 vessels with a carrying capacity <363 t as reported by observers in 44% of all trips that carried an observer. Purse-seine set types: floating object (OBJ) and unassociated tuna schools (NOA).

**Tabla J-8a.** Capturas cerqueras nominales mínimas de a) tiburones, peces grandes y peces pequeños, en toneladas (t), y b) rayas en número de individuos en 2023 para buques de clases 1-5 con una capacidad de acarreo <363 t según lo reportado por los observadores en el 44% de todos los viajes que llevaban observador a bordo. Tipo de lances cerqueros: objeto flotante (OBJ) y atunes no asociados (NOA).

**a.**

Broad group	Common name	Scientific name	Set type	
			OBJ	NOA
Sharks	Silky shark	<i>Carcharhinus falciformis</i>	30	<1
	Oceanic whitetip shark	<i>Carcharhinus longimanus</i>	<1	
	Other Carcharhinidae spp.	Carcharhinidae spp.	<1	
	Smooth hammerhead shark	<i>Sphyrna zygaena</i>	3	
	Scalloped hammerhead shark	<i>Sphyrna lewini</i>	3	
	Great hammerhead shark	<i>Sphyrna mokarran</i>	<1	
	Hammerhead shark, nei	<i>Sphyrna</i> spp.	<1	
	Pelagic thresher shark	<i>Alopias pelagicus</i>	<1	
	Mako shark	<i>Isurus</i> spp.	<1	
	Other shark		<1	
Large fishes	Dorado	Coryphaenidae spp.	268	<1
	Wahoo	<i>Acanthocybium solandri</i>	36	
	Rainbow runner	<i>Elagatis bipinnulata</i>	4	
	Amberjack, nei	<i>Seriola</i> spp.	3	
	Jacks, crevalles, nei	<i>Caranx</i> spp.	<1	
	Amberjack, jack, crevalles, nei	<i>Seriola, Caranx</i> spp.	<1	
	Tripletail	<i>Lobotes surinamensis</i>	<1	
	Mola, nei	Molidae spp.	<1	
Other large fish		<1		
Small fishes	Bullet and frigate tunas	<i>Auxis</i> spp.	253	
	Triggerfishes, Filefishes	Balistidae, Monacanthidae spp.	122	
	Sea chubs	Kyphosidae spp.	1	
	Small carangid, nei	Carangidae spp.	2	
	Epipelagic forage fishes		1	
	Other small fish		<1	

**b.**

Broad group	Common name	Scientific name	OBJ	NOA
Rays	Pelagic stingray	<i>Pteroplatytrygon violacea</i>	30	1
	Chilean devil ray	<i>Mobula tarapacana</i>	13	
	Spinetail manta	<i>Mobula mobular</i>	6	2
	Smoothtail manta	<i>Mobula thurstoni</i>	4	
	Munk's devil ray	<i>Mobula munkiana</i>	3	
	Giant manta	<i>Mobula birostris</i>	2	
	Stingray nei	Dasyatidae spp.	2	
	Mobulidae ray, nei	Mobulidae spp.	1	