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Special Report 25
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HISTORY OF THE IATTC BYCATCH DATA COLLECTION AND DESCRIPTION OF THE 'BYCATCH DATABASE' FOR USE IN ECOSYSTEM AND BYCATCH RESEARCH

HISTORIA DE LA RECOLECCIÓN DE DATOS DE CAPTURA INCIDENTAL POR LA CIAT Y DESCRIPCIÓN DE LA 'BASE DE DATOS DE CAPTURA INCIDENTAL' PARA SU USO EN LA INVESTIGACIÓN ECOSISTÉMICA Y DE CAPTURA INCIDENTAL

By-Por

Leanne Fuller, Nick Vogel, Shane Griffiths, Marlon H Román, and Cleridy Lennert-Cody

La Jolla, California, USA

2022

The Antigua Convention, which was negotiated to strengthen and replace the 1949 Convention establishing the Inter-American Tropical Tuna Commission (IATTC), entered into force on 27 August 2010. The IATTC is responsible for the conservation and management of the "stocks of tunas and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna-like species" in the eastern Pacific Ocean, and also for the conservation of "species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by [the] Convention."

The members of the Commission and the Commissioners are listed in the inside back cover of this report.

The IATTC staff's research responsibilities are met with four programs, the Data Collection and Data Base Program, the Biology and Ecosystem Program, the Stock Assessment Program, and the Bycatch Program and International Dolphin Conservation Program.

An important part of the work of the IATTC is the publication and wide distribution of its research results. These results are published in its Bulletin, Special Report, Data Report series, and papers in outside scientific journals and chapters in books, all of which are issued on an irregular basis, and its Stock Assessment Reports and Fishery Status Reports, which are published annually.

The Commission also publishes Annual Reports and Quarterly Reports, which include policy actions of the Commission, information on the fishery, and reviews of the year's or quarter's work carried out by the staff. The Annual Reports also contain financial statements and a roster of the IATTC staff.

Additional information on the IATTC's publications can be found in its web site.

La Convención de Antigua, negociada para fortalecer y reemplazar la Convención de 1949 que estableció la Comisión Interamericana del Atún Tropical (CIAT), entró en vigor el 27 de agosto de 2010. La CIAT es responsable de la conservación y ordenación de las "poblaciones de atunes y especies afines y otras especies de peces capturadas por embarcaciones que pescan atunes y especies afines" en el Océano Pacífico oriental, así como de la conservación de "especies que pertenecen al mismo ecosistema y que son afectadas por la pesca de especies de peces abarcadas por la … Convención."

En la contraportada del presente informe se alistan los miembros de la Comisión y los Comisionados.

Las responsabilidades de investigación del personal de la CIAT son realizadas mediante cuatro programas: el programa de recolección de datos y bases de datos, el programa de biología y ecosistemas, el programa de evaluación de poblaciones, y el programa de captura incidental y el Acuerdo sobre el Programa Internacional para la Conservación de los Delfines.

Una parte importante del trabajo de la CIAT es la publicación y amplia distribución de los resultados de sus investigaciones. Se publican los mismos en sus series de Boletines, Informes Especiales, Informes de Datos, y publicaciones en revistas científicas externas y capítulos en libros, todos de los cuales son publicados de forma irregular, y sus Informes de la Condición de las Poblaciones e Informes de la Situación de las Pesquerías, publicados anualmente.

La Comisión publica también informes anuales y trimestrales, los que incluyen acciones de política de la Comisión, información sobre la pesquería, y resúmenes de trabajo realizado por el personal en el año o trimestre correspondiente. Los informes anuales contienen también un estado financiero y una lista del personal de la CIAT. Se presenta información adicional sobre las publicaciones de la CIAT en su sitio web.

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1. ABSTRACT

Since its inception, the primary responsibility of the Inter-American Tropical Tuna Commission (IATTC) has been to ensure the sustainable exploitation of principal species of tuna and tuna-like fishes. When the Antigua Convention entered into force in 2010, the IATTC extended its responsibilities to include the ecological sustainability of its tuna fisheries. Observers onboard purse-seine vessels targeting tropical tunas in the eastern Pacific Ocean (EPO) have collected data on the incidental catch of non-target species (*i.e.,* "bycatch") associated with tuna fishing operations for over four decades. The scope of this data collection effort has evolved over time. Bycatch data on marine mammals have been collected since the late 1970s. In the late 1980s, bycatch data collection for sets on floating objects was initiated, and in the early 1990s bycatch data collection began for all species in all set types, with a view for these data to support ecosystem approaches to fisheries management. This wealth of information allows IATTC scientists to conduct various analyses on bycatch species to guide managers and policy makers on potential conservation and management issues. However, not only has the scope of the data collection changed over time, but so have the methods of collection, storage and reporting of bycatch data, in response to changes in financial and staff resourcing, as well as political drivers such as increased scientific and public awareness of potential ecological impacts of tuna fishing. Therefore, in an attempt to maintain transparency in data collection and processing methods, this paper describes the history of bycatch data collection, the bycatch database, methods used to generate summary data tables from the database, and efforts made to improve bycatch data collection and management. Such efforts are aimed at optimizing the quality of data for the purposes of estimating bycatch mortality by tuna fisheries in the EPO, which in turn will enhance the quality of the various analyses that these data may be used for to guide conservation and management efforts for individual bycatch species and the supporting ecosystem more broadly.

2. INTRODUCTION

The ecosystem approach to fisheries management (EAFM) emerged from the 1995 Food and Agriculture Organization (FAO) Code of Conduct for Responsible Fisheries (FAO 1995), that provided a voluntary international framework for responsible fishing practices with ecosystem conservation and the economic and social benefits ecosystems provide to society at its forefront. The Code specifies, "*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*"[1]. In 2001, the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem further sought to effectively implement the FAO Code of Conduct and to incorporate ecosystem considerations and sustainable fishing practices into fisheries management strategies (FAO 2001). To align with these instruments, the Inter-American Tropical Tuna Commission (IATTC) considers ecosystem issues in its management and decision-making processes (Fuller and Griffiths 2019) and has adopted several Resolutions pertaining to bycatch species (IATTC 2019a). The IATTC is mandated under the 2003 Antigua Convention—entering into force in 2010—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*" (IATTC 2003).

Long before the implementation of the Antigua Convention, IATTC observers onboard purse-seine vessels fishing for tunas in the eastern Pacific Ocean (EPO) began collecting data on non-target species, hereafter termed "bycatch", to advocate for responsible fishing practices with a goal to obtain data on species sharing the same ecosystem as the targeted tunas and tuna-like species. In 1993, IATTC staff created the 'Bycatch database' to house these data. Temporal and spatial coverage within the IATTC Convention Area (Figure 1) and species identification has improved considerably over the last two decades. Improvements to species-level bycatch reporting for the purse-seine fleet can be attributed to improved observer training, expansion of a species code table available to observers, development of taxa-specific characteristic data forms and computer algorithms to validate the observers' species identification for several taxa (*i.e.,* turtles, sharks, billfishes, rays) and the 100% observer coverage for trips by large 'size class 6' purse-seine vessels—defined as those with a carrying capacity >363 metric tons (mt). With the adoption of the Antigua Convention and the IATTC's focus on the management of target tunas, bycatch species and ecosystem integrity, it is timely to comprehensively describe the various bycatch datasets included in the Bycatch database held by the IATTC to continue and improve bycatch and ecosystem-related routine reporting and specific research conducted by staff.

Bycatch data are used by various scientific research programs within the IATTC, each having different objectives defined by the goals outlined in the IATTC Strategic Science Plan (SSP) for 2019–2023 (see Document IATTC-93-06a, IATTC 2018). For example, under theme 4 *Ecological Impacts of Fisheries: Assessment and Mitigation*, the Ecosystem and Bycatch Program has two primary goals. Goal L aims to "*evaluate the ecological impacts of tuna fisheries*", while Goal M aims to "*mitigate the ecological impacts of tuna fisheries*". Other themes in the SSP with goals that include data on bycatch are themes 3, *Sustainable Fisheries*, and 5, *Interactions among the Environment, the Ecosystems, and Fisheries*. Research outputs from staff's analyses are subsequently used to inform management of potential conservation and management issues to guide the decision-making processes.

The objectives of this paper are to provide a description of 1) the history of IATTC's bycatch data collection and modifications made over the years and 2) the Bycatch database. This report is aimed at informing users of such historical changes to ensure appropriate usage of the data and interpretation of results from

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

specific analyses related to the goals outlined above. Because changes to the database are routinely undertaken for a variety of reasons, we caution the reader that the information provided about the database is relevant only to September 2021.

The following terms are used throughout this paper to describe bycatch and are defined here for clarification. “Bycatch” is defined as any non-target species that is caught by the fishing gear during a fishing operation. “Capture” and/or “catch” is defined as target or non-target taxa that died during fishing operations, “retained” catch is defined as target or non-target taxa captured and retained onboard the vessel, and “discarded” catch is defined as target or non-target taxa that died during fishing operations but not utilized in any way. Animals returned to the sea alive are not included in capture data reported by observers. Data on live release is available for marine mammals (from 1979), sea turtles (from 1990), sharks (from 2004), and rays (from 2016), and these data are additional to quantities reported as capture by observers (*i.e.,* mortality).

A summary of data collection by taxa is provided in Table 1 as a brief introduction to the types of data recorded by observers onboard the purse-seine vessels, while details of the various data forms (Appendices A-F) are provided below in sections ‘*Marine Fauna Record’* and ‘*Development of Dedicated Species Forms*’. Additionally, a timeline of data collection and revisions is provided as a concise reference guide in Table 2 with discussion of each item in the pertinent sections below.

3. HISTORY OF THE BYCATCH DATABASE

3.1. Establishment of the Bycatch database

Observers from the IATTC have worked onboard purse-seine vessels in the EPO since 1979. Vessels of 364 mt or greater carrying capacity (*i.e., ‘*size class 6’) carried observers on a percentage of their trips to collect information on sightings of marine mammals, interactions between the fishery and marine mammal populations, fishery operational characteristics and catch of target species (Joseph 1994). The first non-mammal bycatch data began to be collected by observers in 1987, but these data were limited to purse-seine sets on floating objects (see section ‘*Flotsam Information Record’*). In 1990, observers began collecting data on sea turtles, both sightings of animals unassociated with fishing operations and interactions with animals during sets. By 1992, nearly 100% observer coverage by IATTC and National Program observers was attained (Joseph 1994), and the 1992 Agreement on the Conservation of Dolphins (the La Jolla Agreement) mandated observers be present on all trips for size class 6 vessels[2] in 1993. At this time, the collection of non-mammal bycatch data was initiated for all purse-seine set types (see section ‘*Marine Fauna Record*’) and the Bycatch database was fully developed. The percent coverage of sets containing bycatch data can be found in Table 14 of IATTC’s 2010 annual report (IATTC 2015).

3.2. National Observer Programs

Additional to the observer mandate in the La Jolla Agreement, a provision was included to allow Parties to establish their own national observer programs. Up to 50% of purse-seine trips undertaken by a participating government was permitted to be monitored by observers from that country’s national observer program, while the remaining 50% of trips are required to be monitored by IATTC observers (see footnote 2). Several Parties have established national observer programs, and most are still active today (Figure 2).

[2] https://www.iattc.org/PDFFiles/AIDCP/_English/AIDCP_La%20Jolla%20Agreement.pdf (see paragraph 12)

The IATTC and national observer programs use identical data collection forms, all data are processed with the same rigorous editing standards, and all data are stored in a database with identical structure, with two exceptions. The first applies to the United States, which began collecting data in 1966; however, a formal sampling program was not established until 1974 (Wahlen 1986). Their original database format differed from that of the IATTC, and therefore, these data are not housed in the IATTC Bycatch database. In 1990 the United States adopted the IATTC database format, which continued until the dissolution of their observer program in 1994. The second exception is Mexico, which established a national observer program in late 1991. From 1992–2008, data were processed and stored in a format different from that of the IATTC database. As a result, detailed trip data, including bycatch data, for trips sampled by the Mexican national observer program from 1992–2008 are not currently housed in the IATTC database. In 2009, Mexico adopted the database structure and data processing procedures used by the IATTC and other national observer programs. Venezuela, Ecuador, and the European Union observer programs started providing data to the IATTC in the early 2000s, while Colombia, Panama and Nicaragua's programs started in the mid-2000s. More recently, in 2018, the Tuna Conservation Group (TUNACONS)—a consortium of Ecuadorian tuna fishing companies—established a voluntary observer program with the primary purpose to attain certification by the Marine Stewardship Council (MSC) for smaller purse-seine vessels (carrying capacity ≤363 mt, termed 'class 1–5 vessels'). In 2020, the TUNACONS observer program sampled about 22% of these Ecuadorian-flagged trips, and an additional 8% of trips were sampled by IATTC and Ecuadorian observer programs. Observer coverage onboard class 1–5 vessels prior to the TUNACONS program has been sporadic, primarily constrained to the IATTC and Ecuadorian observer programs, because observers are not required on these vessels. As such, limited to no data on bycatch is available for these small vessels (see Document SAC-11-12, IATTC 2020). Observers from the TUNACONS and other national observer programs have collected bycatch data from the inception of their programs to present, and annually submit these data to the IATTC (Figure 2). Each national observer program processes their own data but use the same computer program and editing routines as the IATTC. They then submit their edited data to the IATTC, and data are stored in the IATTC database.

4. OBSERVER TRAINING IN SPECIES IDENTIFICATION

Prior to their first trip to sea onboard a purse-seine vessel, trainee observers receive instruction on species identification and are introduced to the key diagnostic characteristics of the more common tuna and non-tuna species they are likely to encounter. Since 1979, observers have received extensive training in the identification of marine mammal species. In 2005, a manual[3] was created by IATTC scientists to assist observers in identifying commonly caught species, other than marine mammals. The manual is based on the species identification guides published by the FAO (Fischer *et al.* 1995a, Fischer *et al.* 1995b) and provides pictures and diagnostic characteristics of various species. Additionally, video presentations have been created to assist observers with identification of common sharks, turtles and fishes encountered in the fishery and are available for download from the IATTC website[4,5,6]. Observers also carry turtle and fish identification guides as part of their gear. The training provides observers with the tools and knowledge needed to correctly identify species and record relevant information on the bycatch forms.

[3] Guía de identificación de peces involucrados en la pesca atunera de cerco en el OPO
[4] http://www.iattc.org/Downloads/Video-de-identificacion-de-tiburones-2009-09.avi
[5] http://www.iattc.org/Downloads/Video-de-identificacion-de-tortugas-2009-09.avi
[6] http://www.iattc.org/Downloads/Video-de-identificacion-de-otros-peces-2009-09.avi

4.1. Species codes table

Prior to 2004, a limited number of taxonomic codes—developed by the IATTC and unique to the observer program—were provided to observers (Table 3) for recording non-tuna species captured during fishing operations. This list included specific codes for the most common bycatch species encountered in the purse-seine fishery and generic codes for unidentified billfishes (120, 121), other sharks (150), unidentified sharks (154), other large fishes (130), other small fishes (140), unidentified fishes (170), unidentified turtles (160), invertebrates (171), and other fauna (172). Only four species-specific or species-complex (*i.e.,* composite taxa) codes for large fishes were included in this original species list: mahi mahi (*Coryphaena* spp.; 131), wahoo (*Acanthocybium solandri*; 132), rainbow runner (*Elagatis bipinnulata*; 133) and yellowtail (*Seriola, Caranx* spp.; 134), while other large fishes were assigned code 130. Only triggerfishes and filefishes (grouped as Balistidae, Monacanthidae; 141) had a dedicated code, while all other small fishes were assigned to code 140. For sharks, 3 species-specific codes were established for oceanic whitetip shark (*Carcharhinus longimanus*; 152), silky shark (*C. falciformis*; 157), and blacktip shark (*C. limbatus*; 151). Species code 153 was used for all species of hammerhead shark (*Sphyrna* spp.), while other sharks (*e.g.* thresher sharks and other carcharhinid sharks) were assigned to the general shark code 150. In 2004, a decision was made to include every reliably identified species in the database (see section '*Recoding species in existing bycatch records*').

5. DATA COLLECTION SCHEME

IATTC observers began collecting information on purse-seine fishing operations in the late 1970's. A timeline showing the implementation of the various forms used to collect data is displayed in Figure 3. This section focuses on the first data forms used to collect bycatch information, namely the floating object form "Flotsam Information Record" and the bycatch form "Marine Fauna Record". Specialized species forms are discussed in section '*Development of Dedicated Species Forms*'.

5.1. Flotsam Information Record

The first non-mammal bycatch data collected by observers were recorded on the IATTC "Flotsam Information Record" (FIR) in 1987. This form was designed to collect information on the number and type of floating objects involved in sets made by purse-seine vessels, as well as sightings of objects not involved in sets. The FIR included a section containing faunal taxa observed to be associated with the floating object. For each taxon, observers recorded their estimates of the number of individuals and/or total weight, minimum and maximum weight, and length based on observations before the catch was brought onto the vessel. A separate estimate was made of the number or weight of animals of each taxon that perished during the set, in an attempt to quantify the proportion of the taxon that escaped the set, presumably alive. However, early analyses revealed that observers were unable to accurately identify the taxonomic composition of the fauna present before the set was made. Experience gained from using the FIR led to the development of the "Marine Fauna Record" (MFR), which became the tool for collecting non-mammal bycatch information for all purse-seine set types.

5.2. Marine Fauna Record

The MFR form was developed in 1993 to allow observers to collect information on the fauna captured during purse-seine sets (Appendix A) and, with the exception of seabirds (see below), contains information only on animals that were killed during the fishing operation. Bycatch escaping the set alive, returned to the sea alive, or entangled in a floating object are not recorded on the MFR. In 1997, the MFR was modified so that observers could use a code to record a discard reason for tunas (*i.e.*, species undesirable for the market, condition undesirable for the market, ripped sack, vessel full, well limitation, or other). For non-tunas, in 1997 a destiny field was included (*i.e.,* human consumption, discarded, or a mixture of both human consumption and discarded). Seabirds are the only fauna for which sightings data, as opposed to mortalities, are recorded on the MFR.

The initial version of the MFR contained five sections for the different taxonomic groups: 1) tuna catch and discards, 2) billfishes, sharks, and rays, 3) sea turtles, large- and medium-sized fish, 4) small fish, invertebrates, and other fauna, and 5) seabird sightings. Information on marine mammals, including sightings and numbers involved in various stages of the fishing operation (*e.g.* chase and encirclement) are recorded on a separate specialized form "Marine Mammal Sighting and Set Record" (MMSSR, Appendix F). In contrast to the FIR, the MFR does not contain a section on fauna present before the set.

Prior to 2004, observers used the limited species codes available (see section above '*Species codes table*') to record the species identification of the bycatch that died during the set. However, because some observers have a stronger interest in species identification than others, if an observer was able to positively identify a species of any fish not listed in this code table, they were instructed to document the scientific and common name of the species in the 'Comments' section of the MFR and use one of the 'other' codes to indicate catch of an identified species not present in the species code table. Observers also used the general species codes where required, for example to record the hammerhead shark genus *Sphyrna*, but in the 'Comments' section the actual species (*e.g.* smooth hammerhead, *Sphyrna zygaena*). These codes and notations on the paper forms were later used to recover species information during a process initiated to expand the species table to include all species encountered in the fishery (see section '*Recoding species in existing bycatch records*').

Observers are trained to take a conservative hierarchical approach to species identification. If they feel confident to accurately identify an animal to species, they record the common and scientific name on the data form. If the genus is known, but the species is questionable, observers record only the genus, and assign the appropriate taxonomic code. If the genus cannot be determined, the observer uses one of the general taxonomic codes (*e.g.* 'Unidentified shark' or 'Unidentified fish'). The observer may also record comments, such as key diagnostic characteristics for species identification, but these are generally not provided.

5.3. MFR: Tuna

The tuna section of the MFR is divided into capture and discard sections. The weight of tuna retained during a fishing operation is recorded in the capture section, while the weight of tuna returned to the sea—presumably dead—is recorded in the discard section. Tuna escaping the set or returned to the sea alive is not recorded. Observers are trained to estimate the catch weight of each species of tuna by size category; as small (<2.5 kg), medium (2.5–15.0 kg), and large (>15.0 kg). These size categories were defined based on tuna cannery preferences at the time. Tuna <2.5 kg are generally not accepted by canneries and are therefore often discarded at sea, while tuna >15.0 kg are highly desirable. If the observers could not determine the catch weight of tuna by size category, they had the option to simply record their estimate of the total catch of each species of tuna. Initially, tuna was recorded in short tons[7] to the nearest 100th of a ton. Observers were not expected to make estimates to this precision, but the

[7] A short ton is 2,000 pounds of mass, or 907.18474 kilograms. A metric ton (mt) is 1,000 kilograms.

precision was provided to allow observers to record quarter and half tons (*e.g.* 0.25 and 5.50). The sum of the tonnage by size category was required to sum to the total for the species. If the entire catch of a species could not be disaggregated by size, all three size category fields would remain blank and only the total catch would be recorded on the form.

In 2000, beginning with IATTC trip number 4760, observers were instructed to begin collecting all tuna catch data in metric tons (mt)[7] rather than in short tons. At the same time, all existing short ton data in the IATTC database tables were converted to metric tons. The original weight unit of each record of a table containing weight data can be found in the field '*TonOrigUnit'*.

Tuna catch is also recorded on the Daily Activity Record (DAR) in whole metric tons. Tuna loaded onto the vessel is recorded on the DAR, while tuna discarded to the sea is recorded on the MFR. The tuna catch and load information from the DAR is available from the inception of the observer database in 1979, while the tuna catch and discard information from the MFR is only available from the implementation of the MFR form in 1993. However, since the implementation of the MFR, the DAR tuna catch information is primarily used as a quality control, cross-checking procedure to corroborate the tuna catch on the MFR, which is recorded in decimal metric tons. While there is redundancy in recording the same data on two forms, this provides an important cross-check for tuna species and catch composition.

5.4. MFR: Non-tuna

In contrast to the tuna catch, from 1993–2004, observers had the option to record non-tuna species in weights or numbers of individuals. In 2004 observers were instructed to record bycatch in numbers only. Similar to tuna, observers use three size categories for bycatch (described for each species group below). The sum of the numbers of individuals or weight by size category must be equal to the total. If the entire catch of a species cannot be estimated by size category, all three size boxes on the form remain blank and only the total catch is recorded. When the form was initially implemented (1993), almost all of the bycatch was assumed to be discarded at sea, so the form did not include a method for recording the disposition of the bycatch (*e.g.* retained or discarded) until it was revised in 1997.

5.5. MFR: Billfishes, Sharks and Rays

The billfish, shark, and ray section of the MFR was designed to record catches of large fishes within three size categories: small (<90 cm), medium (90–150 cm), and large (>150cm). The length of individual animals is estimated rather than being measured to avoid interfering with fishing operations—using post-orbital fork length (billfishes), total length (sharks), and disc width (rays)—and assigned to the appropriate size category.

Although dolphins are considered large fauna that would normally be recorded in this section of the form, dolphins that die in fishing operations are not recorded on the MFR to avoid duplication of dolphin mortality data recorded by observers on the specialized MMSSR form (Appendix F).

5.6. MFR: Turtles and other Large- and Medium-sized fish

This section is identical to the Billfishes, Sharks and Rays section, except that the size categories have been modified to be relevant to the size range of fishes included in this section as: small (<30 cm), medium (30–60 cm), and large (>60 cm). Turtle length is estimated using curved carapace length, while fish length is estimated using fork length.

5.7. MFR: Small fish, Invertebrates, and other fauna

This section of the form is used for fish species that are not typically greater than 30 cm in length. For this reason, size categories were not added to the section. Additionally, invertebrates and other fauna not categorized in other sections (*e.g.* sea snakes) are recorded here.

5.8. MFR: Seabird sightings

Observers record the species and number of seabirds associated with the tuna before the set. Prior to the implementation of the MFR in 1993, information on presence of seabirds was recorded on the FIR form. However, the FIR form related only to seabirds associated with floating objects. With the implementation of the MFR form, seabird sightings from all purse-seine set types were recorded, and seabird data collection was removed from the FIR form when the form was redesigned in 2005. The downside of this change was that seabird sighting data was no longer collected for sightings of floating objects not involved in a set, since an MFR form is filled only when a set is made.

5.9. Methods for observer catch estimation

Observers are trained to estimate the tonnage of tuna captured and loaded onto the vessel. The most common practice is to count the number of brailers—smaller nets used to transfer catch from the purse seine to the vessel—required to empty the purse seine. The brailers typically held around 2 mt of fish in the 1990's, but the use of larger brailers in the 2000s has increased this amount to around 5 mt. The chief engineer of the vessel also makes an estimate of the total tuna catch in the set based on the amount of tuna that is typically required to fill a vessel well of known capacity. As a result, observers form their catch estimates by counting brailers, comparing estimates with the chief engineer, and based on their own experience.

It is worth noting that the estimates of total annual purse-seine catches of bigeye, yellowfin and skipjack tuna that are used in the tuna stock assessments and shown in the Fishery Status Reports are not based on the species composition reported by observers and chief engineers. There can be difficulty in correctly identifying yellowfin and bigeye tuna (Schaefer 1999). This difficulty prompted a decision in 2000 to expand the type of data collected by the IATTC port-sampling program to include data that could be used to estimate tuna catch species composition for the three target tuna species (see Appendix in Suter 2010). (Port-sampling data are collected by IATTC staff when vessels unload their catch in port.) A description of the methodology and the port-sampling data collection protocol for species composition distributions that have been used since 2000 to estimate tuna catches for stock assessments and annual reporting in the Fishery Status Reports can be found in Tomlinson (2002, 2004), Suter (2010) and IATTC (2019b). Despite this, observer and logbook data on tuna catch by species are still used extensively in IATTC research. This is because of their high level of coverage of the purse-seine fishery in space and time, their fine scale resolution, and in the case of observer data, the link they provide between tuna species catch and detailed information on operational characteristics and catch of non-target species.

Additionally, when a set contains a lot of non-tuna catch, it can be difficult to estimate the species composition and their respective quantities. Historically, observers were allowed to record the capture of non-tuna species either in numbers of individuals, weight, or through special codes to indicate 'few', 'moderate', or 'large' amounts of fish (codes '-1', '-2' and '-3' respectively). These codes were discontinued around 1997 when IATTC staff determined that the codes were too subjective to have any meaningful value in scientific analyses.

5.10. Elimination of option to record bycatch in weight

After a decade of bycatch data collection, IATTC staff determined that there was significant ambiguity when converting weight data to numbers to generate the Bycatch table (see section '*Derived Bycatch and BycatchWeight Tables'*), where catches (mortalities) are expressed as number of individuals. For example, the difference between an estimate of 2 tons *versus* 3 tons of small fishes could result in tens of thousands of additional fish when converting from weight to number of individuals. At the time, number of individuals was the preferred unit for quantifying catch of all taxa caught as bycatch. Therefore, it was decided that the accuracy of observer estimates could be improved by eliminating the option to record catch in weight. This change to the data collection instructions was implemented in 2004.

6. DEVELOPMENT OF DEDICATED SPECIES FORMS

To improve data collection for species groups caught as bycatch (*e.g.* turtles, sharks, billfishes, rays), dedicated forms were developed to allow observers to take at-sea measurements and to provide identification characteristics. This eliminated the need to record data for these species groups on the MFR form. Tunas and all other fishes and bird sightings continue to be reported on the MFR form. As previously mentioned, comprehensive data on fishery interactions involving marine mammals (*e.g.* estimates of numbers of dolphin sightings, the chase, encirclement, live release, rescue efforts, condition) have been collected since 1979 (Fig. 3) on the specialized MMSSR (Appendix F). Marine mammals have therefore not been recorded on the MFR to avoid duplication of mortalities. A brief summary of the data collected on the MFR and dedicated species forms is provided in Table 1 and details of the types of information recorded are shown in the actual forms (Appendices A-F). A timeline showing the implementation of the various data collection forms is illustrated in Figure 3.

6.1. Elimination of turtle data collection on the MFR

Since 1990 sea turtle information (sightings, involvement in sets) has been recorded by observers on a dedicated turtle data form, the Sea Turtle Record (STR) (Appendix B). As the MFR form contains data on all species, other than dolphins, captured by the fishery, the same turtles that died during fishing operations were recorded on both the STR form and the MFR form. Beginning in 2000, observers were instructed to stop recording information on incidental turtle mortalities in the fishery on the MFR form and instead record the information exclusively on the STR form. Turtles recorded on the MFR form prior to 2000 were compared to turtles recorded on the STR form, and all inconsistencies were corrected. Since the STR form collects more detailed data than the MFR form (*e.g.* identification characteristics, activity, condition upon leaving the turtle, and individual measurements), STR data were used where a data discrepancy was found. Once the STR forms were routinely being completed by observers, all turtle data recorded on the MFR form was deleted from the MFR tables to eliminate the potential for double counting the same individual when both data sources are used in a database query.

6.2. Elimination of shark data collection on the MFR

At the end of 2004 an enduring problem with shark misidentification, specifically related to the misidentification of silky sharks as blacktip sharks, was addressed with the introduction of the Shark Record (SR) form, which includes identification characteristics (Appendix C). The misidentification issue is briefly described below in '*Misidentification of silky sharks as blacktip sharks'* and detailed in Román-Verdesoto and Orozco-Zöller (2005). The SR form is specifically dedicated to shark species captured in the fishery. Observers ceased recording shark mortality on the MFR form when the new SR form was used during a trip. By the end of 2005, all observer programs recorded shark interactions and mortality on the

SR form and ceased to record shark mortality on the MFR. At this time, diagnostic identification characteristics, individual length measurements and fate data (*i.e.,* retained, discarded, live release, other, unknown) began to be recorded on the SR form.

6.3. Elimination of billfish data on the MFR

In late 2006 the IATTC introduced a dedicated billfish form, the Billfish Record (BFR) (Appendix D). This form is similar in design to the shark form and also includes identification characteristics and a space for individual length measurements. Fate codes are included on the BFR as retained, discarded, escaped net, other and unknown. With the implementation of this form, observers ceased recording billfish mortalities on the MFR form, in order to eliminate duplication of billfish catch data.

6.4. Consolidation of Tuna-Billfish sighting data into the dedicated billfish tables

Data for billfish sightings and catch were collected by observers for the IATTC Tuna-Billfish program from 1989–2006. These data were processed and stored independently from the other data collected by observers. The data were not cross-checked with the MFR billfish data collected between 1993 and 2006 and therefore introduced the potential for mismatched data.

During the development period for the new BFR form, the billfish data from the billfish form and the billfish data recorded on the MFR form were consolidated and incorporated into the new billfish (BFR) tables. All billfish data previously recorded in the bycatch database were retained and duplicated in the BFR database. Data checks were performed to verify that both the BFR and Bycatch databases contained identical billfish data for sets that were originally recorded on the Bycatch forms.

6.5. Elimination of ray data on the MFR

Conservation and management measures were established for rays under IATTC Resolution C-15-04[8] to minimize their mortality after being caught incidentally in purse-seine sets. To collect the necessary data to monitor compliance of the specific measures detailed in the resolution, the Ray Record (RR) was developed and implemented in 2016 (Appendix E). This form is also similar to the shark form and includes data on diagnostic identification characteristics, individual length measurements and fate data (*i.e.,* retained, discarded, live releases, other, unknown). After implementation of this specific form, observers were instructed to cease recording ray data on the MFR form to eliminate duplication of ray mortality data collection.

7. BYCATCH DATABASE

The Bycatch database is a compilation of mortality data collected for all non-tuna species on the various data collection forms (*i.e.,* marine fauna record: MFR, dolphins: MMSSR, turtles: STR, sharks: SR, billfish: BFR, rays: RR). Data from each form is stored in a set of relational tables with primary key fields used to link the tables together. Seabird sighting data is the exception as seabirds are the only fauna for which sightings, not mortalities, are recorded on the MFR, and therefore seabird sightings data are included in the Bycatch database. The MFR form is the most appropriate place to record seabird sighting information because a form is filled out for every set regardless of set type, since there's not a dedicated form for seabird sightings.

[8] https://www.iattc.org/PDFFiles/Resolutions/IATTC/_English/C-15-04-Active_Conservation%20of%20Mobulid%20Rays.pdf

7.1. Marine Fauna Record (MFR) tables

The MFR tables contain data from all non-tuna species that weren't recorded on forms dedicated to individual taxonomic groups, such as dolphins, turtles, sharks, billfishes, and rays. As dedicated forms were put into use, data recorded on these forms stopped being recorded on the MFR form. The MFR tables are the following:

- MFR (primary table)
- MFRTuna (tuna species recorded in weight)
- MFRNumFish (non-tuna species recorded in numbers of individuals)
- MFRTonFish (non-tuna species recorded in weight)
- MFRBirds (bird species, recorded in numbers, present at the beginning of the set *i.e.,* sightings data)

7.2. Marine Mammal Sighting and Set Record (MMSSR) tables

The MMSSR data covers many aspects of dolphin interactions with the purse-seine fishery. The primary table with details of dolphin mortality and injury is the Kills table.

7.3. Sea Turtle Record (STR) table

Sea turtle data is contained in a single table.

- STR (primary table)

7.4. Shark Record (RDT) tables

- RDT (primary table)
- RDTInd (data related to individual sharks, *e.g*. length, sex, utilization)
- RDTMult (data related to aggregated catch by size categories, *e.g.* small, medium, large)

7.5. Billfish Record (BFR) tables

- BFR (primary table)
- BFRInd (data related to individual billfish, *e.g.* length, sex, utilization)
- BFRMult (data related to aggregated catch by size categories, *e.g*. small, medium, large)

7.6. Ray Record (RR) tables

- RR (primary table)
- RRInd (data related to individual rays, *e.g*. disc width, sex, utilization)
- RRMult (data related to aggregated catch by size categories, *e.g.* small, medium, large)

7.7. Derived tables

These tables are compiled using data from all sources listed above with various manipulations applied to the data – see sections *'Derived Bycatch and BycatchWeight tables*' *and 'Manipulations of the data in the derived Bycatch tables'*.

- Bycatch (data generated with all mortality expressed in numbers of individuals)
- BycatchWeight (data generated with all mortality expressed in weights)

7.8. Data processing

An intensive quality control procedure of the data is undertaken. Upon arrival at the regional offices, the observer and editor review the data together and make any necessary corrections. After data entry, each trip is reviewed by two data editors; one editor corrects any errors that are indicated by the computer editing program and the other checks the data a second time as a final review. Bycatch data forms, along with all observer data forms, for an individual fishing trip are manually keyed using a dedicated data entry program developed and maintained by the IATTC. The digitized data are first stored in temporary data tables. Data editors then use a comprehensive validation program to inspect data for errors and inconsistencies. For example, the program may check that the date of a set occurred during the trip dates or check for catch numbers that exceed normal quantities. When all errors have been identified and corrected, the data are transferred to the principal database with the rest of the observer data for the fishing trip.

8. DERIVED BYCATCH AND BYCATCHWEIGHT TABLES

The Bycatch and BycatchWeight tables have been developed to consolidate the source data of non-tuna species, which greatly facilitates access to the data for common research needs. These tables are identical, except for the catch unit, with the Bycatch table containing mortality data expressed as numbers of individuals, and the BycatchWeight table containing mortality data expressed as weights. They are created programmatically by combining the bycatch data recorded by observers on the MFR form and the dedicated forms for marine mammals, turtles, sharks (since 2004), billfishes (since 2006) and rays (since 2016). These tables have been generated after much data processing and assumptions, which are described here.

As a precautionary approach, all animals recorded in the Bycatch tables are considered dead. Dolphins that are considered as dead by the observer (dead or gravely injured where they are unlikely to survive) are included in the Bycatch tables. Turtles passing through the power block are considered dead regardless of whether the observer recorded that they perished, were gravely injured, or were released unharmed. Similarly, sharks that are reported as 'released alive' on the dedicated shark form are precautionarily assumed to be dead (Román-Verdesoto and Orozco-Zöller 2005)—resulting from harsh conditions *e.g.* anoxia within the net, compression within the net and brailer, and high temperatures on the deck of the vessel—and therefore, included in the Bycatch tables. However, sharks released alive prior to the implementation of the dedicated shark form in 2004 were not recorded on the MFR form and consequently, are not included in the MFRNumFish and MFRTonFish tables. For these MFR shark records, an estimated number of sharks released alive was added to the Bycatch table to precautionarily account for post-release mortality as a result of injury and/or trauma caused by the fishing process (see '*Inclusion of sharks released alive in the bycatch estimations'*).

When all observer data for a year has been processed, these data are then added to the Bycatch and BycatchWeight tables using an established procedure. All raw data collected in weight (prior to 2004) were converted to numbers of individuals for the Bycatch table, and all raw data collected as number of individuals are converted to weight for the BycatchWeight table using the conversion process described below (see '*Conversion of numbers to weight and vice-versa*').

8.1. Exclusions to the Bycatch table

Although mortality of many taxonomic groups of non-tuna species can be summarized using data in the Bycatch table, some data for species recorded on the MFR form have been excluded from this table. For example, data on invertebrates (*e.g.* squid and jellyfish) have not been included, primarily due to known inaccuracies in observer weight estimates, and the imprecision of converting weight of invertebrates to numbers of individuals. Additionally, some species recorded on the MFR form lack an observer estimate of the number of individuals or weight caught. Therefore, the Bycatch table should not be used to determine the presence or absence of a species.

9. IMPROVEMENTS TO SPECIES IDENTIFICATIONS AND THE SPECIES CODES TABLE

The development of the Bycatch database, corresponding observer data collection forms and computer algorithms to compare species-specific identification characteristics recorded by observers for key shark species to taxonomic guides (Román *et al.* 2005) as well as for other taxa with dedicated species forms (*e.g.* billfishes, rays), greatly improved the quality of the bycatch data. Of course, these developments did not eliminate potential error sources as users became aware of limitations in the original data collection design. For example, some issues relating to species identifications were encountered. In the absence of a system with photographic confirmation of species identification, the observer's identification is, by necessity, accepted without independent verification. It is essential that users of the data are aware of such issues, particularly when analyzing and/or reporting bycatch from the early years of data collection, as these issues can cause a bias in the results.

9.1. Review of species composition of the observed bycatch of sharks

IATTC staff improved taxonomic classification of sharks in the bycatch data prior to 2005 using methods detailed in Román-Verdesoto and Orozco-Zöller (2005). They reviewed and revised IATTC observers' at-sea species identifications of silky sharks (*Carcharhinus falciformis*), blacktip sharks (*C. limbatus*), and oceanic whitetip sharks (*C. longimanus*) using data from a dedicated sampling program conducted between March 2000 and March 2001 and a review of observers archived field notes from 1993–2004.

For the special sampling program (Román-Verdesoto and Orozco-Zöller 2005), a Shark Characteristics Form (SCF) was designed for the observers to record species-specific diagnostic identification information based on distinct morphological characteristics of the carcharhinid sharks believed to be commonly encountered by the purse-seine fishery in the EPO. The observers had two tasks in the program: 1) to record the shark species identification code as they had done previously, and 2) to select the drawing on the SCF that best reflected the morphological characteristics corresponding to the shark they observed. The SCF forms were then analyzed, and identifications were validated by comparing the shark drawing selected with the species code recorded by the observer. The SCF was a precursor to the modern-day SR (Appendix C) and contains drawings of key anatomical features to allow observers to record the species code and then select the drawings of the key anatomical features (*e.g.* caudal fin shape and head shape) used to identify the shark.

The data collected on the SCF provided reasonable coverage of the spatial and temporal distributions of the sets in the IATTC observer database during its sampling period. SCF forms were collected for 2,830 sharks of all species. Of the 1,444 silky sharks identified by the observers, 1,440 (99.7%) had at least one key characteristic for this species. Of the 311 blacktip sharks identified at sea, 299 (96%) had at least one major characteristic for silky sharks, and 12 (4%) had none of the three key characteristics for silky sharks.

The staff's review of observers' archived field notes facilitated a reclassification of individual sharks classified as "other sharks" when the observer recorded specific notes on the scientific or common name of a specimen on the MFR paper forms (Román-Verdesoto and Orozco-Zöller 2005). See section '*Recoding species in existing bycatch records*' for details.

9.2. Misidentification of silky sharks as blacktip sharks

As a result of the review of the data collected on the SCF (Román-Verdesoto and Orozco-Zöller 2005), and given the coastal distribution of *C. limbatus* (Castro *et al.* 1999a), it was concluded that there was confusion by observers over the identification of various species of sharks commonly referred to as "blacktip sharks". The IATTC staff became aware that most sharks identified as *C. limbatus* were in fact the silky shark, *C. falciformis*. This meant that *C. limbatus* could not be reliably retrospectively differentiated from *C. falciformis* in the Bycatch database. As part of the expansion of species codes available for observer use, the species code of all blacktip sharks present in the MFRNumFish and MFRTonFish tables was changed from code 151 (*C. limbatus*) to code 159 (*C. limbatus* or *C. falciformis*). This allows researchers to identify records that were changed and at the same time not to confuse positive silky shark identifications with possible misidentified blacktip sharks. Positive silky shark identifications in the Bycatch and MFR tables were not affected. At the time of this change in 2004, the dedicated shark data collection (SR) form was introduced, and shark species were no longer recorded on the MFR form.

9.3. Shark verification computer data editing procedure

A shark identification routine developed in 2004 (Román et al. 2005) has been subsequently used to verify and upgrade or downgrade observers at-sea identifications of sharks. To upgrade an observer's identification of a specimen, a general identification (*e.g.* genera) is changed to a more specific identification (*e.g.* species), based on diagnostic characteristics recorded by the observer. To downgrade an observer's specimen identification, a species name is replaced with a more general identification. The observer's identification of a specimen is compared to the diagnostic characteristics of 40 shark species. For upgrading or downgrading, only 19 species within 4 of the most common genera in the purse-seine bycatch (*Alopias, Carcharhinus, Isurus, Sphyrna*) are considered. The computer program checks the diagnostic characteristics recorded by the observer on the shark form against the key diagnostic characteristics for each species. If the characteristics do not match, then a warning is generated to alert the data editor to upgrade or downgrade the taxonomic classification of the specimen. A conservative approach is taken for misidentified sharks or rarely encountered species whereby a species is downgraded to "unidentified shark". For at-sea observer identifications that fail the verification step against the 4 common genera, the computer program searches the diagnostic characteristics in the same genus and the identification is upgraded by the data editor if a match is found with another species within one of the 4 genera. Where a match is not found at the genus level, the data editor conservatively changes the identification to "unidentified shark".

After using the editing routine for a few years, staff decided that a more conservative approach should be to only downgrade species identifications. At this time, data editors no longer upgraded species identifications using the computer algorithm.

9.4. Recoding species in existing bycatch records

As a result of the expansion of the species code table in 2004 (see section '*Species codes table*'), an effort was made to review all existing MFR paper forms to search for animals identified to species in the comments section. When found, the assigned species code was changed to a code that best represented the animal, or a new species code was assigned. Due to time constraints and limitations in editing resources, only sharks, rays and large fishes were reviewed, and a detailed description of the review of observer records for sharks can be found in Román-Verdesoto and Orozco-Zöller (2005). Briefly, they found that from 1993–2004 more than 25,000 sharks were recorded as "other sharks" on the MFR. Most of these "other sharks" were reclassified as oceanic whitetip sharks (55%), while other specimens were reclassified as silky sharks (6%), "unidentified sharks" (8%), and "unidentified carcharhinid sharks" (4%). Observers did not record notes for the other sharks that were not reclassified. Small fishes were generally not recoded to a finer taxonomic resolution (*e.g.* species, genera, or family), unless they were encountered while reviewing the MFR paper forms for identified sharks, rays and large fishes that did not have a species code available when the form was completed. Following the review of the paper forms, the species code table was expanded to include all species identified by observers, and in 2006 the MFRNumFish and MFRTonFish tables were updated to include the newly identified species.

9.5. Uncertainty in identification of rainbow runner and yellowtail

Observers often experience difficulty in differentiating rainbow runner (*Elagatis bipinnulata*) and yellowtail amberjack (*Seriola lalandi*). Staff suspected these two species were likely being misidentified on the MFR form based on the known spatial distribution of each species relative to the set location. Yellowtail has a subtropical northern distribution (north of 20°N) compared to the more tropical distribution (south of 20°N) of rainbow runner (Fischer *et al.* 1995a).

Additionally, yellowtail was generally reported by observers under the Spanish common name 'Jurel'. In the species codes table prior to 2004, yellowtail was recorded as a broad taxonomic group "*Seriola*, *Caranx* spp." (Table 3), despite fishes in these genera being distinctly different (Fischer *et al.* 1995a). Considering that only four groups of large fishes were included in the original species codes table, observers did not have many options for reporting bycatch of large fishes and two of these—yellowtail and rainbow runner—were often confused with one another. As part of the effort to allow observers to record all identified species (see section '*Recoding species in existing bycatch records*'), all species grouped in the general '*Seriola*, *Caranx* spp.', which were identified to species on the paper form, were recoded to the correct species-specific code.

After 2004, species codes for 'yellowtail' included *S. rivoliana*, *S. lalandi*, *S. peruana*, *Caranx sexfasciatus*, and *Caranx* spp. (Table 4). To minimize misidentification of *S. lalandi* and *E. bipinnulata*, a species identification manual was developed in 2005[9]. Observer training workshops were held to teach observers how to properly identify the two species, and consequently, IATTC staff have greater confidence in reported catch data for yellowtail and rainbow runner after 2005. If an observer was not confident in their species identification, they would report at the next lowest taxonomic resolution (*e.g.* to genera, family, or another broad taxonomic grouping).

The issue of 'yellowtail' encompassing several species has caused concern among staff because of the confusion it creates when reporting the catch of 'yellowtail' (*i.e.*, *Seriola lalandi*), particularly in the early years of bycatch data collection. There is a data bias that stems from combining two different genera into a single species grouping (*i.e., Seriola, Caranx* spp.), and a data user should be aware of this issue when reporting catch of 'yellowtail.' In an attempt to address this concern, staff revised the species codes table in 2020 to include separate grouping codes for species in the genera *Seriola* and *Caranx*, primarily for IATTC's ecosystem reporting (see Document SAC-11-12, IATTC 2020).

[9] Guía de identificación de peces involucrados en la pesca atunera de cerco en el OPO

9.6. Uncertainty in the identification of blue and black marlin

There has been, and continues to be, uncertainty in observers' at-sea species identifications for blue marlin (*Makaira nigricans*) and black marlin (*Istiompax indica*). Observers have recorded catches of billfish on the billfish form since 1989 and the revised billfish form (BFR), which has included drawings of key anatomical features since 2006. Historically, observers collected tissue samples of billfish and these samples were at times shared with scientific researchers outside the IATTC for genetic studies. Genetic analyses concluded that many specimens identified by observers as blue marlin were in fact black marlin. Therefore, IATTC staff reviewed and revised the diagnostic characteristics on the BFR. It was discovered that one identification characteristic, 'mobility of pectoral fins', was difficult for the observers to distinguish between the two species. The pectoral fin on black marlin is rigid, and this characteristic was difficult to distinguish between black marlin and other billfish species, leading to misidentification of other billfish species as black marlins. As a result, in 2016 the BFR was revised to replace the 'mobility of pectoral fins' characteristic with two additional characteristics: 1) 'pectoral fin posterior margin' and 2) the 2nd dorsal and 2nd anal fin relationship. A researcher should proceed with caution when using observer identifications of blue and black marlin. The IATTC staff is considering creating a combined code for these species, as was done to resolve the identification issues for the silky and blacktip sharks (*i.e.,* species code 159).

9.7. Reassessment of Seabird 'other' species code to specific codes

In February 2006 new species codes for albatross, seagulls, pelicans, and herons were added to the seabird species code table (tblBirds). Any seabird species that did not have a code in the seabird species table was assigned an 'Other bird' code, meaning the seabird species was identified, but the species was not present in the seabird species table. Records originally coded as 'Other bird' were reviewed, and seabirds found to be one of the four species groups were recoded to reflect the new species code. Observers subsequently used the new codes for seabird species. Any new sightings of a seabird species not present in the seabird species table were added to the table, so that every seabird species with a positive identification could be included in the database.

9.8. Addition of seabird species to the main species table

When bird information was first collected on the Flotsam Information Record (FIR), the most common seabird species were listed in the dedicated tblBirds. The numeric species codes ranged from 20 to 82. This table was separate from the species table (tblSpecies) used for other animals. In 2020, it was decided to add the seabird species to the main species code table (tblSpecies), which is a compilation of all species reported to have been caught or interacted with the various fishing vessels (*e.g.* purse seiners, longliners) operating in the EPO. However, because many seabird codes were already assigned to non-bird species in the main species code table, the digits 700 were added as a prefix to each existing seabird species code. The seabird species codes in all affected data tables were also modified in this way.

10. MANIPULATIONS OF THE DATA IN THE DERIVED BYCATCH TABLES

When generating the Bycatch and BycatchWeight tables of the estimated number or weight of dead animals, there have been instances where estimations have been added to account for missing data or data conversions. It is important to note that the source data in the MFR and data tables for dedicated species (sharks, rays, billfishes, turtles, marine mammals) are never modified. This section describes these estimations and other necessary data manipulations.

10.1. Inclusion of sharks released alive in the bycatch estimations

Since 1993, observers have been instructed to only record species on the bycatch forms that perish during the set. Moribund sharks often show signs of life on deck, though their survivorship is unknown following release. With these signs of life, many observers do not record these sharks on the MFR forms, and therefore they are not often recorded as being present in a set.

The use of the shark form (SR, Appendix C) from 2004 allowed observers to record the final disposition of each captured shark, and whether it was released alive. As a precautionary approach, a decision was made at the end of 2009 to consider all live release sharks as dead because of the uncertainty in their post-release survival, considering possible injury and trauma endured during the brailing process amongst the tuna catch, exposure on deck, and handling to the point of release.

The original shark data collected on the MFR form and stored in the MFR tables is never altered. However, the process used to create the Bycatch tables was modified to include an estimate of these 'live release' sharks which were not recorded on the MFR form. This was done to try to minimize any bias caused by the absence of live release sharks originating from the MFR form and the presence of live release sharks originating from the SR form after 2004. The percentage of live release of each shark species recorded on the SR form during the first 5 years was applied to the shark mortality recorded on the MFR form to obtain this estimate of 'live release'. This procedure effectively increased the number of reported sharks caught as bycatch in 1993–2005. Since 2005, there has been no need to estimate shark live releases because this information is collected on the dedicated shark form.

10.2. Missing size data

At times, size data (small, medium, large categories) are not recorded by the observer for a variety of reasons. However, size estimates are important for accurately converting catch from numbers to weight and vice-versa. The missing size data are estimated and added to the Bycatch table based on existing size data for the same species from other sets within a defined space/time threshold. If there are no existing size data available within the threshold, the Bycatch table size data are estimated based on the known annual percentage of catch in each of the three size categories. The annual percent of catch in each size category for each of the original species (Table 3) is stored in database table SppSizes. The size estimation of any species not specifically listed in the table is based on a representative species listed in the table. For example, the missing small, medium, and large size for scalloped hammerhead shark *Sphyrna lewini* would be estimated based on the percentage of each size of hammerhead genus *Sphyrna* (SPN, code 153) from the SppSizes table. Marine mammals are not included in the SppSizes table because all marine mammals are in the large size category.

10.3. Conversion of numbers to weight and vice-versa

As previously noted, bycatch data were collected in either number of individuals or weight prior to 2004. The Bycatch table contains non-tuna catch, including marine mammals and sea turtles, with all data expressed in number of individuals. The analogous BycatchWeight table contains the same data with catch expressed in weight. These Bycatch tables are used to create reports of bycatch species in either number of individuals or weight. To create the two specialized tables, a conversion methodology was developed.

To convert catch numbers to weight, and vice-versa, an estimate of the average weight of an individual in each of the size classes (small, medium, large) for each of the species in the limited species code table used prior to 2004 (see section '*Species codes table*') was determined from the literature available in 1993 and held in the database table SppFauna. To reiterate, size categories of billfishes (post-orbital fork length), sharks (total length) and rays (disc width) are recorded as small <90 cm, medium 90–150 cm and large >150 cm, while other fishes (fork length) are recorded as small <30 cm, medium 30–60 cm and large >60 cm. Small fishes (*e.g.* triggerfish and bait fish) were always assumed to rarely exceed 30 cm and therefore recorded as 'small' in the database. When the size class information of the catch could not be determined, a numbers weighted-average weight was used to make the conversion and is described below (see section '*Single species*'). The weighted average is the average weight of the species, regardless of size category.

The original conversion factors for each bycatch species (Table 3) consisted of an average weight for each size class. The conversion factors for new species added to the species table after 2004 were based on the most morphologically similar bycatch species already in the species table, although this often did not produce reliable results. Additionally, as bycatch data from the MFR form and new catch-at-size data sources became available, the conversion factors were fine-tuned where sufficient data existed. However, to improve the accuracy of the conversion from numbers to weight and vice-versa, the process was reevaluated during 2004.

11. REEVALUATION OF THE CONVERSION METHODOLOGY IN THE DERIVED BYCATCH TABLES

By 2004, there was reason to believe that the conversion factors overestimated the number of individuals for some species when converted from weights. This was especially true for small fish species when the observer's weight estimates may have been overestimated, which resulted in excessively large numbers upon conversion. Additionally, the conversion factors for many different species were based on the limited species present in the original species table. During 2004, conversion factors were re-evaluated based on the best available literature sources and databases and the SppFauna table expanded to include all frequently encountered species.

11.1. Expansion of species used for conversions

At the end of 2004 observers were given an expanded species table that would allow them to record every species that they could identify, and new species were added to the SppFauna table as they were encountered. The original species list used in the conversions is shown in Table 3. The conversion procedure for individual species and species complexes (described in detail below) was finalized and applied to all existing data in May 2007, affecting data from 1993–2006. At that time, the Bycatch and BycatchWeight tables were recreated using the more precise conversion factors.

11.2. Single species

The ideal data set on which to base a re-evaluation would consist of length-frequency data for each of the most frequently encountered species in the fishery. This would provide the average size of the catch of each species in each of the three size classes. Equipped with this information, weight-length relationships would be applied to the average lengths to estimate the average weights of the catch of each species in each size category. These average values could then be applied to catch data collected in numbers to estimate total weights, and to catch data collected in weight to estimate the total numbers of individuals caught. With the dedicated shark (2004), billfish (2006) and ray (2016) forms, observers have been able to provide accurate length measurements at sea. For these measured animals, the length is used directly to determine the weight using the conversion formula for the species.

In lieu of a laborious and expensive bycatch length-frequency sampling program, various databases containing length measurements were used to estimate average lengths by size class for taxa lacking reliable length measurements. These databases include:

- The IATTC Food Habits database (various species),
- A prototype shark database used to collect information as a precursor to the eventual dedicated shark database (sharks),
- The final version of the newly established shark database (sharks),
- The IATTC turtle database (turtles), and
- The longline turtle experimental database used in the coastal longline fishery of Central and South America (various species).

Using these datasets, a compilation was made of the average lengths of each species in the small, medium, and large categories. Average lengths for those species not represented by a sufficiently large length-frequency sample were estimated using the best methods available (*e.g.* values for similar species). Once the average length for each species and size class was determined, the lengths were converted to weights, as detailed below, to arrive at a standard average weight for each species and size category. In addition to the average weights by size class, a weighted average for each species was computed as described in this section below.

Maximum length estimates for marine mammals (most from Perrin and Reilly 1984) were used in special relationships developed by Trites and Pauly (1998) to estimate mean body weights of the mammals from the maximum lengths.

For most individual species, the average lengths by size class were converted to average weights using weight-length (W-L) regressions for these particular species from the literature (Table 6) or for taxonomically or morphologically similar species if regressions were not available for these exact species. The regressions were of the format (or were converted to the format):

$W = aL^b$ (Eqn. 1)

where *W* is body weight (mass) in kg, *L* is total length (for sharks), post-orbital fork length (for billfishes), or fork length (for other fishes) in cm, and *a* and *b* are constants. The W-L regression parameters for each species or group of species and their sources are presented in Table 5. When more than one plausible W-L regression equation was available for any particular species, a single regression was derived by least-squares fitting to weights calculated at fixed length intervals and averaged over each regression estimate at each length interval.

The average weight ($\overline{W}$) per individual estimated from the W-L regressions (Eqn. 1) for each taxon (*i*) and each of the three size classes (*j*; small, medium, and large) was then multiplied by the estimated number of individuals (*n*) for that taxon (*i*) and corresponding size class (*j*) from the Bycatch table. A numbers-weighted average was then derived for each taxon by summing these values and dividing by the sum of the estimated number of individuals ($n_{i,j}$) (Eqn. 2; values reported in column “Weighted Average” in Table 6):

$\overline{n}_i = \frac{\sum(\overline{W}_{i,j} * n_{i,j})}{\sum n_{i,j}}$ (Eqn. 2)

11.3. Composite taxa

For taxa comprised of more than one species, such as a species complex (*e.g.* Silky and Blacktip sharks), genera (*e.g. Aluterus* spp.), families (*e.g.* Coryphaenidae), groupings of unidentified species (*e.g.* Sharks nei), or animals that were identified but not assigned a SpeciesID code for a variety of possible reasons (*e.g.* Sharks – identified), W-L regressions were derived in some cases (*e.g.* Marlin, nei, Table 5) using the aforementioned fitting procedure.

To derive numbers-weighted-average ($\bar{n}_i$) body weights for composite taxa, equation 2 was applied using the average weights ($\bar{W}$) and numbers of individuals (*n*) for the groups that pertained to the composite taxon. For example, the $\bar{n}_i$ for each of the 3 size classes (*j*: small, medium, large) for the composite taxon "Coryphaenidae" was derived using the $\bar{\bar{W}}$ and *n* of *Coryphaena equiselis* and *C. hippurus*.

Unidentified species (*e.g.* Sharks nei) were converted using factors that were weighted by the values of all identified species in the corresponding bycatch group (billfishes, sharks, rays, large fishes, small fishes, and turtles). Species that were identified but not assigned a SpeciesID code at sea (*e.g.* Sharks - identified) were converted using factors of the most likely true species. The most likely species were determined from a review of the Bycatch database which involved reassignment of all identified species to their correct SpeciesID code. This provided the basis for a determination of the most likely species for all identified yet unassigned species.

Average body weights for each taxon are displayed in Table 6. Each weight value computed from average length estimates are scored on a four-point reliability scale (see footnotes in Table 6). No reliability score was assigned if an average weight was based on numbers-weighted averages for other taxa.

Details of the data conversion are in documentation held at the IATTC.

12. METHODS USED TO DETERMINE THE FLEET ESTIMATES OF BYCATCH: BYCATCH REPORTS DATABASE

An estimation procedure was developed to estimate the non-tuna catch in the EPO by size-class 6 purse-seine vessels using data from the Bycatch and BycatchWeights tables to extrapolate data for unobserved trips, and from sets lacking bycatch information. The total estimated bycatch data can be found in the IATTC SQL 'Reports' database in tables specifically created for reporting catches of non-tuna species, particularly in the annual *Ecosystem Considerations* document (see *e.g.* Document SAC-11-12, IATTC 2020). These tables contain summarized non-tuna data collected by observers. Table names for data collected in the EPO contain the text 'InEPOExcel' and include observed and estimated catch and discards. For example, 'InEPOExcelBycatch' and 'InEPOExcelBCWeight' tables contain total estimated bycatch, *i.e.,* total animals killed, in numbers of individuals and weights, respectively.

In 1993, when the methodology was introduced, all data for Colombia, Ecuador, Mexico, United States, Venezuela, and Vanuatu were extrapolated separately because these flags represented much of the active fishing fleet. Data from all other flags were pooled and processed as a single group. However, significant changes to the flag composition of the fleet over time required the extrapolation methodology to be modified in January 2007. This involved extrapolating unobserved trip data based on the true flag of the unobserved trip, rather than basing the extrapolation on data from a single group of vessels from smaller fleets.

There are known unobserved sets for which no information exists. The number of these sets is determined from logbooks and other sources, such as at-sea reports or trip summaries if observer data were lost before processing. These sources report tuna catches, but not catches of bycatch species. Another source of missing bycatch data is from western Pacific Ocean (WPO)-based observer trips, which only report information on EPO sets and catch by set type.

The observed bycatch data are aggregated by species, year, flag and set type. This produces a bycatch per set value for each stratum. A computer program extrapolates known species bycatch per set to the known sets lacking bycatch information. The known bycatch per set is applied to these unobserved sets and added to the known set totals. Occasionally, data from an observed trip is lost before the bycatch information can be processed so the bycatch must be estimated for sets where the data were lost.

Additionally, unloading records indicate known EPO trips for which the number and type of sets is unknown. These trips have no observer or logbook information, only the number of days at sea in the EPO (trip depart date to arrive date). Bycatch per day from observer data is calculated by species, year, flag and set type, and applied to these days for an estimate of bycatch for these trips.

Finally, there may be unobserved sets or days-at-sea data for a flag which has no observer data for the year, and therefore has no bycatch data to facilitate extrapolation. For these trips, a proxy flag must be used. This is done by taking the subsequent 5 trips for the vessel and using the predominant flag of those trips as the proxy flag. Then, the bycatch per set or day of the proxy flag is applied to the data for the unrepresented flag.

These total fleet estimates of bycatch that died during fishing operations are used for reporting non-tuna species in IATTC's *Fisheries Status Report* (Table A-2c) and in the *Ecosystem Considerations* section of the same report (Tables 2-6) (IATTC 2019c).

13. DISCUSSION

A great deal of resources have been dedicated to the development of the IATTC Bycatch database since its initial development in 1993 to provide a comprehensive data resource accessible by IATTC staff. The purposes of this dedication are to maximize the reliability of data used for routine reporting as well as scientific endeavors to fulfill IATTC's responsibilities under the Antigua Convention to ensure the long-term sustainability of tunas and associated and dependent species, and the structure of the supporting ecosystem more broadly. As the EPO tuna fishery evolved over time, the need to modify data collection protocols or to collect new data also resulted in many changes to the Bycatch database. The history of the database outlined in this paper documents such changes and helps to facilitate appropriate data analysis and interpretation of results, because it provides users of the Bycatch database with the knowledge and timelines of historical modifications to the data.

Although other sources of bycatch data exist for the EPO, discussion around them is beyond the scope of this paper, which is solely focused on the history of the IATTC Bycatch database. This is because these other data sources, such as from purse-seine size class 1–5 vessels and the large longline fleets, are either monitoring programs that are in their infancy or limited in their reporting of bycatch species (see Document SAC-11-12, IATTC 2020) owing to very low observer coverage. However, with the implementation of the Antigua Convention in 2010, the responsibilities of the IATTC have shifted to incorporate ecosystem considerations, which includes reporting of bycatch. As such, it is essential that IATTC's Resolution C-03-05[10] on data provision be revised to align with these responsibilities. Revision of this resolution by staff is under discussion (see Document SAC-12-09, IATTC 2021). One of the IATTC's objectives is to support EAFM and ensure ecological sustainability. The collaborative process of improving

[10] https://www.iattc.org/PDFFiles/Resolutions/IATTC/_English/C-03-05-Active_Provision%20of%20data.pdf

requirements of data provision will support this objective and enable IATTC to provide better estimates of total bycatch by species. Such estimates help staff fulfill the goals and targets set forth in the Strategic Science Plan, including improved ecosystem models and ecological risk assessments, which help to provide an overall assessment of the ecosystem. Perhaps with better bycatch data collection in the future, the Bycatch database may include these other sources of data.

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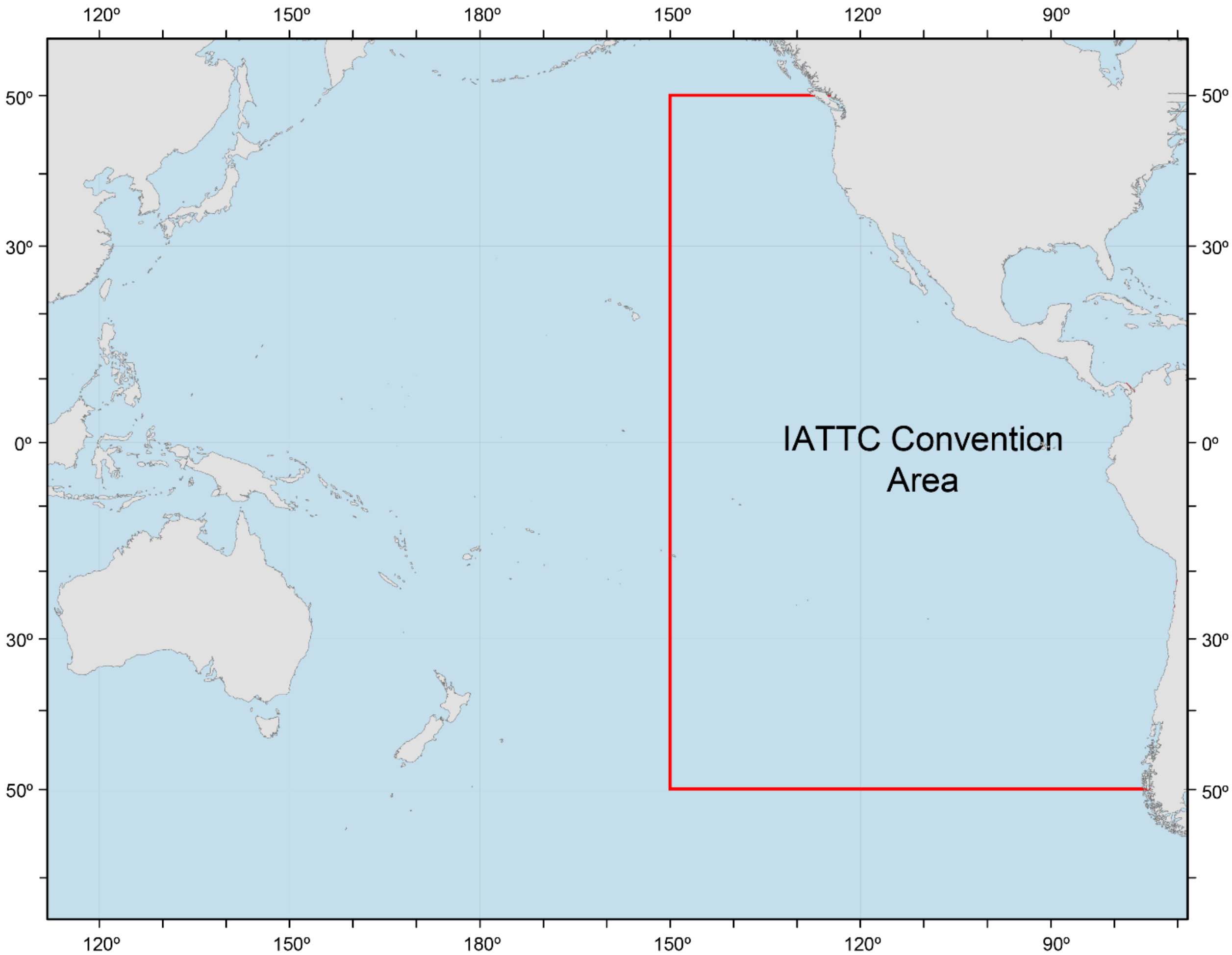


Figure 1. IATTC Convention Area covering 50°N to 50°S from the coast of the Americas to the 150°W meridian of the eastern Pacific Ocean.

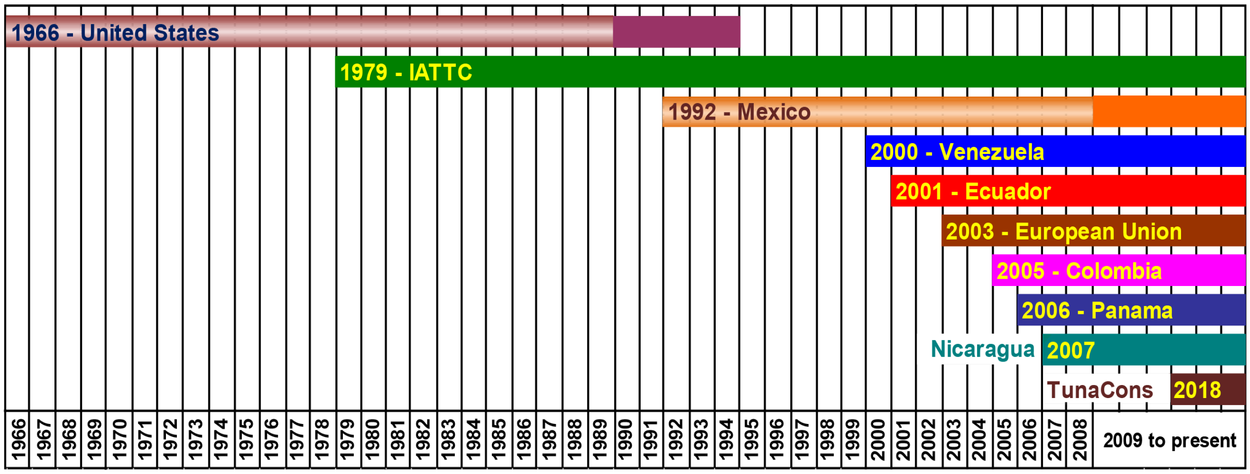


Figure 2. Time series of Observer Programs for purse-seine vessels. Darker colors for the United States (1990–1994) and Mexico (2009 to present) indicate when full observer data have been provided to IATTC for these time periods, *i.e.*, complete detailed observer data from the United States prior to 1990 and from Mexico prior to 2009 are not held by the IATTC.

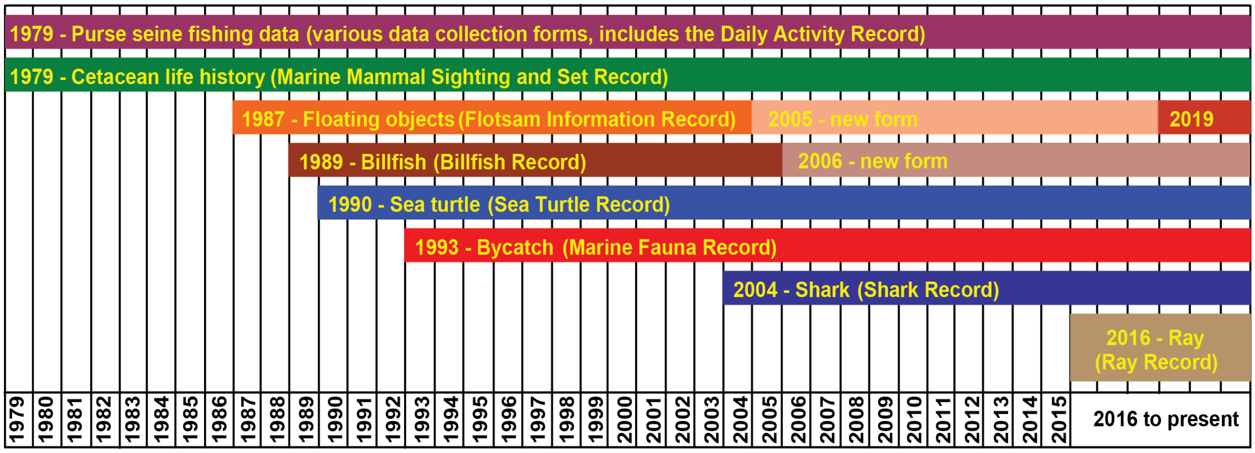


Figure 3. Timeline of the various forms used for data collection by observers onboard purse-seine vessels. The name of the data collection form is in parentheses. In 1993 the "Bycatch" or Marine Fauna Record form was created to collect information on species caught as bycatch and killed during purse-seine sets. Dedicated species-specific data collection forms have been created for cetaceans, billfishes, sea turtles, sharks and rays, and these forms contain more information than the 1993 "Bycatch" or Marine Fauna Record (MFR) form (see Appendices A-F). The Flotsam Information Record underwent modifications in 2005 and 2019, and the Billfish Record was modified in 2006.

Table 1. Data collected for taxa caught by the purse-seine fishery of the eastern Pacific Ocean. Non-mammal taxa were recorded on the Marine Fauna Record prior to the implementation of dedicated taxa-specific forms. Length measurements: FL: fork length; CCL: curved carapace length; TL: total length; POFL: post orbital fork length; DW: disc width; NA: not applicable. The revised data collection forms are current at the time of this paper and provided in the appendices listed in the 'Reference' column.

Taxa	Form (implementation year, revision year(s), and modifications)	Species identification characteristics	Destiny/Fate	Biological characteristics	Other	Reference
Fishes (including tunas), **Turtles** (until 2000), **Sharks** (until 2004), **Billfishes** (until 2006), **Rays** (until 2016), **Birds**, **Invertebrates**, **Other fauna**	**Marine Fauna Record: MFR** (1993, 1997, 2004, 2006, 2016). **1997 modifications**: Discard reason for tunas added; non-tuna destiny (utilization) fields added. **2004 modifications**: Section for recording non-tuna catch in weight was removed. **2004, 2006, 2016 modifications**: Title of the large fish section was modified to remove sharks, billfishes, and rays, respectively as a result of the new dedicated species forms.	None	**Tuna discard reason**: species/size undesirable for market, condition undesirable for market, ripped sack, vessel full, well limitation, other. **Bycatch destiny**: human consumption, discarded, mixed (part of the catch was used for human consumption and part was discarded). Only captured (killed) animals are recorded on the MFR. Any animals escaping the set alive, returned to the sea alive, or entangled in a floating object are not recorded on the MFR.	**Tunas**: estimated mortalities (captured and discarded) in metric tons by size category (small: <2.5 kg, medium: 2.5-15.0 kg, large: > 15 kg). **Bycatch**: estimated number or weight (until 2004) of individual mortalities by size category (cm). **Billfishes** (POFL), **sharks** (TL), and **rays** (DW): small: <90, medium: 90-150, large: >150. **Other large and medium fishes** (FL): small: 30, medium: 30-60, large: >60.	Starting in 2004 observers were instructed to record mortalities in numbers only. Seabirds are the only taxa with sightings data recorded on the MFR; all other taxa recorded on the MFR are mortalities.	**Appendix A**
Turtles	**Sea Turtle Record: STR** (1990, 2001) **2001 modifications**: Sighting and set forms were combined into a single form.	Scute counts, shell coloration, and Y/N fields (overlapping scutes, inframarginal pores, 1 pair of prefrontal scales, leathery shell).	Starting in 1990: entangled alive in floating object (FOB), already dead, released unharmed, released with light injuries, released with grave injuries, accidentally killed, escaped net, consumed, not involved in fishing operation, other.	Length estimates for individual turtle mortalities (cm, CCL): shell length, shell width, head width, tail length.	Sightings, condition when last seen, activity (alive and immobile, swimming, copulating, feeding, dead, other/unknown), association (e.g. unassociated, floating object), tag information, entangled or trapped in a floating object, passed alive through power block.	**Appendix B** (noting sea turtles were recorded on both the MFR and the Sea Turtle Record until 2000; beginning in 2000, observers only recorded turtles on the STR).

Taxa	Form (implementation year, revision year(s), and modifications)	Species identification characteristics	Destiny/Fate	Biological characteristics	Other	Reference
Sharks	**Shark Record: SR** (2004, 2019) The SR was implemented in 2004 and fully adopted by the end of 2005. **2019 revisions:** Fate code 1 was modified from "human consumption" to "retained".	Caudal fin shape, head shape, 1st dorsal fin shape, distance between 1st dorsal fin and pectoral fin, internal border length of 2nd dorsal fin, pectoral fin coloration, and presence/absence of inter-dorsal crest.	Retained, discarded, released alive, other, unknown.	**Individual**: length (measured or estimated), sex, fate. **Collective**: size categories (TL, cm) (small: <90, medium: 90-150, large: >150) by fate (2004).	NA	**Appendix C** (noting sharks were no longer recorded on the MFR starting in 2004).
Billfishes	**Billfish Record: BFR** (1989, 2006, 2016, 2019) The new form was developed in 2006 and fully adopted by early 2007. **2016 modifications**: Removed diagnostic characteristic of pectoral fin mobility for black marlin and added 2 additional diagnostic characteristics: 1) pectoral fin posterior and 2) 2nd dorsal and 2nd anal fin relationship). **2019 revisions:** Fate code 1 was modified from "human consumption" to "retained".	1st dorsal fin shape, caudal peduncle keel, pectoral fin posterior margin shape, upper and lower jaw relationship, 2nd dorsal and 2nd anal fin relationship, and body height/dorsal fin relationship.	Retained, discarded, escaped net, other, unknown.	**Individual**: length (measured or estimated), sex, fate. **Collective**: size categories (POFL, cm) (small: <90, medium: 90-150, large: >150) by fate (2006).	NA	**Appendix D** (noting billfishes were no longer recorded on the MFR starting in 2006).
Rays	**Ray Record: RR** (2016, 2019) The RR was implemented and fully adopted during 2016. **2019 revisions:** Fate code 1 was modified from "human consumption" to "retained".	Head shape, spiracle position, mouth position, and tail spine.	Retained, discarded, released alive, other, unknown.	**Individua**l: length (measured or estimated), sex, fate. **Collective**: size categories (DW, cm) (small: <90, medium: 90-150, large: >150) by fate (2016).	NA	**Appendix E** (noting rays were no longer recorded on the MFR in 2016).
Marine Mammals	**MMSSR** (1979)	Identification characteristics documented by the observer on the MMSSR.	Live release, rescue efforts, condition (dead, injured).	Age, sex.	Sightings, school size estimations by species, behavior during chase and set, gear performance and malfunctions.	**Appendix F**

Table 2. Reference guide showing a timeline of data collection and/or revisions.

Implementation year	Data collection and revisions
1979	• Purse-seine vessels 364 mt or greater (size class 6) carried observers on a percentage of trips to collect information on marine mammal sightings, interactions of the fishery with marine mammal populations, operational characteristics and catch of target species (Joseph 1994): Marine Mammal Sightings and Set Record (MMSSR, Appendix F).
1987	• First non-mammal bycatch information collected on the Flotsam information record (FIR), developed for floating object sets only, to record number and type of floating objects involved in sets and sightings of objects not involved in sets. • Estimates of numbers of individuals and/or weights were recorded before the set with a separate estimate for mortality that occurred during the set.
1990	• Sightings of sea turtles recorded on the Sea Turtle Record (STR, Appendix B) for those unassociated with fishing operations and interactions with sets.
1992	• Nearly 100% observer coverage was obtained on trips for size class 6 purse-seine vessels (Joseph 1994).
1993	• Agreement on the International Dolphin Conservation Program (AIDCP) mandated observers be present on all trips for size class 6 vessels (see Fig. 2 for timeline of observer programs). • Implementation of Marine Fauna Record (MFR, Appendix A) to record numbers of individuals or weights of dead non-mammals and number of seabird sightings in a purse-seine set for all set types; filled out by observer only if a set is made. • Creation of the Bycatch database.
1997	• Reason code for tuna discards and destiny code for non-tunas added to the MFR form; discontinuation of non-tuna special codes for recording catch as 'few', 'moderate' or 'large' on the MFR.
2000	• Observers instructed to record tuna data in metric tons instead of short tons; previous data in short tons converted to metric tons. • Observers stopped recording sea turtle data on MFR; turtle data only collected on STR (Appendix B). • A shark characteristics form (SCF) was implemented for a special shark sampling project (Mar 2000–Mar 2001).
2004	• Expansion of the species codes table. • Observers were instructed to record bycatch mortalities in numbers only on the MFR. • Shark Record (SR, Appendix C) introduced; disposition (*i.e.,* shark live releases, retained, discarded) 1st recorded on the SR; individual and size-based length estimates (*i.e.,* small, medium, large) recorded. • Conversion factors for converting numbers to weights for the BycatchWeight table and weights to numbers for the Bycatch table were reevaluated.
2005	• Seabird sighting data removed from FIR form and only recorded on MFR when a set is made. • An IATTC species identification manual was developed.
2006	• Dedicated billfish record (BFR, Appendix D) introduced, fate codes initiated (*e.g.* retained, discarded, escaped net), individual and size-based (i.e. small, medium, large) length estimates recorded. • Bycatch database was updated to account for the taxa that were recoded as a result of the review of the paper MFR forms (*i.e.,* when observers recorded scientific or common names in the MFR comments section for taxa that did not have a dedicated species code in tblSpecies). • New seabird species codes were added to the bird's species code table (tblBirds). • MFRNumFish and MFRTonFish tables in the Bycatch database were updated to reflect the newly identified species based on staff's review of MFR paper forms and observer's species identification notes in the MFR comments (mainly sharks, rays and large fishes).
2007	• New conversion factors applied to existing data in May 2007 and affected data from 1993–2006; Bycatch and BycatchWeight tables were recreated to include the more precise conversion factors. • Extrapolation procedure for populating the InEPOExcelBycatch and InEPOExcelBCWeight tables in the BycatchReports database was revised to extrapolate unobserved trip data based on the true flag of the unobserved trip, rather than basing the extrapolation on data from a single group of vessels from smaller fleets.
2009	• Precautionary decision to count live-released sharks as dead in the Bycatch and BycatchWeight tables; percentage of live release of each shark species recorded on the SR form during the first 5 years was applied to the shark mortality recorded on the MFR form to obtain this estimate of 'live release'; increased the number of reported sharks caught as bycatch in 1993–2005.
2016	• Implementation of Ray Record (RR, Appendix E) to monitor compliance with Resolution C-15-04; includes fate codes (e.g. retained, discarded, released alive), individual measurements and collective size-based estimates (*i.e.,* small, medium and large).
2020	• Species code table was revised to disaggregate some species groupings (*e.g.* yellowtail: *Caranx* spp., *Seriola* spp.) and new fields were added for the purposes of grouping species for annual FSR reporting. Seabird species were integrated into the main species codes table (tblSpecies).

Table 3. List of the original general species codes available to observers for reporting bycatch on the Marine Fauna Record prior to 2004.

Species Code	Common Name	Scientific Name
120	Unid. Billfishes	Istiophoridae
121	Unid. Marlins	*Makaira, Tetrapturus*[1]
122	Sailfish	*Istiophorus platypterus*
123	Swordfish	*Xiphias gladius*
124	Black marlin	*Makaira indica*[2]
125	Striped marlin	*Tetrapturus audax*[3]
126	Blue marlin	*Makaira nigricans*
127	Shortbill spearfish	*Tetrapturus angustirostris*
130	Other large fishes	
131	Dorado, Mahi mahi	Coryphaenidae
132	Wahoo	*Acanthocybium solandri*
133	Rainbow runner	*Elagatis bipinnulata*
134	Yellowtail	*Seriola, Caranx* spp.
140	Other small fishes	
141	Triggerfishes	Balistidae, Monacanthidae
142	Unidentified bait fish	
150	Other sharks	
151	Blacktip shark	*Carcharhinus limbatus*
152	Oceanic whitetip shark	*Carcharhinus longimanus*
153	Hammerhead shark	*Sphyrna* spp.
154	Unidentified sharks	
155	Manta rays	Mobulidae
156	Stingray	*Dasyatis violacea*[4]
157	Silky shark	*Carcharhinus falciformis*
160	Unidentified turtles	Testudinata
161	Olive Ridley turtle	*Lepidochelys olivacea*
162	Loggerhead turtle	*Caretta caretta*
163	Green turtles	*Chelonia mydas mydas, C. m. agassizii*
164	Leatherback turtle	*Dermochelys coriacea*
165	Hawksbill turtle	*Eretmochelys imbricata*
170	Unidentified fishes	Pisces
171	Invertebrates	Invertebrata
172	Other fauna	

[1] Presently includes *Istiompax* and *Kajikia*

[2] Presently *Istiompax indica*

[3] Presently *Kajikia audax*

[4] Presently *Pteroplatytrygon violacea*

Table 4. Table of expanded species codes implemented in 2004. Codes in bold represent species codes that were collected prior to 2004. New codes continue to be added as needed[1].

Family	Scientific name	Common name	Species identification code and abbreviation			Unidentified
Billfishes (spearfish, marlins, sailfish, swordfish)						
Xiphiidae	*Xiphias gladius*	Swordfish	**123 SWO**			
Istiophoridae	*Istiophorus platypterus*	Sailfish	**122 SFA**			
	Kajikia audax[2]	Striped marlin	**125 MLS**			
	Tetrapturus angustirostris	Shortbill spearfish	**127 SSP**	**121 MRNI**	**120 BIL**	129 PINI
	Makaira indica[3]	Black marlin	**124 BLM**			
	Makaira nigricans	Blue marlin	**126 BUM**			
Other billfish species not included						128 OPIC
Elasmobranchs (sharks)						
Carcharhinidae	*Carcharhinus falciformis*	Silky shark	**157 FAL**			
	Carcharhinus limbatus	Blacktip shark	**151 CCL**	240 RSK		
	Carcharhinus longimanus	Oceanic whitetip shark	**152 OCS**			
	Carcharhinus leucas	Bull shark	243 CCE			
	Prionace glauca	Blue shark	245 BSH			
Sphyrnidae	*Sphyrna lewini*	Scalloped hammerhead	310 SPL			
	Sphyrna zygaena	Smooth hammerhead	246 SPZ	**153 SPN**		**154 TINI**
	Sphyrna mokarran	Great hammerhead	241 SPK			
Lamnidae	*Isurus oxyrinchus*	Shortfin mako shark	247 SMA			
	Isurus spp.	Mako shark	158 MAK			
Alopiidae	*Alopias pelagicus*	Pelagic thresher shark	307 PTH			
	Alopias superciliosus	Bigeye thresher shark	306 BTH	248 THR		
	Alopias vulpinus	Thresher shark	242 ALV			
Rhincodontidae	*Rhincodon typus*	Whale shark	312 RHN			
Other shark species not included						**150 OTIB**
Elasmobranchs (manta rays, devil rays and stingrays)						
Mobulidae	*Mobula thurstoni*	Smoothtail manta	261 RMO			
	Mobula mobular[4]	Spinetail manta	262 RMJ	268 RMV		
	Mobula munkiana	Munk's devil ray	263 RMU		**155 MAN**	269 RANI
	Mobula tarapacana	Chilean devil ray	264 RMT			
	Mobula birostris[5]	Giant manta	265 RMB			
Dasyatidae	*Pteroplatytrygon violacea*[6]	Pelagic stingray	**156 PLS**			
Other ray species not included						260 ORAY
Teleosts (fishes) large and medium						
Coryphaenidae	*Coryphaena hippurus*	Common dolphinfish	182 DOL	**131 DOX**		
	Coryphaena equiselis	Pompano dolphinfish	183 CFW			
Carangidae	*Seriola rivoliana*	Longfin yellowtail	137 YTL			
	Seriola lalandi	Yellowtail amberjack	138 YTC	184 AMX		
	Seriola peruana	Fortune jack	139 RLN		**134 JURE**	
	Caranx sexfasciatus	Bigeye trevally	234 CXS			239 PGNI
Carangidae	*Caranx* spp.	Jacks, crevalles nei	232 TRE			
	Elagatis bipinnulata	Rainbow runner	**133 RRU**			
Scombridae	*Acanthocybium solandri*	Wahoo	**132 WAH**			239 PGNI
Lobotidae	*Lobotes surinamensis*	*Tripletail*	135 LOB			

Family	Scientific name	Common name	Species identification code and abbreviation			Unidentified
Molidae	*Mola mola*	Ocean sunfish, mola	136 MOX			
Other species of large or medium fishes not included						**130 OTPG**
Teleosts (fishes) small						
Kyphosidae	*Sectator ocyurus*	Bluestriped chub	143 ECO			
	Kyphosus analogus	Blue-bronze sea chub	186 KIN	188 KYP		
	Kyphosus elegans	Cortez sea chub	187 KYE			
Balistidae	*Canthidermis maculata*	Ocean triggerfish	145 CNT			
	Balistidae nei	Triggerfish nei	146 TRI		**141 CCHI**	**142 PPNI**
Monacanthidae	*Aluterus scriptus*	Scrawled filefish	147 ALN	189 ALT		
	Aluterus monoceros	Unicorn filefish	148 ALM			
Carangidae	*Naucrates ductor*	Pilotfish	149 NAU			
	Decapterus macarellus	Mackerel scad	185 MSD			
Other species of small fishes not included						**140 OTPP**
Miscellaneous						
Unidentified fish						**170 PENI**
Other fauna identified						**172 OFTA**
Unidentified marine fauna						180 FANI
Invertebrates						
Ommastrephidae	*Dosidicus gigas*	Giant squid	175 GIS	**171 INNI**		
Rhizostomidae	*Rhopilema* spp.	Jellyfishes	176 JEL			
Other invertebrates not included						179 OTIN
Sea turtles						
Cheloniidae	*Lepidochelys olivacea*	Olive Ridley turtle	**161 LKV**			
	Caretta caretta	Loggerhead turtle	**162 TTL**			
	Chelonia mydas	Black/green turtle	**163 VDPT**	**160 TONI**		
	Eretmochelys imbricata	Hawksbill turtle	**165 TTH**			
	Dermochelys coriacea	Leatherback turtle	**164 DKK**			
Other species of turtles not included						167 OTTO
Tunas						
Scombridae	*Thunnus albacares*	Yellowfin tuna	110 YFT			
	Thunnus obesus	Bigeye tuna	106 BET			
	Thunnus alalunga	Albacore tuna	102 ALB			
	Thunnus orientalis	Pacific bluefin tuna	101 PBF			
	Katsuwonus pelamis	Skipjack tuna	111 SKJ			
	Euthynnus lineatus	Black skipjack	103 BKJ			107 TUN
	Auxis rochei	Bullet tuna	114 BLT	104 FRZ		
	Auxis thazard	Frigate tuna	116 FRI			
	Sarda orientalis	Striped bonito	117 BIP	105 BZX		
	Sarda chiliensis	Eastern Pacific bonito	115 BEP			

[1] IATTC's current table of species codes contains 565 taxa as of September 2021.
[2] Previously known as *Tetrapterus audax*
[3] Previously known as *Istiompax indica*
[4] Previously known as *Mobula mobular*
[5] Previously known as *Manta birostris*
[6] Previously known as *Dasyatus violacea*

Table 5. Parameter values for weight-length regressions in the form W=aL^b, and their literature sources. Some parameter values were derived by fitting to W-L relationships for other taxa (see column 'References/Notes').

Group	SpeciesID code	Common Name	Scientific Name	N estimates	Weight-length regression parameters		References/Notes
					a	b	
Dolphins	11	Coastal spotted dolphin	*Stenella attenuata*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	12	Offshore spotted dolphin	*Stenella attenuata*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	10	Unidentified spotted dolphin	*Stenella attenuata*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	21	Eastern spinner dolphin	*Stenella longirostris*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	22	Whitebelly spinner dolphin	*Stenella longirostris*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	23	Central Am spinner dolphin	*Stenella longirostris*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	20	Unidentified spinner dolphin	*Stenella longirostris*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	32	Striped dolphin	*Stenella coeruleoalba*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	31	Common dolphin	*Delphinus delphis*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	34	Longsnouted common dolp.	*Delphinus capensis*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	33	Fraser's dolphin	*Lagenodelphis hosei*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	30	Whitebelly dolphin	*Stenella, Lagenodelphis, Delphinus*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	41	Bottlenose dolphin	*Tursiops truncatus*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	43	Roughtoothed dolphin	*Steno bredanensis*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	44	Risso's dolphin	*Grampus griseus*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	45	Pacific whitesided dolphin	*Lagenorhynchus obliquidens*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	92	Dolphin, nei	Delphinidae	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)

Small whales	61	Shortfin pilot whale	*Globicephala macrorhynchus*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	62	Melon-headed whale	*Peponocephala electra*	1	-9.003	2.432	(Perrin and Reilly 1984, Trites and Pauly 1998)
	66	Pygmy sperm whale	*Kogia breviceps*	1	-9.003	2.432	(Trites and Pauly 1998)
	60	Unidentified small whale	Odontoceti				
Billfishes	124	Black marlin	*Istiompax indica*	2	5.5E-06	3.165	(Skillman and Yong 1974, Uchiyama and Kazama 2003)
	126	Blue marlin	*Makaira nigricans*	5	1.1E-05	3.044	(Kume and Joseph 1969, Skillman and Yong 1974, Wares and Sakagawa 1974, Uchiyama and Kazama 2003)
	125	Striped marlin	*Kajikia audax*	5	7.6E-06	2.988	(Kume and Joseph 1969, Skillman and Yong 1974, Wares and Sakagawa 1974, Melo-Barrera *et al.* 2003, Uchiyama and Kazama 2003)
	127	Shortbill spearfish	*Tetrapturus angustirostris*	2	7.6E-06	2.988	(Kume and Joseph 1969, Uchiyama and Kazama 2003)
	121	Marlin, nei	*Makaira, Tetrapturus, Istiompax, Kajikia*	--	1.3E-05	2.988	Regression fitted to average weights at length intervals for SpeciesID 124-127
	122	Indo-Pacific sailfish	*Istiophorus platypterus*	3	6.8E-05	2.531	(Kume and Joseph 1969, Wares and Sakagawa 1974, Uchiyama and Kazama 2003)
	120	Marlin, sailfish, spearfish, nei	Istiophoridae	--	3.1E-05	2.840	Assumed same as for SpeciesID 129
	123	Swordfish	*Xiphias gladius*	3	9.1E-07	3.531	(Kume and Joseph 1969, Skillman and Yong 1974, Uchiyama *et al.* 1999)
	129	Billfish, nei	Istiophoridae, Xiphiidae	--	3.1E-05	2.840	Regression fitted to average weights at length intervals for SpeciesID 122-127
Large fishes	182	Common dolphinfish	*Coryphaena hippurus*	3	2.9E-05	2.714	(Tester and Nakamura 1957, Quevado and Aguilar 1984, Lasso and Zapata 1999)
	183	Pompano dolphinfish	*Coryphaena equiselis*	1	3.1E-05	2.761	(Castro *et al.* 1999b)
	131	Dorado, mahi mahi, dolphin	Coryphaenidae	--	--	--	see Table 6

	132	Wahoo	*Acanthocybium solandri*	4	8.2E-07	3.411	(Iversen and Yoshida 1957, Hogarth 1976, Van der Elst 1981, Uchida and Uchiyama 1986)
	133	Rainbow runner	*Elagatis bipinnulata*	1	9.3E-06	2.919	(Schroeder 1982)
	137	Longfin yellowtail	*Seriola rivoliana*	1	4.1E-05	2.888	(Morato *et al.* 2001)
	138	Yellowtail amberjack	*Seriola lalandi*	1	4.6E-05	2.838	(Baxter 1960)
	139	Fortune jack	*Seriola peruana*	1	4.1E-05	2.888	Assumed same W-L regression as for *Seriola lalandi*
	184	Amberjacks, nei	*Seriola* spp.	--	--	--	see Table 6
	234	Bigeye trevally	*Caranx sexfasciatus*	2	1.4E-05	3.053	(Schroeder 1982, González Acosta *et al.* 2004)
	430	Green jack	*Caranx caballus*	1	-9.0E+00	2.432	Assumed same as for *Caranx sexfasciatus*
	431	Pacific crevalle jack	*Caranx caninus*	1	-9.0E+00	2.432	Assumed same as for *Caranx sexfasciatus*
	232	Jacks, crevalles, nei	*Caranx* spp.	2	1.4E-05	3.053	Assumed same as for *Caranx sexfasciatus*
	134	Yellowtail	*Seriola, Caranx* spp.	--	--	--	see Table 6
	135	Tripletail	*Lobotes surinamensis*	1	7.5E-05	2.744	(Van der Elst 1981)
	457	Whitemouth jack	*Uraspis helvola*	1	1.9E-05	2.995	Assumed same as for *Uraspis secunda;* (Froese and Pauly 2000)
	136	Ocean sunfish	*Mola mola*	1	4.9E-05	3.037	(Coull *et al.* 1989)
	446	Chilean jack mackerel	*Trachurus murphyi*	1	7.7E-06	3.081	(Froese and Pauly 2000)
	449	Flat needlefish	*Ablennes hians*	1	7.0E-07	3.130	(Van der Elst 1981)
	130	Large fish - identified	Osteichthyes	--	--	--	see Table 6
	498	Great barracuda	*Sphyraena barracuda*	1	3.6E-05	2.702	(García-Arteaga *et al.* 1997)
	239	Large fish, nei	Osteichthyes	--	--	--	see Table 6
Small fishes	145	Ocean triggerfish	*Canthidermis maculata*	1	2.9E-05	2.952	Regression for *Canthidermis sufflamen* from (Froese and Pauly 2000)
	472	Finescale triggerfish	*Balistes polylepis*	various	1.8E-05	2.894	values for genus *Balistes;* (Froese and Pauly 2000)

	146	Triggerfishes, durgons, nei	Balistidae	--	--	--	see Table 6
	147	Scrawled filefish	*Aluterus scriptus*	1	2.2E-06	3.000	(Froese and Pauly 2000)
	148	Unicorn filefish	*Aluterus monoceros*	1	1.2E-05	2.958	(García *et al.* 1998)
	189	Leatherjacket filefishes	*Aluterus* spp.	--	7.6E-06	2.958	Regression fitted to average weights at length intervals for SpeciesID 147 and 148
	141	Triggerfishes, filefishes	Balistidae, Monacanthidae	--	--	--	see Table 6
	143	Bluestriped chub	*Sectator ocyurus*	1	2.0E-05	2.999	(Average for Kyphosidae from Froese and Pauly 2000)
	186	Blue-bronze sea chub	*Kyphosus analogus*	1	2.2E-05	3.002	(Values for genus Kyphosus from Froese and Pauly 2000)
	187	Cortez sea chub	*Kyphosus elegans*	1	2.2E-05	3.002	(Values for genus Kyphosus from Froese and Pauly 2000)
	188	Drummer	*Kyphosus* spp.	--	2.2E-05	3.002	(Values for genus Kyphosus from Froese and Pauly 2000)
	185	Mackerel scad	*Decapterus macarellus*	1	1.0E-05	3.140	(Froese and Pauly 2000)
	442	Bigeye scad	*Selar crumenophthalmus*	1	1.9E-05	2.980	(Froese and Pauly 2000)
	149	Pilotfish	*Naucrates ductor*	1	3.7E-05	2.884	(Froese and Pauly 2000)
	479	Shark sucker	*Remora remora*	1	5.0E-06	3.000	(Froese and Pauly 2000)
	140	Small fish - identified	Osteichthyes	--	--	--	see Table 6
	142	Small fish, nei	Osteichthyes	--	--	--	see Table 6
Sharks	157	Silky shark	*Carcharhinus falciformis*	5	5.6E-06	3.025	(Quevado and Aguilar 1984, Branstetter 1987b, Kohler *et al.* 1995, García-Arteaga *et al.* 1997, Oshitani *et al.* 2003)
	152	Oceanic whitetip shark	*Carcharhinus longimanus*	2	1.6E-05	2.862	(Quevado and Aguilar 1984, García-Arteaga *et al.* 1997)

	151	Blacktip shark	*Carcharhinus limbatus*	3	6.7E-06	3.002	(Branstetter 1987a, Castro 1996, García-Arteaga *et al.* 1997)
	159	Silky or Blacktip shark	*Carcharhinus falciformis, C. limbatus*	--	5.6E-06	3.025	Assumed same as for *Carcharhinus falciformis*
	243	Bull shark	*Carcharhinus leucas*	2	7.6E-06	3.006	(Branstetter and Stiles 1987, García-Arteaga *et al.* 1997)
	309	Dusky shark	*Carcharhinus obscurus*	1	1.9E-05	2.786	(Kohler *et al.* 1995)
	402	Bignose shark	*Carcharhinus altimus*	1	5.3E-07	3.461	(Kohler *et al.* 1995)
	403	Copper shark	*Carcharhinus brachyurus*	2	1.4E-06	3.273	Assumed same as for *Carcharhinus signatus*
	404	Galapagos shark	*Carcharhinus galapagensis*	4	2.8E-06	3.229	(De Crosta *et al.* 1984, Wetherbee *et al.* 1996, IGFA 2001)
	405	Sandbar shark	*Carcharhinus plumbeus*	1	6.1E-06	3.012	(Kohler *et al.* 1995)
	406	Smalltail shark	*Carcharhinus porosus*	1	6.1E-06	3.012	Assumed same as for *Carcharhinus plumbeus*
	240	Requiem sharks, nei	*Carcharhinus* spp.	--	5.9E-06	3.025	Regression fitted to average weights at length intervals for SpeciesID 152 and 157
	242	Thresher shark	*Alopias vulpinus*	2	1.9E-04	2.519	(Kohler *et al.* 1995)
	306	Bigeye thresher shark	*Alopias superciliosus*	2	9.1E-06	3.080	(Kohler *et al.* 1995)
	307	Pelagic thresher shark	*Alopias pelagicus*	--	3.1E-05	2.597	Regression fitted to average weights at length intervals for SpeciesID 242 and 306; (Kohler *et al.* 1995)
	248	Thresher shark, nei	*Alopias* spp.	2	3.1E-05	2.597	Regression fitted to average weights at length intervals for SpeciesID 242 and 306; (Kohler *et al.* 1995)
	247	Short fin mako shark	*Isurus oxyrinchus*	4	1.1E-05	2.953	(Stevens 1983, Kohler *et al.* 1995, Ayers *et al.* 2004, Campana *et al.* 2005)
	158	Mako shark, nei	*Isurus* spp.	--	1.1E-05	2.953	Assumed same as for *Isurus oxyrinchus*
	246	Smooth hammerhead shark	*Sphyrna zygaena*	1	1.4E-06	3.300	(Van der Elst 1981)

	310	Scalloped hammerhead shark	*Sphyrna lewini*	2	7.6E-06	2.919	(Branstetter 1987b, Kohler *et al.* 1995)
	416	Scalloped bonnethead	*Sphyrna corona*	1	1.4E-06	3.300	Assumed same as for *Sphyrna zygaena*
	417	Scoophead	*Sphyrna media*	1	1.4E-06	3.300	Assumed same as for *Sphyrna zygaena*
	418	Bonnethead	*Sphyrna tiburo*	1	1.4E-06	3.300	Assumed same as for *Sphyrna zygaena*
	241	Great hammerhead	*Sphyrna mokarran*	1	1.9E-06	3.160	(García-Arteaga *et al.* 1997)
	153	Hammerhead shark, nei	*Sphyrna* spp.	--	1.0E-05	2.919	Regression fitted to average weights at length intervals for Species 246 and 310
	245	Blue shark	*Prionace glauca*	5	4.4E-07	3.392	(Stevens 1975, Kohler *et al.* 1995, Ayers *et al.* 2004)
	312	Whale shark	*Rhincodon typus*	1	4.3E-06	3.000	(Froese and Pauly 2000)
	410	Tiger shark	*Galeocerdo cuvier*	2	1.0E-06	3.303	(Branstetter *et al.* 1987, Kohler *et al.* 1995)
	411	Whitenose shark	*Nasolamia velox*	1	6.1E-06	3.012	Assumed same as for *Carcharhinus plumbeus*
	412	Lemon shark	*Negaprion brevirostris*	1	2.2E-06	3.160	(Froese and Pauly 2000)
	413	Pacific sharpnose shark	*Rhizoprionodon longurio*	1	6.1E-06	3.012	Assumed same as for *Carcharhinus plumbeus*
	415	Basking shark	*Cetorhinus maximus*	1	4.9E-06	3.000	(Froese and Pauly 2000)
	419	Great white shark	*Carcharodon carcharias*	1	6.0E-06	3.085	(Kohler *et al.* 1995)
	150	Shark - identified	Euselachii				
	154	Sharks, nei	Euselachii	--	1.6E-05	2.855	Regression fitted to average weights at length intervals for all *Alopias* spp., *Carcharhinus* spp., and *Sphryna* spp.
Rays	265	Giant manta	*Mobula birostris*	--	--	--	see Table 6
	261	Smoothtail manta	*Mobula thurstoni*	--	--	--	see Table 6
	262	Spinetail manta	*Mobula mobular*	--	--	--	see Table 6
	263	Munk's devil ray	*Mobula munkiana*	--	--	--	see Table 6

	264	Chilean devil ray	*Mobula tarapacana*	--	--	--	see Table 6
	268	Manta ray, nei	*Mobula* spp.	--	--	--	see Table 6
	155	Manta rays	Mobulidae	--	--	--	see Table 6
	156	Pelagic stingray	*Pteroplatytrygon violacea*	--	--	--	see Table 6
	271	Eagle rays nei	Myliobatidae	--	--	--	see Table 6
	269	Rays, nei	Mobulidae, Dasyatidae	--	--	--	see Table 6
Turtles	161	Olive Ridley turtle	*Lepidochelys olivacea*	--	9.0E-05	3.070	Assumed same as for *Chelonia mydas*
	162	Loggerhead turtle	*Caretta caretta*	1	2.1E-03	2.422	(Sato *et al.* 1998)
	163	Black/Green turtle	*Chelonia mydas mydas, agassizii*	2	9.3E-05	3.062	(Seminoff *et al.* 2003, Thomson *et al.* 2009)
	164	Leatherback turtle	*Dermochelys coriacea*	2	9.8E-06	3.460	(Georges and Fossette 2006, James *et al.* 2007)
	165	Hawksbill turtle	*Eretmochelys imbricata*	3	1.0E-04	3.032	(Diez and Van Dam 2002)
	160	Marine turtles, nei	Testudinata	5	1.7E-04	2.937	Regression fitted to average weights at length intervals for SpeciesID 161-163 and 165
Unid./Others	170	Fish, nei	Pisces	--	--	--	see Table 6
	172	Other fauna - identified		--	--	--	see Table 6

Table 6. Average body weights (factors for converting numbers to weights and vice versa) for small, medium, and large size classes of bycatch in the eastern Pacific Ocean.

Group	SpeciesID code	Common Name	Scientific Name	Estimated average body weight (kg) per individual				Notes
				Small	Medium	Large	Weighted Average	
Dolphins	11	Coastal spotted dolphin	*Stenella attenuata*	--	--	84.32	84.32	Maximum lengths averaged for 85 females and 43 males, eastern tropical Pacific.
	12	Offshore spotted dolphin	*Stenella attenuata*	--	--	65.31	65.31	Maximum lengths averaged for >2,792 females and >3,141 males, eastern tropical Pacific.
	10	Unidentified spotted dolphin	*Stenella attenuata*	--	--	74.45	74.45	Maximum length based on average of max lengths for coastal and offshore spotted dolphins, eastern tropical Pacific.
	21	Eastern spinner dolphin	*Stenella longirostris*	--	--	44.3	44.3	Maximum lengths averaged for 1,297 females and 1,102 males, eastern tropical Pacific.
	22	Whitebelly spinner dolphin	*Stenella longirostris*	--	--	60.35	60.35	Maximum lengths averaged for 1,155 females and 142 males.
	23	Central Am spinner dolphin	*Stenella longirostris*	--	--	44.3	44.3	Maximum lengths for females and males assumed same as for eastern spinner dolphins, eastern tropical Pacific.
	20	Unidentified spinner dolphin	*Stenella longirostris*	--	--	51.87	51.87	Maximum length based on average of max lengths for eastern and whitebelly spinner dolphins, eastern tropical Pacific.
	32	Striped dolphin	*Stenella coeruleoalba*	--	--	64.63	64.63	Maximum lengths averaged for 99 females and 103 males, eastern tropical Pacific.
	31	Common dolphin	*Delphinus delphis*	--	--	70.91	70.91	Maximum lengths averaged for 236 females and 216 males, north tropical stock, eastern tropical Pacific.
	34	Longsnouted common dolphin	*Delphinus capensis*	--	--	70.91	70.91	Maximum lengths for females and males assumed same as for common dolphins, eastern tropical Pacific.
	33	Fraser's dolphin	*Lagenodelphis hosei*	--	--	96.44	96.44	Maximum lengths averaged for 12 females and 6 males, all regions: west North Pacific, eastern tropical Pacific, S. Africa.

	30	Whitebelly dolphin	*Stenella, Lagenodelphis, Delphinus*	--	--	65.45	65.45	Maximum lengths for females and males based on averages of max lengths for whitebelly spinner and common dolphins, eastern tropical Pacific.
	41	Bottlenose dolphin	*Tursiops truncatus*	--	--	93.88	93.88	Maximum lengths averaged for 9 females and 12 males, eastern tropical Pacific.
	43	Roughtoothed dolphin	*Steno bredanensis*	--	--	93.02	93.02	Maximum lengths averaged for 65 females and 68 males, all regions: off Senegal, eastern tropical Pacific, off Florida.
	44	Risso's dolphin	*Grampus griseus*	--	--	223.82	223.82	Maximum lengths averaged for 69 females and >81 males, several regions: N. Atlantic, N. Pacific, Mediterranean, Indian Ocean.
	45	Pacific whitesided dolphin	*Lagenorhynchus obliquidens*	--	--	72.14	72.14	Maximum lengths averaged for >115 females and >162 males, N. Pacific.
	92	Dolphin, nei	Delphinidae	--	--	56.11	56.11	Maximum lengths for females and males based on averages of max lengths for whitebelly spinner, e. spinner, and offshore spotted dolphins, eastern tropical Pacific.
Small whales	61	Shortfin pilot whale	*Globicephala macrorhynchus*	--	--	627.14	627.14	Maximum lengths averaged for >344 females and >231 males, several regions: N. Atlantic, N. Pacific, Indian Ocean.
	62	Melon-headed whale	*Peponocephala electra*	--	--	97.47	97.47	Maximum lengths averaged for 8 females and 9 males, all regions: off Australia, eastern tropical Pacific.
	66	Pygmy sperm whale	*Kogia breviceps*	--	--	177.29	177.29	Maximum lengths averaged for unknown numbers of females and males (Trites and Pauly 1998).
	60	Unidentified small whale	Odontoceti	--	--	627.14	627.14	Assumed same as for *Globicephala macrohynchus*, the only small whale in database
Billfishes	124	Black marlin	*Istiompax indica*	6.04[1]	31.13[1]	123.14[1]	119.56	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.
	126	Blue marlin	*Makaira nigricans*	7.22[3]	34.95[1]	125.53[1]	123.68	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.
	125	Striped marlin	*Kajikia audax*	7.30[3]	30.93[1]	94.37[1]	90.82	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.

	127	Shortbill spearfish	*Tetrapturus angustirostris*	2.48[4]	17.30[1]	40.41[1]	32.47	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.
	121	Marlin, nei	*Makaira, Tetrapturus, Istiompax, Kajikia*	6.49[3]	30.68[2]	119.92[2]	114.54	Numbers-weighted-average weights for SpeciesID 122-127.
	122	Indo-Pacific sailfish	*Istiophorus platypterus*	3.04[1]	16.95[1]	32.55[1]	30.36	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.
	120	Marlin, sailfish, spearfish, nei	Istiophoridae	3.72[3]	22.05[1]	94.29[1]	89.34	Assumed same as for SpeciesID 129
	123	Swordfish	*Xiphias gladius*	3.79[1]	21.75[1]	100.97[1]	76.53	Mean lengths by size stratum from sampling by IATTC Tuna-Billfish section.
	129	Billfish, nei	Istiophoridae, Xiphiidae	3.72[3]	22.05[2]	94.29[2]	55.37	Numbers-weighted-average weights for SpeciesID 122-127.
Large fishes	182	Common dolphinfish	*Coryphaena hippurus*	0.29[3]	1.37[1]	4.07[1]	3.39	
	183	Pompano dolphinfish	*Coryphaena equiselis*	0.37[3]	1.32[2]	13.54[2]	5.43	
	131	Dorado, mahi mahi, dolphinfish	Coryphaenidae	0.29	1.37	4.08	3.40	Numbers-weighted-average weights for SpeciesID 182 and 183.
	132	Wahoo	*Acanthocybium solandri*	0.09[4]	0.96[4]	2.12[1]	1.72	
	133	Rainbow runner	*Elagatis bipinnulata*	0.19[3]	0.67[1]	2.87[1]	0.70	
	137	Longfin yellowtail	*Seriola rivoliana*	0.58[1]	1.02[1]	8.68[4]	1.49	
	138	Yellowtail amberjack	*Seriola lalandi*	0.55[1]	0.97[3]	7.99[4]	0.89	
	139	Fortune jack	*Seriola peruana*	0.67[1]	1.02[3]	8.68[4]	0.96	
	184	Amberjacks, nei	*Seriola* spp.	0.55	0.99	8.16	1.19	Numbers-weighted-average weights for SpeciesID 137-139.
	234	Bigeye trevally	*Caranx sexfasciatus*	0.21[1]	1.02[1]	7.71[3]	0.40	
	430	Green jack	*Caranx caballus*	0.21[1]	1.02[1]	7.71[3]	0.40	Assumed same as for *Caranx sexfasciatus*
	431	Pacific crevalle jack	*Caranx caninus*	0.21[1]	1.02[1]	7.71[3]	0.40	Assumed same as for *Caranx sexfasciatus*
	232	Jacks, crevalles, nei	*Caranx* spp.	0.21[3]	1.02[3]	7.71[1]	0.42	Assumed same as for *Caranx sexfasciatus*

	134	Yellowtail	*Seriola, Caranx* spp.	0.54	0.99	8.16	1.18	Numbers-weighted-average weights for SpeciesID 137-139, 184, 232, 234, 430, and 431.
	135	Tripletail	*Lobotes surinamensis*	0.61[2]	1.56[2]	7.05[3]	1.49	
	457	Whitemouth jack	*Uraspis helvola*	0.08[2]	0.69[2]	3.97[4]	0.18	Assumed same as for *Uraspis secunda*
	498	Great barracuda	*Sphyraena barracuda*	0.35[4]	1.81[4]	3.48[4]	3.28	
	136	Ocean sunfish	*Mola mola*	1.50[3]	12.33[3]	128.99[3]	46.13	
	446	Chilean jack mackerel	*Trachurus murphyi*	0.20[4]	0.66[2]	2.44[4]	1.10	
	449	Flat needlefish	*Ablennes hians*	0.03[4]	0.10[4]	0.33[4]	0.26	
	130	Large fish - identified	Osteichthyes	0.26	1.16	3.25	1.13	Numbers-weighted-average weights for SpeciesID 131-139, 184, 232, 457, 498.
	239	Large fish, nei	Osteichthyes	0.26	1.17	3.28	1.32	Numbers-weighted-average weights for SpeciesID 131-139, 182-184, 232, 234, 430-431, 446, 449, 457, 498.
Small fishes	145	Ocean triggerfish	*Canthidermis maculata*	0.43[1]	0.81[1]	5.20[4]	2.14	
	472	Finescale triggerfish	*Balistes polylepis*	0.16[2]	0.79[3]	2.57[4]	1.17	values for genus *Balistes*
	146	Triggerfishes, durgons, nei	Balistidae	0.29	0.80	3.88	3.88	Numbers-weighted-average weights for SpeciesID 145 and 472.
	147	Scrawled filefish	*Aluterus scriptus*	0.06[2]	0.14[1]	0.48[4]	0.22	
	148	Unicorn filefish	*Aluterus monoceros*	0.16[1]	0.64[1]	2.25[4]	1.02	
	189	Leatherjacket filefishes	*Aluterus* spp.	0.11	0.39	1.36	0.16	Numbers-weighted-average weights for SpeciesID 147 and 148.
	141	Triggerfishes, filefishes	Balistidae, Monacanthidae	0.11	0.39	3.88	0.11	Numbers-weighted-average weights for SpeciesID 146 and 189.
	143	Bluestriped chub	*Sectator ocyurus*	0.47[1]	0.69[1]	4.40[4]	0.68	
	186	Blue-bronze sea chub	*Kyphosus analogus*	0.23[1]	0.60[4]	4.84[4]	0.23	
	187	Cortez sea chub	*Kyphosus elegans*	0.17[1]	0.67[4]	4.84[4]	0.60	

	188	Drummer	*Kyphosus* spp.	0.22[3]	0.67[3]	4.84[4]	0.22	Numbers-weighted-average weights for SpeciesID 186 and 187.
	185	Mackerel scad	*Decapterus macarellus*	0.33[1]	0.51[1]	3.90[4]	0.45	
	442	Bigeye scad	*Selar crumenophthalmus*	0.14[4]	0.58[4]	3.77[4]	1.50	
	149	Pilotfish	*Naucrates ductor*	0.24[4]	0.81[4]	4.95[4]	0.78	
	479	Shark sucker	*Remora remora*	0.04[2]	0.32[4]	1.36[4]	0.47	
	140	Small fish - identified	Osteichthyes	0.11	0.59	1.74	0.11	Numbers-weighted-average weights for SpeciesID 141, 143, 145-149, 185-189, 442, 472, 479.
	142	Small fish, nei	Osteichthyes	0.11	0.59	1.74	0.16	Numbers-weighted-average weights for SpeciesID 141, 143, 145-149, 185-189, 442, 472, 479.
Sharks	157	Silky shark	*Carcharhinus falciformis*	2.61[1]	11.37[1]	38.76[1]	19.29	
	152	Oceanic whitetip shark	*Carcharhinus longimanus*	4.92[4]	20.95[1]	38.35[1]	28.56	
	151	Blacktip shark	*Carcharhinus limbatus*	3.44[4]	15.00[2]	56.20[1]	45.11	
	159	Silky or Blacktip shark	*Carcharhinus falciformis, C. limbatus*	2.61[1]	11.37[1]	38.78[1]	29.64	
	243	Bull shark	*Carcharhinus leucas*	4.27[4]	17.47[2]	113.30[2]	93.41	
	309	Dusky shark	*Carcharhinus obscurus*	4.15[4]	12.00[4]	37.15[4]	19.79	
	402	Bignose shark	*Carcharhinus altimus*	2.23[4]	8.33[4]	48.82[3]	27.76	
	403	Copper shark	*Carcharhinus brachyurus*	2.56[4]	8.90[4]	47.39[3]	26.03	Assumed same as for *Carcharhinus signatus*
	404	Galapagos shark	*Carcharhinus galapagensis*	4.20[4]	27.67[2]	45.08[2]	28.82	
	405	Sandbar shark	*Carcharhinus plumbeus*	3.55[4]	11.16[4]	37.87[4]	22.17	
	406	Smalltail shark	*Carcharhinus porosus*	3.55[4]	11.16[4]	37.87[4]	22.17	Assumed same as for *Carcharhinus plumbeus*
	240	Requiem sharks, nei	*Carcharhinus spp.*	2.80	13.44	38.88	22.65	Numbers-weighted-average weights for SpeciesID 151, 152, 157, 243, 309, and 402-406.
	242	Thresher shark	*Alopias vulpinus*	3.01[3]	9.66[3]	58.46[1]	54.69	

306	Bigeye thresher shark	*Alopias superciliosus*	3.01[3]	8.91[2]	56.15[1]	53.97	
307	Pelagic thresher shark	*Alopias pelagicus*	3.01[3]	10.05[2]	57.88[1]	54.46	
248	Thresher shark, nei	*Alopias* spp.	3.01[3]	9.66[3]	63.86[1]	55.91	
247	Short fin mako shark	*Isurus oxyrinchus*	1.97[3]	25.02[1]	57.29[1]	45.36	
158	Mako shark, nei	*Isurus* spp.	1.97[3]	25.02[2]	57.29[2]	45.36	Assumed same as for *Isurus oxyrinchus*
246	Smooth hammerhead shark	*Sphyrna zygaena*	3.26[4]	10.17[2]	74.06[1]	62.59	
310	Scalloped shark	*Sphyrna lewini*	3.24[2]	12.51[1]	48.00[1]	41.70	
416	Scalloped bonnethead	*Sphyrna corona*	0.78[4]	3.94[2]	21.24[2]	21.24	Assumed same as for *Sphyrna zygaena*
417	Scoophead	*Sphyrna media*	2.67[4]	10.17[4]	64.48[2]	59.05	Assumed same as for *Sphyrna zygaena*
418	Bonnethead	*Sphyrna tiburo*	2.67[4]	10.17[4]	21.24[2]	15.71	Assumed same as for *Sphyrna zygaena*
241	Great hammerhead	*Sphyrna mokarran*	2.39[4]	9.14[4]	69.50[1]	66.84	
153	Hammerhead shark, nei	*Sphyrna* spp.	3.24	11.21	60.50	48.47	Numbers-weighted-average weights for SpeciesID 241, 246, 310, and 416-418.
245	Blue shark	*Prionace glauca*	0.59[3]	3.61[2]	30.76[1]	22.53	
312	Whale shark	*Rhincodon typus*	3.14[2]	14.51[2]	2640.49[4]	2479.49	
410	Tiger shark	*Galeocerdo cuvier*	2.46[4]	9.99[4]	86.67[4]	86.67	
411	Whitenose shark	*Nasolamia velox*	2.71[4]	11.16[3]	24.14[3]	19.27	Assumed same as for *Carcharhinus plumbeus*
412	Lemon shark	*Negaprion brevirostris*	2.24[4]	8.05[4]	40.43[4]	40.43	
413	Pacific sharpnose shark	*Rhizoprionodon longurio*	3.29[4]	11.16[4]	21.87[2]	14.49	Assumed same as for *Carcharhinus plumbeus*
415	Basking shark	*Cetorhinus maximus*	3.57[2]	16.54[2]	612.47[4]	612.47	
419	Great white shark	*Carcharodon carcharias*	5.39[4]	25.14[4]	424.47[4]	424.47	
150	Shark - identified	Euselachii	4.00[2]	13.41[2]	41.49[2]	40.08	Numbers-weighted-average weights for SpeciesID 151-152, 157-158, 240, 242-243, 245, 247- 248, 306-307, 309-310, 312, 402-406.

	154	Sharks, nei	Euselachii	2.80[2]	13.35[2]	43.80[2]	14.57	Numbers-weighted-average weights for SpeciesID 151-153, 157-158, 240-243, 245-248, 306-307, 309-310, 312, 402-406, 410-413, 415-419.
Rays	265	Giant manta	*Mobula birostris*	3.85	21.34	625.99	108.03	
	261	Smoothtail manta	*Mobula thurstoni*	3.85	20.61	41.95	19.23	
	262	Spinetail manta	*Mobula mobular*	3.85	21.54	91.01	19.23	
	263	Munk's devil ray	*Mobula munkiana*	3.85	10.27	28.59	19.23	
	264	Chilean devil ray	*Mobula tarapacana*	3.85	18.86	121.31	19.23	
	268	Manta ray, nei	*Mobula* spp.	3.85	20.55	82.64	19.23	Numbers-weighted-average weights for SpeciesID 261-265.
	155	Manta rays	Mobulidae	3.85	20.55	82.64	19.23	Numbers-weighted-average weights for SpeciesID 261-265.
	156	Pelagic stingray	*Pteroplatytrygon violacea*	3.00			4.99	
	271	Eagle rays nei	Myliobatidae	3.00			4.99	Assumed similar to SpeciesID 156
	269	Rays, nei	Mobulidae, Dasyatidae	3.85	20.55	82.64	19.23	Numbers-weighted-average weights for SpeciesID 156, 261-265.
Turtles	161	Olive ridley turtle	*Lepidochelys olivacea*	5.00[2]	18.46[2]	35.71[2]	36.87	
	162	Loggerhead turtle	*Caretta caretta*	8.00[4]	26.15[4]	66.29[4]	71.98	
	163	Black/Green turtle	*Chelonia mydas mydas, agassizii*	8.00[2]	16.25[2]	48.65[2]	62.33	
	164	Leatherback turtle	*Dermochelys coriacea*	10.00[2]	5.15[2]	141.93[3]	221.93	
	165	Hawksbill turtle	*Eretmochelys imbricata*	5.00[2]	10.86[2]	37.03[2]	18.27	
	160	Marine turtles, nei	Testudinata	8.00[3]	19.64[3]	44.49[4]	46.9	
Unid./Others	170	Fish, nei	Pisces	0.41	0.69	4.95	0.78	Assumed same as for SpeciesID 140
	172	Other fauna - identified		0.2	0.68	1.60	0.83	Assumed same as for SpeciesID 140

[1] High reliability of mean size estimates, and adequate sample sizes.

[2] Medium reliability of mean size estimates; estimates from similar species.

[3] Medium reliability of mean size estimates, based on assumptions.

[4] Low reliability of mean size estimates.

APPENDICES

Appendix A: The IATTC Marine Fauna Record (MFR 04/2019) form used by observers from 2019–present. The MFR was introduced in 1993 and initially contained sections for the various taxonomic groups prior to the implementation of dedicated species forms (see Table 1).

Inter-American Tropical Tuna Commission

MARINE FAUNA RECORD

Trip Number	Set Number

Reasons for discard of the tuna catch:

1 - Species/size undesirable for market
2 - Condition undesirable for market
3 - Ripped sack
4 - Vessel full
5 - Well limitation
6 - Other

TUNA: Use code table 2

Code	MT Capture				MT Discard to the sea				
	Small <2.5 Kg	Medium 2.5 - 15.0 Kg	Large > 15.0 Kg	Total	Small <2.5 Kg	Medium 2.5 - 15.0 Kg	Large > 15.0 Kg	Total	Reason 1 - 6
	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	
	.	.	.	.	.	.	.	.	

OTHER BIG and MEDIUM FISH: Use code table 10

Code	Est. by number of individuals				Destiny				Additional codes
	Small < 30 cm	Medium 30 - 60 cm	Large > 60 cm	Total	S	M	L	T	Code

SEA BIRDS: Use code table 14

Code	Number

OTHER FISH, INVERTEBRATES, OTHER FAUNA: Use code table 10

Code	Number	Destiny

Destiny codes

1 - Retained
2 - Discarded
3 - Mixed

IATTC MFR 04/2019

ADDITIONAL CODES: Use code table 10

Code		Est. by number of individuals: Small	Medium	Large	Total		Destiny: S	M	L	T

ADDITIONAL COMMENTS:

TUNA:

OTHER BIG and MEDIUM FISH:

SEA BIRDS, OTHER FISH, INVERTEBRATES and OTHER FAUNA:

Appendix B: The IATTC Sea Turtle Record (STR 01/2001) used by observers from 2001 to present. The STR was introduced in 1990 and revised in 2001 (see Table 1).

Inter-American Tropical Tuna Commission

SEA TURTLE RECORD

Cruise Number	Record Number	Set Numbr	DATE YY	DATE MM	DATE DD	TIME	LATITUDE	N/S	LONGITUDE	W

SPECIES:

Olive Ridley	[ ] 1
Green	[ ] 2
Leatherback	[ ] 3
Hawksbill	[ ] 4
Loggerhead	[ ] 5
Unidentified	[ ] 6

ACTIVITY:

Alive & immobile	[ ] 1
Swimming	[ ] 2
Copulating	[ ] 3
Feeding	[ ] 4
Dead	[ ] 5
Other / Unknown	[ ] 6

OTHER DATA:

Number of turtles

If there is more than one turtle answer:

- Various individual sightings [ ] 1
- One group with multiple turtles [ ] 2

	Yes
¿Found trapped/entangled in a floating object?	[ ]
¿Passed alive through the power block?	[ ]

CONDICION UPON LEAVING THE TURTLE

Mark only one

Entangled alive in a FOB	[ ] 0
Already dead	[ ] 1
Released unharmed	[ ] 2
Released with light injury	[ ] 3
Released with grave injury	[ ] 4
Accidentally killed	[ ] 5
Escaped/evaded the net	[ ] 6
Treated as catch (consumed)	[ ] 7
Not involved in fishing operation	[ ] 8
Other / Unknown	[ ] 9

ASSOCIATION:

With marine mammals	[ ] 1	No. MMSSR: ________
With tuna (BREEZER)	[ ] 2	
Unassociated	[ ] 3	
With other (not turtles)	[ ] 4	Other: ________
With floating object	[ ] 5	No. FIR: ________

Distance of the association: ________ m

Comments on the condition:

The following section should only be filled out for INDIVIDUAL turtle sightings.
Be sure to carefully read the notes at the end of section 11.7 of the manual before proceeding.

IDENTIFICATION:

Indicate the number of:

Left costal scutes:	
Right costal scutes:	
Vertebral scutes:	
Inframarginal scutes:	

	Yes	No	Unk.
¿Overlapping scutes?	[ ]	[ ]	[ ]
¿Inframarginal pores?	[ ]	[ ]	[ ]
¿1 pair of prefrontal scales?	[ ]	[ ]	[ ]
¿Leathery shell (not hard)?	[ ]	[ ]	[ ]

DORSAL COLORATION

Red/Orange	[ ] 1
Gray	[ ] 2
Green	[ ] 3
Other / Unknown	[ ] 4

DIMENSIONS (cm):

Shell length over the curve	.
Shell width over the curve	.
Head width	.
Tail length	.

TAGS:

If the turtle is tagged,

record the tag number(s):

If you tagged the turtle, note the number:

IATTC STR 01/2001

Appendix C: The IATTC Shark Record (SR 04/2019) used by observers from 2019 to present. The SR was introduced in 2004 with a minor revision in 2019 (see Table 1).

Inter-American Tropical Tuna Commission

SHARK RECORD

Trip number	Record number	Set number	Species	Total number of sharks

INDIVIDUAL RECORD

Total length (cm)	Estimation	Sex M	Sex F	Sex Unk	Fate (code)
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	

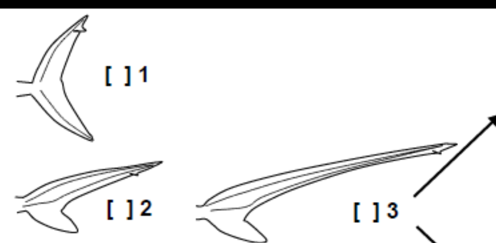
COLLECTIVE RECORD

Estimate by number of individuals: Small < 90 cm	Medium 90 – 150 cm	Large > 150 cm	Total	Fate (code)

FATE CODES

1 - Retained
2 - Discarded
3 - Released alive
4 - Other
5 - Unknown

CAUDAL FIN SHAPE



[ ] 1

[ ] 2

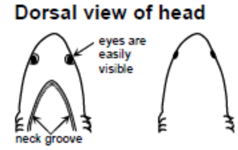
[ ] 3

If option 3 is chosen, complete the sections to the right (3.1 – 3.4)

None of these [ ] 4

Could not determine [ ] 5

Dorsal view of head

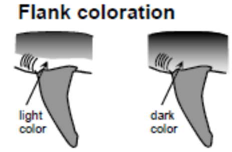


[ ] 3.1 [ ] 3.2

Neither of these [ ] 3.3

Could not determine [ ] 3.4

Flank coloration



[ ] 3.1 [ ] 3.2

Neither of these [ ] 3.3

Could not determine [ ] 3.4

HEAD SHAPE

[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5 [ ] 6

None of these [ ] 7

Could not determine [ ] 8

IATTC SR 2019/04

FIRST DORSAL FIN SHAPE

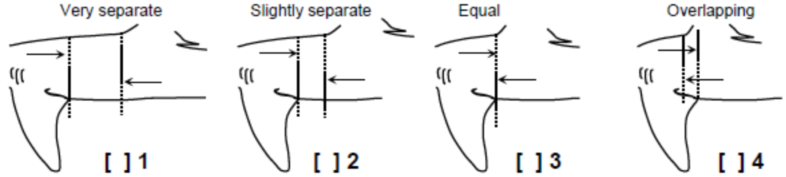
[ ] 1 | [ ] 2 | [ ] 3 | [ ] 4

None of these [ ] 5

Could not determine [ ] 6

DISTANCE BETWEEN FIRST DORSAL FIN AND PECTORAL FIN

Very separate | Slightly separate | Equal | Overlapping



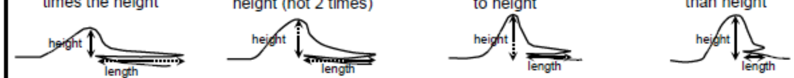
[ ] 1 | [ ] 2 | [ ] 3 | [ ] 4

None of these [ ] 5

Could not determine [ ] 6

INTERNAL BORDER LENGTH OF SECOND DORSAL FIN

Length is 2 or more times the height | Length is greater than height (not 2 times) | Length is equal to height | Length is less than height

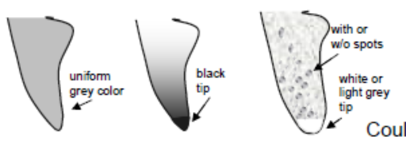


[ ] 1 | [ ] 2 | [ ] 3 | [ ] 4

None of these [ ] 5

Could not determine [ ] 6

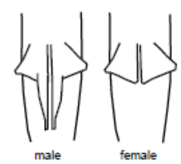
PECTORAL FIN COLORATION (external side)



[ ] 1 | [ ] 2 | [ ] 3

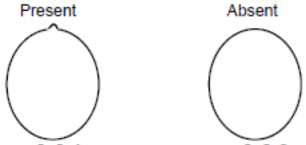
None of these [ ] 4

Could not determine [ ] 5



PRESENCE – ABSENCE OF INTERDORSAL CREST

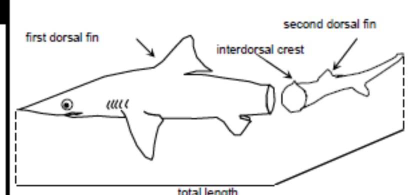
Present | Absent



[ ] 1 | [ ] 2

Unsure [ ] 3

Could not determine [ ] 4



COMMENTS:

Appendix D: The IATTC Billfish Record (BFR 01/2019) used by observers from 2019 to present. The BFR was introduced in 1989 with a new form developed in 2006. Revisions were made in 2016 and 2019 (see Table 1).

BILLFISH RECORD

Trip Number	Record Number	Set Number	Species code	Total number of billfishes

INDIVIDUAL SECTION

Post-orbital length (cm)	Est.	Fate (code)	Post-orbital length (cm)	Est.	Fate (code)
	[ ]			[ ]	
	[ ]			[ ]	
	[ ]			[ ]	
	[ ]			[ ]	
	[ ]			[ ]	
	[ ]			[ ]	
	[ ]			[ ]	

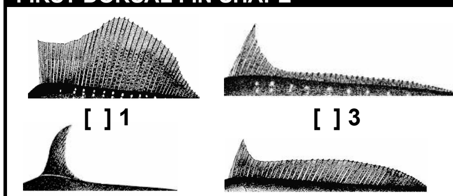
COLLECTIVE SECTION

Estimation by number of individuals				Fate (code)
Small < 90 cm	Medium 90 – 150 cm	Large > 150 cm	Total	

FATE CODES

1- Retained
2- Discarded
3- Escaped net
4- Other
5- Unknown

FIRST DORSAL FIN SHAPE

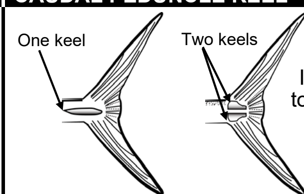


[ ] 1 [ ] 2 [ ] 3 [ ] 4

None of these [ ] 5

Impossible to determine [ ] 6

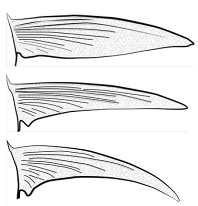
CAUDAL PEDUNCLE KEEL



[ ] 1 [ ] 2

Impossible to determine [ ] 3

PECTORAL FIN POSTERIOR MARGIN

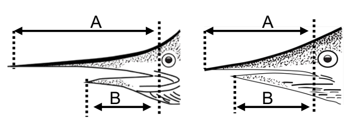


[ ] 1 [ ] 2 [ ] 3

None of these [ ] 4

Impossible to determine [ ] 5

UPPER AND LOWER JAW RELATIONSHIP

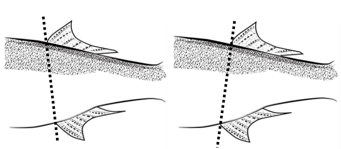


B < 2/3(A) [ ] 1

B > 2/3(A) [ ] 2

Impossible to determine [ ] 3

2nd DORSAL AND 2nd ANAL FIN RELATIONSHIP

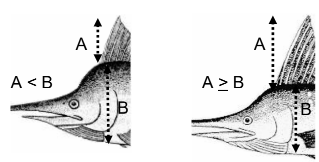


[ ] 1 [ ] 2

None of these [ ] 3

Impossible to determine [ ] 4

BODY HEIGHT-DORSAL FIN RELATIONSHIP



[ ] 1 [ ] 2

Impossible to determine [ ] 3

ADDITIONAL COMMENTS

Appendix E: The IATTC Ray Record (RR 04/2019) used by observers from 2019 to present. The RR was introduced in 2016 with a minor revision in 2019 (see Table 1).

RAY RECORD

Trip number	Record number	Set number	Species	Total number of rays

INDIVIDUAL RECORD

Disc width (cm)	Estimation	Sex M	Sex F	Sex U	Fate (code)
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	
	[ ]	[ ]	[ ]	[ ]	

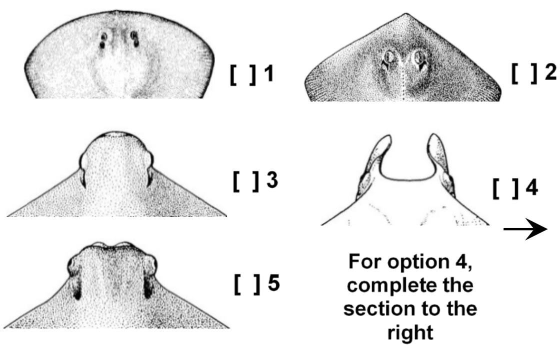
COLLECTIVE RECORD

Estimate by number of individuals: Small < 90 cm	Medium 90 – 150 cm	Large > 150 cm	Total	Fate (code)

FATE CODES

1- Retained
2- Discarded
3- Released alive
4- Other
5- Unknown

HEAD SHAPE (Drawings not to scale)



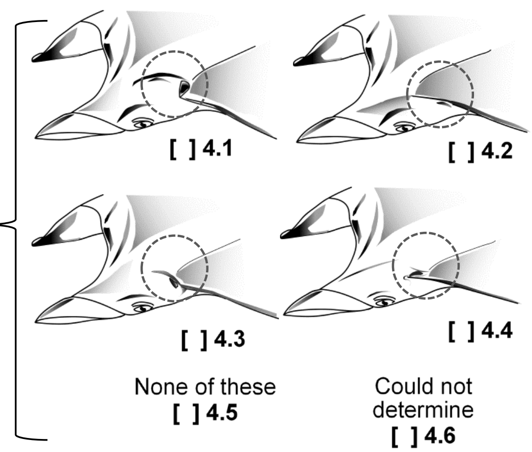
[ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

For option 4, complete the section to the right

None of these **[ ] 6**

Could not determine **[ ] 7**

SPIRACLE POSITION

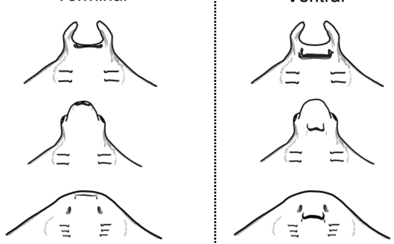


[ ] 4.1 **[ ] 4.2** **[ ] 4.3** **[ ] 4.4**

None of these **[ ] 4.5**

Could not determine **[ ] 4.6**

MOUTH POSITION (ventral view)

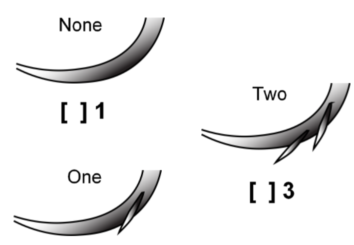


Terminal **[ ] 1**

Ventral **[ ] 2**

Could not determine **[ ] 3**

TAIL SPINE



None **[ ] 1**

One **[ ] 2**

Two **[ ] 3**

None of these **[ ] 4**

Could not determine **[ ] 5**

COMMENTS

Appendix F. The IATTC Marine Mammal Sighting and Set Record (MMSSR) used by observers.

MARINE MAMMAL SIGHTING AND SET RECORD SIGHT NUMBER ___ ___ ___ SET NUMBER ___ ___ ___ **PAGE 1**

DATE ___ ___ ___ ___ ___ ___ (YY MM DD) CRUISE NO. ___ ___ ___ ___ ___ ___ HOUR OF MARINE MAMMAL SIGHTING ___ ___ ___ ___

1. INITIAL ESTIMATE OF THE NUMBER AND SPECIES COMPOSITION OF THE ENTIRE SCHOOL

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE BELLY SPINNER	% UNIDENT. SPINNER	% COMMON DOLPHIN	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES STOCK (1)	OTHER SPECIES STOCK (2)
OBSERVER	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	______	______	______
CREW	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	______	______	______
AERIAL	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	______	______	______
									CODE	CODE	CODE

2. SIGHTING AND IDENTIFICATION NOTES

SIGHTING NOTES:

LIST ALL CHARACTERISTICS USED FOR IDENTIFICATION AND MAKE A DRAWING OF EACH SPECIES OBSERVED

SPOTTED:
NEON. _____%
TWO T. _____%
SPECK _____%
MOTTL _____%
ADULT _____%

CATEGORIES:	HERD-ING CODE	SPP. NO. 1 ACTIVITY CODE	NUMBER EVADED, OMITTED OR ESCAPED	SPP. NO. 2 ACTIVITY CODE	NUMBER EVADED, OMITTED OR ESCAPED	SPP. NO. 3 ACTIVITY CODE	NUMBER EVADED, OMITTED OR ESCAPED	SPP. NO. 4 ACTIVITY CODE	NUMBER EVADED, OMITTED OR ESCAPED	CATEGORY TOTALS
BEFORE CHASE	____	____		____		____		____		
DURING THE CHASE	____	____	__ __ __ __	____	__ __ __ __	____	__ __ __ __	____	__ __ __ __	__ __ __ __
DURING ENCIRCLEMT	____	____	__ __ __ __	____	__ __ __ __	____	__ __ __ __	____	__ __ __ __	__ __ __ __
INTENTIONALLY CUT OUT			__ __ __ __		__ __ __ __		__ __ __ __		__ __ __ __	__ __ __ __
EVADED UNDER THE NET			__ __ __ __		__ __ __ __		__ __ __ __		__ __ __ __	__ __ __ __
ESCAPED OVER THE NET			__ __ __ __		__ __ __ __		__ __ __ __		__ __ __ __	__ __ __ __

GRAND TOTAL __ __ __ __

CREW ESTIMATE

TOTAL % COMPOSITION BY SPECIES

1. ____

2. ____

3. ____

CLOSEST DISTANCE THAT EACH SPECIES WAS OBSERVED ____________________

DATA REVIEWED
IATTC TUNA DOLPHIN ☐

MMSSR 1/2005

CRUISE NO. __________ SET NO.__________

3. MARINE MAMMAL EVASION AND ESCAPE BEHAVIOR

4. CHASE AND SET TIMES

CHASE START	NO. OF SPDBOATS	CHASE CALLED OFF	REASON CHASE CALLED OFF	¿EXPLO-SIVES?	LET GO	REASON SET ABORTED	RINGS UP	BACKDOWN START	BACKDOWN FINISH	SUNDOWN TIME IF IT OCCURS BEFORE ENDSET	ENDSET
__ __ __ __	________	__ __ __ __	________	________	__ __ __ __	________	__ __ __ __	__ __ __ __	__ __ __ __	__ __ __ __	__ __ __ __
TIME		TIME			TIME		TIME	TIME	TIME	TIME	TIME

5. OBSERVATIONS

PROVIDE DETAILS OF THE MARINE MAMMAL EVASION AND ESCAPE BEHAVIOR (INCLUDE TIMES):

DATA REVIEWED ☐

CRUISE NO. __________ SET NO.__________

6. ESTIMATE OF THE NUMBER AND SPECIES COMPOSITION OF CAPTURED MARINE MAMMALS

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE BELLY SPINNER	% UNIDENT. SPINNER .	% COMMON DOLPHIN	% OTHER SPECIES (1)	% OTHER SPECIES (2)
OBSERVER	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___
CREW	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___

SPOTTED STOCK	OTHER SPECIES STOCK (1)	OTHER SPECIES STOCK (2)
________	________	________
________	________	________
CODE	CODE	CODE

TOTAL % COMPOSITION BY SPECIES

CREW ESTIMATE
1 ______________________________
2 ______________________________
3 ______________________________

NEONATES CAPTURED? Yes____ No

7. LIVE MARINE MAMMALS RESCUED AFTER RINGS UP

(a) BEFORE BACKDOWN [IF NO BACK-DOWN PROCEED TO SECTION (d)]					(b) BACKED OUT DURING BACKDOWN		(c) DURING BACKDOWN (DO NOT INCLUDE ANIMALS WHICH WERE BACKED OUT)				NUMBER OF MARINE MAMMALS ALIVE IN THE NET AFTER BACKDOWN	(d) FOLLOWING BACKDOWN TO BEGINNING OF SACKUP OR IF NO BACKDOWN						(e) SACK RESCUE
SPDBT	RAFT	SWIMMER	DECK	NUMBER ACTIVELY RELEASED	NUMBER BACKED OUT	FISH LOST (TONS)	SPDBT	RAFT	SWIMMER	NUMBER ACTIVELY RELEASED		SPDBT	RAFT	SWIMMER	DECK	OTHER	NUMBER ACTIVELY RELEASED	NUMBER RELEASED
___	___	___	___	___ ___ ___	___ ___ ___ ___	___ ___ ___	___	___	___	___ ___ ___	___ ___ ___	___	___	___	___	___	___ ___ ___	___ ___ ___

8. DESCRIBE ALL RESCUE EFFORTS AND BACKDOWN PROCEDURE (INCLUDE TIMES):

____

____

____

____

____

____

____

____

9. BEST ESTIMATE OF NUMBER AND SPECIES COMPOSITION OF THE ENTIRE SCHOOL

	TOTAL NUMBER	% SPOTTED	% EASTERN SPINNER	% WHITE BELLY SPINNER	% UNIDENT. SPINNER	% COMMON DOLPHIN	% OTHER SPECIES (1)	% OTHER SPECIES (2)	SPOTTED STOCK	OTHER SPECIES STOCK (1)	OTHER SPECIES STOCK (2)
OBSERVER	___ ___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	___ ___ ___	________ CODE	________ CODE	________ CODE

DATA REVIEWED ☐

CRUISE NO. ____________________ SET NO. ___________

TALLY SHEET

SYMBOLS:

✓ = DEAD

⊕ = INJURED

? = UNDETERMINED CONDITION

NOTE: AN "INJURED" DOLPHIN IS ONE THAT APPEARS TO HAVE BROKEN BONES, FLIPPER OR SNOUT, OR SEVERELY TORN FLIPPERS, FINS OR FLUKES. ANIMALS WHICH ARE PROFUSELY BLEEDING SHOULD BE CONSIDERED **INJURED**, BUT DO NOT CONFUSE PROFUSE BLEEDING WITH SUPERFICIAL ABRASIONS CAUSED BY THE NET. ANY DOLPHIN PASSED THROUGH THE POWER BLOCK SHOULD BE MARKED AS **DEAD**.

	SPOTTED																SPINNER									COMMON DOLPHIN			OTHER SPECIES			UN-ID.
	NEONATE			TWO-TONE			SPECKLED			MOTTLED			ADULT			EDAD	EASTERN			WHITEBELLY SPINNER			OTHER OR UNID.									
	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	DESC	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	M	F	UNKN SEX	
PROCESSED																																
✓																																
⊕																																
?																																

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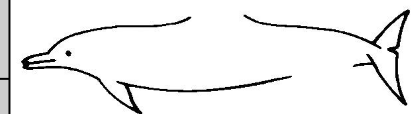
10. DOLPHIN MORTALITY AND CAUSES

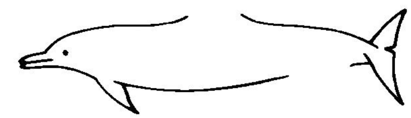
SPECIES/STOCK KILLED, INJURED OR COND. UNDETERMINED (CODE)	TOTAL NUMBER KILLED	PORCENTAGE OF MORTALITY BY CAUSE			NUMBER KILLED			NUMBER INJURED			CONDITION UNDETER-MINED
		TRAPPED OR ENTANGLED	DIED IN SACK	OTHER	M	F	UNKN. SEX	M	F	UNKN. SEX	
SPOTTED											
SPINNER											
OTHER SPP./STOCK											
OTHER SPP./STOCK											
OTHER SPP./STOCK											

SKETCH THE DORSAL FIN, VENTRAL PROTUBERANCE AND COLOR PATTERN OF EACH SPECIES OR STOCK THAT WAS KILLED IN THE SET

SPP./STOCK NO. 1 ____________



SPP./STOCK NO. 2 ____________



SPP./STOCK NO. 3 ____________

DETAIL THE SPOTTED DOLPHIN MORTALITY BY COLOR PATTERN/AGE AND SEX

NEONATE			TWO-TONE			SPECKLED			MOTTLED			ADULT			UNKN SEX
M	F	UNKN. SEX	M	F	UNKN. SEX	M	F	UNKN. SEX	M	F	UNKN. SEX	M	F	UNKN. SEX	

DESCRIBE THE LIKELY CAUSES OF MORTALITY; GIVE DETAILS ON YOUR CLASSIFICATION OF INJURED AND UNDETERMINED CONDITION.:

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11.

HOW MANY BOW BUNCHES WERE PULLED DURING THIS SET?

12.

HOW MANY SPEEDBOATS WERE USED TO TOW THE NET?

13.

DURING BACKDOWN DID THE SAFETY PANEL COVER THE PERIMETER OF THE BACKDOWN CHANNEL? (INCLUDE THE LOCATION OF THE DSP IN THE DRAWINGS IN SECTION 19 – REFER TO THE MANUAL TO CORRECTLY ANSWER THIS QUESTION)

14.

WAS A STRONG CURRENT EVIDENT DURING THIS SET?

(a) HOW DID YOU DETERMINE A STRONG CURRENT? __________

15.

DID A NET COLLAPSE OCCUR WHILE MARINE MAMMALS WERE IN THE NET?

(a) WERE MARINE MAMMALS KILLED AS A RESULT OF THE NET COLLAPSE?

(b) HOW WAS THE NET COLLAPSE CLEARED?__________

16.

DID A NET CANOPY OCCUR WHILE MARINE MAMMALS WERE IN THE NET?

(a) WERE MARINE MAMMALS KILLED AS A RESULT OF THE NET CANOPY?

(b) HOW WAS THE NET CANOPY CLEARED? ______

17.

IF ALL OR PART OF THE BACKDOWN OCCURRED IN DARKNESS, WERE LIGHTS USED TO ILLUMINATE THE BACKDOWN CHANNEL? (HIF=HIGH INTENSITY FLOODLIGHT, Y=OTHER LIGHT USED, N=NO LIGHTS, N/A=NOT DARK)

(a) DESCRIBE THE TYPE, LOCATION AND USE OF THE LIGHTS ______

18.

DID A MALFUNCTION OCCUR DURING THE SET?

(a) DESCRIBE ALL MALFUNCTIONS IN ORDER OF OCCURRENCE

	TIME MALF OCCURRED	TIME REPAIR COMPLETED	DELAY IN THE SET	(DESCRIBE THE TYPE OF MALFUNCTION, OPINION OF THE CAUSE, AND HOW RESOLVED)	WERE LIVE M. MAMMALS IN THE NET?	MALF. CODE
1						
2						
3						
4						

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19. ILLUSTRATION OF THE SET AND NOTES (CONTINUE WITH DRAWINGS UNTIL ALL OF THE DOLPHINS HAVE BEEN REMOVED FROM THE NET)

W WIND DIRECTION	X DOLPHINS	SI SINKING CORKLINE
D CURRENT DIRECTION	E ENTANGLED OR ENTRAPPED	C CANOPY
Ø BOW BUNCHLINE	S SWIMMER	Ⓡ RAFT

IF OTHER SYMBOLS ARE USED, DRAW AND DEFINE THEM HERE:

SPEEDBOAT

SAFETY PANEL

SPEEDBOAT TOWING THE CORK LINE

S SKIFF

VESSEL

TIME

NOTES: ____________________

TIME

NOTES: ____________________

TIME

NOTES: ____________________

TIME

NOTES: ____________________

TIME

NOTES: ____________________

TIME

NOTES: ____________________

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CRUISE NO. __________ SET NO.__________

19. ILLUSTRATION OF THE SET AND NOTES (CONTINUATION)

TIME

NOTES:

TIME

NOTES:

TIME

NOTES:

TIME

NOTES:

TIME

NOTES:

TIME

NOTES:

20. CAPTAIN COMMENTS REGARDING THIS SET

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CRUISE NO. __________ SET NO.__________

21. CONTINUATION OF INCOMPLETE SECTIONS

TIME	TIME	TIME

NOTES:

NOTES:

NOTES:

TIME	TIME	TIME

NOTES:

NOTES:

NOTES:

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CRUISE NO. ___________ SET NO.___________

DATA REVIEWED ☐