BYCATCH MITIGATION ACTIONS ON TROPICAL TUNA PURSE SEINERS: BEST PRACTICES PROGRAM AND BYCATCH RELEASING TOOLS

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In order to mitigate and reduce the effects of the purse seiner FAD fishery on non-target species and the marine ecosystem, the two Spanish tuna purse seiner associations (ANABAC and OPAGAC) operating in all oceanic regions, established a voluntary agreement for the application of sustainable fishing practices. The aim of this agreement is to use best fauna handling and releasing practices to maximize survival of sensitive species incidental catches (i.e., elasmobranchs and sea turtles) and prevent passive ghost fishing by using non-entangling FADs. Fishers, both officers and crew, are regularly trained in best practices and to monitor the application of these practices 100% observer coverage has been adopted by the fleet in all ocean. Observations show that most releases of large bycatches such as sharks and manta rays in tuna purse seiners are still done manually, which potentially poses a risk to crew members. Some tools such as cargo nets or stretcher beds have been used with some success to release large bycatches, but there is still much room to refine deck release equipment to maximize their survival, facilitate rapid handling and ensure fishers' safety. The objective of the HELEA project is to develop and test new tools to release sharks and rays in tuna purse seiners that maximize their survival and are practical to use onboard. Metallic frame grids to release manta rays and manual tools like handles and specially designed fasteners will be tested to measure their efficiency for manipulating these bycatches while minimizing injury to the animals and crew. In addition, the efficiency of shark releases with and without hoppers will be evaluated.

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1 Introduction

The use of man-made drifting fish aggregating devices (FADs) in tropical tuna (i.e. skipjack tuna, *Katsuwonus pelamis*; yellowfin tuna, *Thunnus albacares*, and bigeye tuna, *Thunnus obesus*) purse seine (PS) fisheries has been significantly increasing since their introduction in the early 90s, improving fishing efficiency, reducing searching time and increasing successful catch rates (Dagorn et al., 2012; Fonteneau et al., 2013) and becoming the principal fishing mode for the purse seine fleet in all oceans. Nowadays, over half of the tropical tuna caught worldwide is fished by PS on FADs (Fonteneau et al., 2013; Scott and Lopez 2014, ISSF, 2019).

The increasing use of FADs in the past decades [i.e., about 100,000 FADs are estimated to be deployed annually worldwide (Scott and Lopez 2014)], and their impact on the marine ecosystem, have received much attention (Dagorn et al. 2012). The main concerns over FAD fishing are common for all tuna regional fisheries management organizations (RFMOs) are (1) reduction in yield per recruit of some target species (i.e. yellowfin and bigeye tuna); (2) increased by-catch and perturbation of pelagic ecosystem balance, including ghost fishing of sensitive species (e.g. sharks, turtles); (3) source of marine debris and impacts on coastal habitats as a result of beaching events; and (4) alteration of the tuna behavior (Bromhead et al. 2003; Hallier and Gaertner, 2008; Dagorn et al. 2012; Filmalter et al., 2013).

Among others, fishing mortality of non-target species is commonly used to measure the environmental impacts of a fishery, which is a direct driver of change and loss of global marine biodiversity (Pauly et al., 2005; Worm et al., 2006). Recent studies have shown that tropical tuna purse seine fisheries have an overall bycatch rate for non-target fish species (including minor tuna as bycatch) of 1.40% relative to target tuna caught. These estimates decreased to 0.92% of non-tuna species when minor tunas are excluded from bycatch (Justel-Rubio and Restrepo, 2017). These minor tunas can comprise 80% of the bycatch in FAD fishing (Hall and Roman, 2013). Stocks of these fish bycatch species are considered in a healthy state and are commercialized in the local markets, especially in the Atlantic Ocean (Amandè et al.,2010; Chavance et al., 2015; Amandè et al., 2016). These estimates are variable depending on the region and fishing mode, with higher bycatch rates and more diversity observed in FAD fishing, i.e. about 2–9% of total catch by weight, than in free-schools sets, i.e. <2% of total catch by weight (Hall and Roman, 2013; Amandè et al., 2012; Torres-Irineo et al., 2014; Ruiz Gondra et al., 2017a; Justel-Rubio and Restrepo, 2017; Lezama-Ochoa et al., 2017; Lezama-Ochoa et al., 2018; Ruiz Gondra et al., 2018).

On the other hand, man-made FADs traditionally consisted of floating bamboo rafts with PS net panels hanging underneath, but designs have been evolving to favor desirable characteristics that increase fish aggregation potential (Murua et al., 2018). FADs themselves, due to materials used in their construction, are a concern due to the increase in use of synthetic materials like plastic netting and flotation (Moreno et al 2017; Murua et al., 2018; Moreno et al 2018a, 2018b). These long-lasting synthetic materials may eventually end up sinking or reaching coastal ecosystems such as beaches, coral reefs or mangroves (i.e. beaching); damaging coastal habitats and contributing to marine debris. Studies in the Indian Ocean provide variable estimates of beaching rates, i.e. from 1% to 45% (Maufroy et al. 2015, 2017; Davies et al. 2017; Zudaire et al., 2018). Also, if entangling materials, such as large mesh size netting, are used in FAD construction, they can contribute to ghost fishing of associated fauna (e.g. sharks) (Filmalter et al., 2013). Results on turtles show that entangling rate is low for this group of animals (Bourjea et al., 2014).

In this context, mortality reduction and conservation of by-catch species has become a priority for RFMOs and for the fishing industry that are working towards higher sustainability standards (e.g. Marine Stewardship Council). Considering all these potential impacts, since 2013 most RFMOs have gradually adopted bycatch mitigation measures on the use of non-entangling FADs and have promoted the use of biodegradable materials to reduce both the incidence of species accidental meshing and littering on marine and coastal ecosystem. In addition, measures to safely release the sensitive fauna such as turtles, sharks, whale sharks, and mantas are included, and the obligation of recording all the interactions with these species' groups to fill data gaps and improve bycatch management.

In this line, the Spanish tuna purse seiner associations ANABAC and OPAGAC, operating in all oceanic regions pioneered in 2012 a voluntary agreement for the application of a code of good practices (CGP) for responsible tuna fishing activities. Some of the mitigation measures were adopted voluntarily before the tuna RFMOs did and efforts were also devoted to promote the adoption of these higher standards at RFMO level. The CGP was developed with the aim of minimizing bycatch mortality and potential FAD environmental impacts. The program undergoes continuous revisions and adjustments, to respond to any newly identified need. This initiative has been also the precursor for other sustainability initiatives and standards such as the UNE 195006:2016 for Tuna from Responsible Fishing which includes the Best Practices as a must, or the recently adopted conservation measure on transactions with vessels that use only non-entangling FADs by ISSF (International Seafood Sustainability Foundation).

The guide by Poisson et al. (2012), designed by scientists collaborating with fishers, has set the standard for best shark, turtle and manta ray release practices in the last years. These procedures were adopted in the CGP (Annex 1 and Annex 2). However, some fishers complain that some of these practices can be risky and time consuming when applied during daily commercial fishing operations. It is highlighted that a key factor for the adoption of proposed bycatch release protocols for sharks and manta rays is the lack of tools to safely manipulate these animals, in some cases involving very large and dangerous individuals. Crew safety should always prime. During the implementation of the CGP some rudimentary “homemade” tools such as shark stretcher beds built with bamboo poles and pieces of netting or manta ray canvases/nets lifted with a crane have been proposed. However, there are two problems with their implementation. Firstly, fishers still must pull the animal out of the brail with their hands to lay it on the bed or canvas. This entails risk of damage to the animal and injury to fishers. Secondly, as there are no minimum standard construction specifications, often the self-built tools are not adequate (e.g. nets or canvases which are too small, forcing the manta rays to fold its wings excessively) and fishers rapidly give up on using them. Successful bycatch mitigation tools such as Turtle Excluder Devices (TEDs), Medina panels for dolphin release, Tori lines for birds have very specific designs and this equipment is available commercially (e.g. fishers do not make them onboard). Therefore, the objective of the HELEA project, which runs in parallel with the CGP program, is to develop and test new tools with specific construction characteristics to release sharks and rays in tuna purse seiners that maximize their survival, ensure crew safety and are practical to use onboard.

The aim of this work is to present the progress made on the implementation of the code of good practices in the Pacific Ocean in terms of FAD use and methods to release fauna during the period 2015 to 2017, and present alternative solutions in development by the HELEA project which aim to enhance the survival and preserve the security of the fishing crew manipulating the fauna.

2 Material and Methods

2.1 Code of Good Practices

2.1.1 *Observer data*

In the frame of the Code of Good Practices observers collect specific information on FAD structures and components including the mesh size on the floating and underwater structure, if meshed material is present, and its configuration (i.e. open net or wrapped in coils) (Annex 1). All FADs are evaluated, the ones deployed by the fleet and any other FAD encountered at sea, either when arriving to the FAD or when deploying it at sea, to evaluate modifications on FAD material and design in each interaction if occurring. The non-entangling classification followed the definitions of the CGP, including as non-entangling, lower entanglement risk FADs that are constructed with non-entangling mesh (i.e. mesh size ≤ 7 cm) if the open net is present or tied-up in sausages, and non-entangling FADs constructed with no meshed material (i.e. including lower entanglement risk FADs and non-entangling FADs as referred in the ISSF classification criteria, ISSF, 2015). Thus, any open net above 7 cm mesh size is considered high entanglement risk.

For sensitive fauna release, the CGP developed species-specific handling procedures that intend to prioritize crew safety while discouraging other practices that are less desirable, and specific material has been developed to inform observers and crew about best available handling practices (Annex 1 and 2). These release procedures are based on the outputs of the EU project MADE (Poisson et al., 2012, 2014a), which have been used as standard best practice for safe bycatch release operations for purse seiners in RFMOs. AZTI is in charge of coordinating, collecting, processing and analyzing CGP bycatch release data and has developed specific forms in English, French and Spanish to collect detailed information on bycatch release operations for scientific observers (Annex 1). In each interaction the releasing mode is recorded as described in the CGP: (i) using the brailer, (ii) using light equipment such as stretchers, fabric, *sarria* or cargo net, (iii) using specific equipment such as a hopper or lateral doors, (iv) manually from deck, (v) after disentangling, when during a release event the practices applied were in line with the those defined in the CGP. Since 2016, the cause of events where there was a non-application of the best releasing practices (i.e. residual mortality: RI; lack of specific material for the manipulation; application of incorrect practices), as well as the time used to release animals were introduced for each species group (i.e. sharks other than hammerhead sharks and whale sharks, hammerheads sharks, whale sharks, mantas, rays and turtles). Also, the state of the animal when released at sea is registered based on the categories proposed by Heuter and Manire (1994), (i) excellent (very active and energetic, strong signs of life on deck and when returned to water); (ii) good (active and energetic, moderated signs of life on deck and when returned to water); (iii) correct (tired and sluggish, limited signs of life, moderate revival time required when returned to water, slow or atypical swimming away); (iv) poor (exhausted, no signs of life, bleeding from gills, jaw or cloaca, long revival time required when returned to water, limited or no swimming observed upon release); (v) very poor or moribund: moribund, no signs of life, excess bleeding from gills, jaw or cloaca, unable to revive upon return to water, no swimming movement, sinks. In the evaluation, the whale sharks and hammerheads sharks are classified in an independent group apart from sharks due to their size, morphology and sensibility which require specific handling. Information on biological parameters such as the size and sex of the specimens is also recorded when possible. Entangling events in FADs were included in CGP observer forms since 2016, when specific guidelines were included in the observer manuals for the registration of fauna entanglements on FADs. When a FAD is found by a purse seiner or a supply vessel at sea, observers record the presence or absence of specimens entangled in the FAD. The number of specimens or species is not generally recorded.

These data collection forms were first implemented in the Atlantic and Indian Ocean (Lopez et al., 2017; Grande et al., 2019). In the case of the Pacific Ocean, IATTC and WCPFC are running their observer program with 100 % coverage in the purse seiners with their specific data forms on sensitive species releasing state and faith and FAD configuration details. The IATTC observers already collect information on the interactions with sensitive fauna indicating the fate in each case. In the case of sharks, a specific form is dedicated to collect the information (SR, Shark Record) in which the fate (i.e. human consumption, discarded, release alive, other, unknown) is identified and biological characteristics such as species, sex and size recorded. It is also the case for turtles (STR, Sea Turtle Record), in which the biological characteristics and the condition upon release are recorded (i.e. entangled alive in a FOB, already dead, released unharmed, released with light injury, released with grave injury, accidentally killed, escaped/evaded the net, treated as catch, not involved in fishing operation, other/Unknown). In case of manta-rays and rays the interactions are registered in the MRF (Marina Fauna Record) Form in which the species and size class are identified and the fate in each case (i.e. human consumption, discarded, release alive, other, unknown) annotated. In addition, the IATTC observers also collect details in each interaction with FADs in the FIR (floatsam information record) form as found and as left, including the components on the FAD (i.e. tree dead animal, chain/cable/rings/weights, cane/bamboo, bait container/bait, cord/rope, artificial lights, netting material, sack/bags, plank/pallets, metal drum/plastic drum, PVC or other plastic tubes, plastic sheeting), and location equipment (i.e. buoys). Also, additional characteristics as the FAD´s mesh size and m^2 of the hanging netting, location method, the origin of the FAD and the presence of entangled fauna are provided among others. This allows to evaluate the nature of the floating object but does not allow to do an integral evaluation of the non-entangling character, as the mesh size on the raft is not given and neither the configuration of the submerged structure (i.e. open panels or wrapped in coils). Given the amount of data collected by the IATTC observers, the specific forms developed in the frame of the CGP are not generally fulfilled in the Pacific Ocean and the progress on the implementation of the CGP is partially evaluated. However, occasionally in an opportunistic way data on Good Practices are collected in EU flag vessels, which allows to have a snapshot of the progress of the implementation of the Good Practices Program.

For the evaluation on the progress on good practices in the Pacific Ocean information collected by IATTC observers is used in this study. This allow a partial evaluation on the progress, as specific criteria on best practices cannot be totally analyzed (e.g. non-entangling characteristics of the raft and underwater structure on the FADs when >7 cm mesh size is present or specific fauna handling practices). The data recorded by IATTC observers is sent to the fishing companies after signing data requests through the national correspondents of Ecuador, El Salvador, Panama and Spain, which is then transferred to AZTI. On the present study, information on 223 fishing trips has been analyzed in the frame of the IATTC observers' program (Table 1). In addition, in 11 trips (i.e. 2 in the 2015, 3 in 2016 and 6 in 2017) observers managed to complete the specific CGP forms (Annex 1), which allowed for a snapshot of the implementation progress (Table 1). The results are presented here. In addition, AZTI has visited the at port FAD construction facilities in order to evaluate the FADs deploy by the fleet.

Table 1. Number of trips analyzed

Observer Program	year	n.trip
Code of Good Practices	2015	2
	2016	3
	2017	6
IATTC	2015	74
	2016	76
	2017	73

2.1.2 *Evaluation of FAD entanglement risk*

In each interaction with FADs, these are evaluated when encountered at sea through either random encounters with non-owned FADs or targeted encounters with owned and tracked FADs (i.e. at arrival), and thereafter when placed at sea after the encounter or as the result of a new deployment (i.e. at departure).

In the case of the IATTC observer program, mesh size on the submerged structure is recorded. Considering the classification criteria for entangling material which limit mesh size to 7 cm if open panels are present (C-18-05 and criteria on the Code of Good Practices), two categories have been established for analyzing the FAD types: (1) mesh size <7cm and (2) >7cm in the submerged structure. This only allows a partial description of the non-entangling character of FAD's tail as the configuration of the submerged structure is unknown, and consequently if >7cm mesh size is present the non-entangling character (e.g. netting tied into coils) cannot be determined. Importantly, entanglement information for the raft is not reported either.

On the other hand, using the information collected in the frame of the CGP, 7 FAD categories are established as follows (from lowest to highest risk of entanglement): 1- Totally non-entangling, constructed with materials with non-entangling characteristics (i.e. if mesh material is present the mesh size is ≤ 7 cm or rolled in sausages); 2 - net of >7 cm in the bottom part of the raft; 3- net of >7cm in the upper part of the raft; 4: pieces of net >7cm in the underwater part; 5: underwater part with net >7cm; 6: raft and underwater part with net >7cm. 0- not visible (this last category was used when the underwater structure of the FAD was not visible for observers because the FAD was not lifted from the water to avoid interfering with the aggregation underneath or breaking the submerged structure and not evaluated by the observer). Given the FAD characteristics, in each interaction each FAD is classified in one of these categories. Note that, the same FAD can be subjected to multiple evaluations during its lifetime, i.e. at arrival and at departure. The resulting percentage in each category is the number of FADs classified in the corresponding category relative to the total visible FADs by timeframe (i.e. at arrival and at departure). The totally non-entangling FADs are considered those from category 1 in which if mesh material is present either in the raft or tail the mesh size is ≤ 7 cm or rolled in sausages.

2.1.3 *Evaluation of the interactions with fauna and releasing methods used by the crew*

Upon the IATTC observer program the fate of sensitive fauna is registered in each case. In this work the percentage of specimens released by species group, year and fate is described, by summing up the releases by fate type relative to the total observed releases by species group in each year. For this analysis fate has been re-grouped as follows (Released alive: release alive, released unharmed; Released Dead: Discarded; Released injured: released with light injury, released with grave injury; Other: Other, unknown or retained accidentally classified as human consumption).

On the other hand, the Code of Good Practices establishes several releasing practices for each species group (Annex 1 and 2) and observers when possible measure the time invested by crew for fauna release. In this study the percentage of individuals released using each method is quantified by summing up the releases following each handling method relative to the total observed releases by species group in each year. In addition, the percentage of release actions occurring by time categories of 1 to 10 minutes, an hour and more than an hour from detection is computed by group and year.

2.2 Development of alternative bycatch release tools and evaluation of hopper fauna release efficiency

Based on feedback gathered during skippers' workshops, in which skippers and crew share their experiences and ideas on best releasing practices operations new bycatch release equipment prototypes for sensitive fauna are being developed. The objective is to design and construct a selection of bycatch release tools for sharks and manta rays that: (1) ensure crew safety, (2) are practical to use, (3) maximize animal survival, and (4) provide specific construction details to make them replicable. This equipment should try to adapt to the deck space and configuration requirements of different vessels. The prototypes which are being built and tested are presented here.

Additionally, to validate the efficiency of an already existing release tool, the hopper (named "chute" in Spanish), shark and manta release rates in two vessels from the Garavilla fleet, one with and other without a hopper will be evaluated. These two vessels have very similar characteristics and operate in the same fishing region. The study uses electronic monitoring systems (EMS) with collaboration from DOS (Satlink) capturing 100 sets from each vessel over a 6-month period to compare operational parameters including set size, total set loading time, number of sharks and mantas released from the top deck and sharks and mantas arriving to the lower deck, and their state.

3 Results and Discussion

3.1 The use of non-entangling FADs

Traditionally the FADs used by industrial purse seiners consisted of bamboo rafts with extra floats (platform) and nets hanging below (submerged appendage), typically constructed with reused purse seine nets with large mesh size (>12 cm). As this kind of FAD with large mesh size is supposed to entail higher risk of entanglement for sensitive species like sharks or turtles (Filmanter et al., 2013), the CGP promoted a design, construction and deployment of FADs that minimize the potential for accidental animal entanglements. As such, the replacement and use of non-entangling FADs (including lower entanglement risk FADs referring to ISSF categories, ISSF 2015) has been promoted since 2012. This voluntarily adopted mitigation measure has allowed replacing the traditional FADs for non-entangling FADs. In order to further assure that FADs are in line with the criteria established in the CGP, nowadays most FADs used by the target fleet are built at port facilities, where the construction and materials utilized are supervised both by fishing companies (**Fig. 1**), and by AZTI scientists.

Figure 1. Example of non-entangling FADs constructed at port facilities by a CGP program participating company in the Pacific Ocean.

At sea, IATTC observers in the context of the Commission's program evaluate FAD characteristics using the specific form FIR and describe FAD devices both for non-tracked random encounters or planned encounters with tracked FADs (i.e. as found or at arrival), and thereafter when placed at sea after the encounter or as the result of a new deployment (i.e. as left or at departure). During the 3 years (2015-2017) examined 32,598 FAD evaluations have been recorded, 9,799 evaluations of FADs "at arrival" and 22,799 "at departure" were recorded (note that for FAD activities other than new deployment the same FAD could be evaluated multiple times as subjected to the two evaluations in each visit, i.e., at arrival and at departure, and may experience multiple visits during the FAD's lifetime) (**Table 2**). This allows to conduct a partial evaluation of the FADs, as the net size of the underwater structure is provided but not its configuration (e.g. open panel or tied coil). Opportunistically in some trips observers also collect the data by the use of Good Practices specific form (Annex 1) which has allowed to have an snapshot to evaluate FADs under the CGP criteria, including the mesh size on the raft and submerged structure if present and the configuration of the net (Table 2).

Table 2. Number of evaluations on FADs done by observers "at arrival" (during unplanned or planned FAD encounters) and "at departure" (when placed at sea after the encounter or because of a deployment) by year during the study period (2015 to 2017) under the IATTC observer program and under Good Practices Program (note that this results on the GCP refer to an opportunistic data collection).

Obeserver program	year	at arrival	at departure
IATTC	2015	3711	7312
	2016	2881	7179
	2017	3207	8308
Good Practices	2015	153	193
	2016	102	228
	2017	239	395

In the data collected under the IATTC program in the Pacific Ocean, from 2015 to 2017, the annual mean percentage of 3.3% of the FADs at departure (e.g. a deployment or left at sea after an unplanned or a planned activity) did not have any reference to the mesh size. Discarding these cases and considering only those FADs specifying mesh size in the submerged structure, a progressive improvement is observed since 2015 towards reduction of the mesh size in the submerged structure (**Fig. 2**). The percentage of FADs evaluated at departure, with <7 cm mesh size in the submerged structure increased from 43.6% in 2015 to 64% in 2016 and to 75.6% in 2017. A similar pattern is observed when analyzing characteristics of FADs at arrival or when encountered at sea (which could refer to tracked FADs or randomly encountered non-tracked FADs). Discarding the ones with no reference to mesh size (annual mean percentage of 7.7%), the percentage of FADs with mesh size <7cm in the submerged structure increases from 36.9% in 2015 to 57.7% in 2016, reaching 71.6.% during 2017 (**Fig. 2**). Note that in those cases in which the mesh size is classified as being >7cm, the entangling character of the FAD is unknown because we do not have information about the configuration of the structure (i.e. wrapped in coils or open panels).

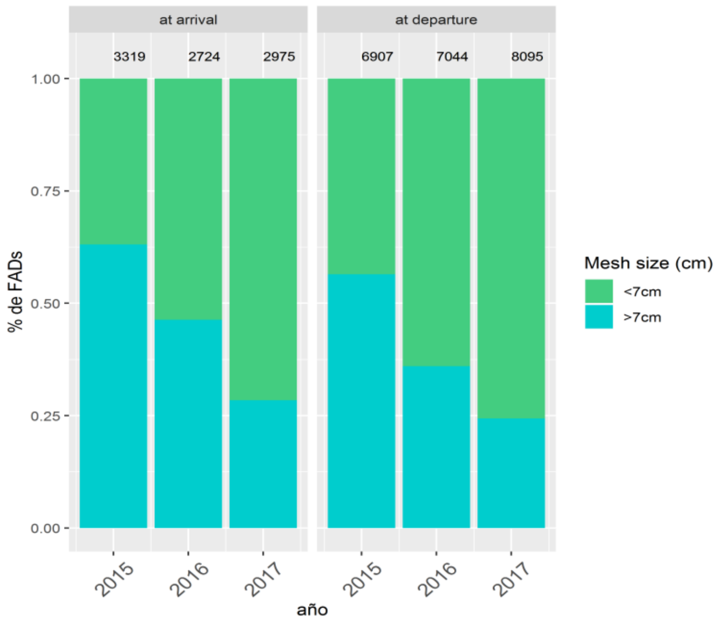

Figure 2. Evolution of the mesh size in the underwater structures of FADs used by the target fleet in the Pacific Ocean based on the data recorded in the FIR form under the frame of the IATTC observer program. The % of FADs with mesh size <7 cm or >7cm on the submerged structure is given at arrival and at departure during the study period (re-scaled discarding those FADs with no reference to the mesh size [mean percentage of 3.3% at departure and 7.7% of observations in case of at arrival]).

On the other hand, based on the opportunistic evaluation made based on the CGP criteria (note that it refers to a subset of the data, i.e. a total of 11 trips in the study period), discarding those considered as not visible (annual mean of 7.2% at arrival and 3.5% at departure), we observed that in 2015 approximately 97% of the FADs at arrival an at departure were classified as Ind. 3, constructed with entangling netting in the upper part of the raft (**Fig. 3**). This raft configuration changed by 2016 in which mainly the FADs at arrival and at departure where classified as non-entangling, 91.2% and 93.2% respectively. In 2017, the percentage of non-entangling FADs increased to 96.1% at arrival and 97.7 at departure (Fig. 3).

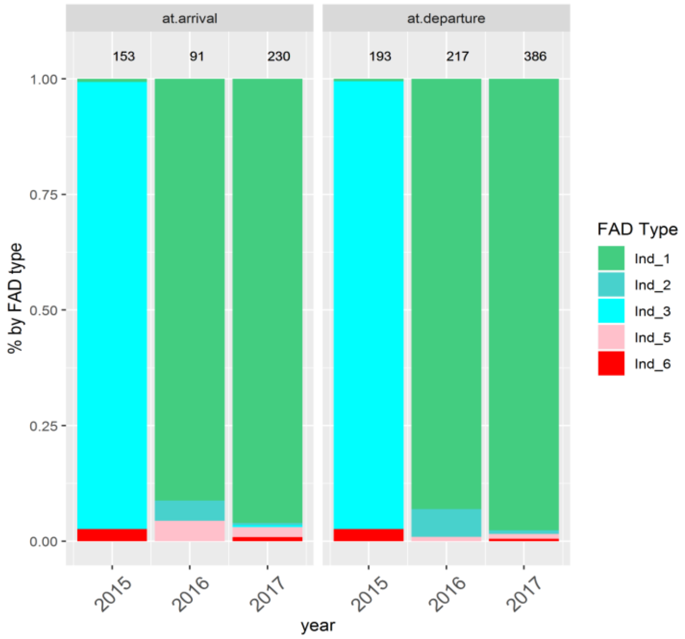

Figure 3. Evolution of the FAD types (% of number of evaluations on FADs by category) in interactions with FADs for observed FADs at arrival and at departure during the study period (re-scaled with no consideration of unknowns [mean percentage of 7.2 at arrival and 3.5% of observations in case of at departure]), based on the data recorded in under the frame of the CGP program**.** The indices refer to FAD categories classified from lowest to highest risk of entanglement: Ind 1 (totally non-entangling); Ind 2 - net of >7 cm in the bottom part of the raft; Ind 3- net of >7cm in the upper part of the raft; Ind 5: underwater part with open net >7cm; Ind 6: raft and underwater part with net >7cm. This data has been opportunistically recorded in the Pacific Ocean.

Since 2015 to 2017 the used of nets with mesh size <7cm in the submerged structure of FADs used in the Pacific Ocean has increased based on the IATTC observer's data for CGP participating vessels, reaching 71.6% of the evaluated FADs at arrival and 75.6% at departure. As the configuration of the submerged structure is not recorded, the entangling character of those classified as having >7cm is unknown. On the hand and in support of this evaluation the data collected in the frame of the CGP provided the possibility of analyzing in detail a subset of the FADs. In this case, it was observed how in 2017, entangling netting (i.e. open netting with mesh size >7cm) in the submerged structure of FADs was a residual component of the total numbers of evaluated FADs at sea (at arrival: 3.0%; at departure: 1.6% [Ind.4. Ind.5. and Ind.6]). A similar tendency is observed for the entangling character of the floating structure at arrival: 0.9%; and at departure: 0.8% [Ind.2. and Ind.3]). Therefore, the FADs used by the CGP fleet were almost entirely non-entangling (i.e. 96.1% at arrival and 97.6 at departure). Those FADs in the water classified as having entangling material could partially correspond to re-used FADs deployed by the fleet which had lost their non-entangling character due to raft cover deterioration or breakdown of the submerged structure. FADs deployed by other fleets and found by CGP program vessels, which entangling materials were not replaced by non-entangling ones after a visit could also account for some cases of these cases. However, in order to further reduce the entangling character of FADs in the water, whenever possible, entangling material should be replaced by the non-entangling ones or FADs should be repaired if the material is deteriorated.

Considering data collected in the frame of the IATTC observers program and those collected in the CGP program, results show that the voluntarily adopted commitment by the ANABAC and OPAGAC fleets and the effort made since the implementation of the Good Practices is rapidly replacing traditional high entanglement risk FADs in the water with non-entangling FADs, as shown by the characteristics of the FADs evaluated at arrival (i.e., tracked FADs or randomly encountered non-tracked FADs), and at departure (i.e., FADs left at sea as a result of a deployment or after a visit). Entanglement events on FADs are systematically recorded in the IATTC observers' program. From 9,799 FAD evaluations made on FADs at arrival during the study period, 40 entanglements have been registered (27 sharks and 13 turtles), i.e. a 0.004 FAD entanglement ratio.

Moving to non-entangling FADs constructed entirely without any netting and with biodegradable materials will help to minimize the potential entangling risk, detected when netting material is deteriorated over time. Besides, eliminating all synthetic materials used in the construction of FADs will reduce their residence time at sea, and consequently their associated impacts in marine ecosystem (i.e. beaching), which will result in significant progress for the fishery (Davis et al., 2017; Moreno et al., 2018a). Currently, the CGP fleet, together with the other EU and associated purse seine fleets, is working in parallel in different projects in the Indian and Eastern and Central Pacific Oceans to test new FAD prototypes built with biodegradable non-entangling materials (Moreno et al., 2017; Zudaire et al., 2017; Moreno et al., 2018b). The findings of these ongoing projects will potentially contribute to identify effective FAD designs and materials for those oceans, which will potentially make possible in theshort-medium term a gradual replacement of traditional synthetic-material FADs for biodegradable NEFADs.

3.2 Interactions with sensitive fauna and release operations

In the frame of the IATTC observer program a total of 32,888 interactions with vulnerable specimens were registered during the study period (2015-2017) in the Eastern Pacific Ocean (**Table 3**). Sharks (other than hammerhead shark and whale shark) were the dominant group with 31,878 records (98.7%), followed by turtles (n=262, 0.8%), hammerheads (n=104, 0.3%), rays (n=18, 0.05%), mantas (n=15; 0.05%) and whale sharks (n=9, 0.02%). The most frequently identified species for sharks, turtles, hammerheads, rays and mantas were *Carcharhinus falciformis*, *Lepidochelys olivacea*, *Sphyrna lewini*, *Pteroplatytrygon violacea*, *Mobula thurstoni*, respectively.

Table 3. Number of specimens by species registered by IATTC observers from 2015 to 2017

ScientificName	FAO code	Total
Sphyrna lewini	SPL	47
Sphyrna spp.	SPN	15
Sphyrna zygaena	SPZ	40
Sphyrna mokarran	SPK	2
Mobula japanica	RMJ	2
Mobula tarapacana	RMT	2
Mobula thurstoni	RMO	6
Mobula spp.	RMV	5
Pteroplatytrygon violacea	PLS	18
Rhincodon typus	RHN	9
Carcharhinidae	RSK	1627
Carcharhinus falciformis	FAL	29487
Carcharhinus longimanus	OCS	132
Euselachii	SKH	603
Isurus oxyrinchus	SMA	9

Prionace glauca	BSH	10
Alopias spp.	THR	3
Alopias pelagicus	PTH	2
Isurus spp.	MAK	1
Carcharhinus limbatus	CCL	4
Chelonia mydas	TUG	20
Dermochelys coriacea	DKK	3
Lepidochelys olivacea	LKV	62
Testudinata	TTX	157
Caretta caretta	TTL	9
Eretmochelys imbricata	TTH	11
Mobulidae, Dasyatidae	RANI	2

In each interaction under the IATTC observer program animal fate was identified. The percentage of specimens by species group, year and type of fate is included in the **Figure 4.** For this analysis fate type has been re-grouped as follows (Released alive: release alive, released unharmed; Released Dead: Discarded; Released injured: released with light injury, released with grave injury; Other: Other, unknown or retained accidentally classified as human consumption). During the study period the percentage of specimen released alive has increased in all the species groups or has maintained high levels.

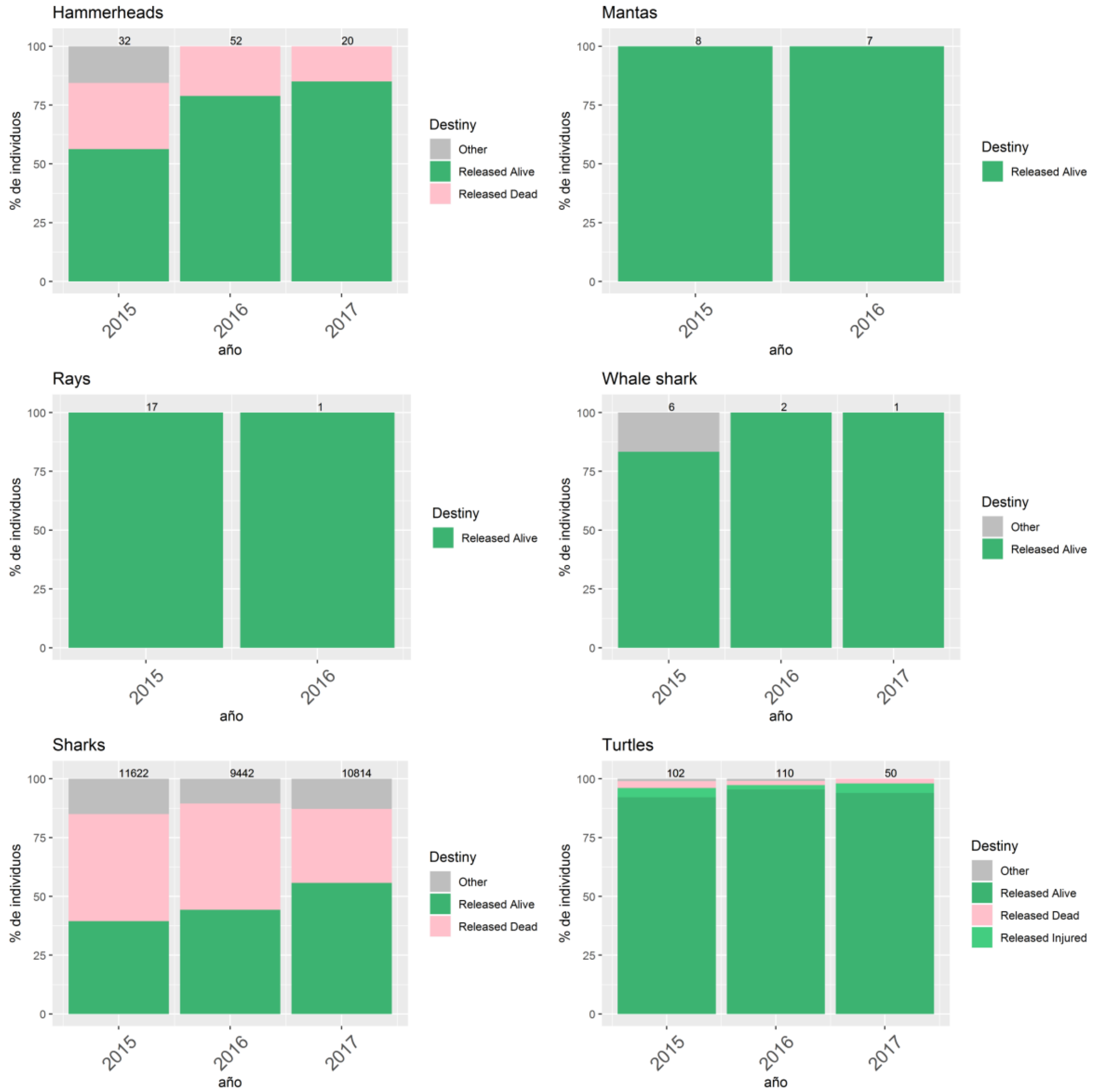

Figure 4. The percentage of specimens released during 2015-2017 period in the Pacific Ocean based on the data recorded in the frame of the IATTC observer Program.

In an opportunistic way, in some trips (i.e. 11 trips) the interactions with sensitive specimens was also evaluated by applying CGP criteria (Annex 1). In these specific trips, when possible in each interaction observers noted the handling method used for releasing the sensitive fauna. It allowed evaluation of handling methods and average times dedicated to release sharks. The percentages of sharks released by each method on this data subset for cases in which release mode was observed, are shown in the **Figure 5**. Sharks are mainly handled manually, a technique that is described in the CGP (Annex 1 and Annex 2,) which enables quick release from the deck especially when various specimens are caught in a set. However, manipulating animals by hand supposes a risk for crew, especially in the case of larger sharks. Indeed, some serious accidents involving shark bites have been registered during the last years. In the case of whale sharks, in the Atlantic Ocean it was observed that animals are released by submerging the floats or by breaking the net as described in the CGP (Annex 1 and Annex 2). In case of mantas and hammerheads instances using specific tools like handmade stretchers or cargo nets has been identified in the Atlantic Ocean (Grande et al., 2019).

Whenever possible, observers also record the time passed between detection and release of bycatch individuals, making it possible to assess release time by crew when a specimen is detected on board. The opportunistic data collection in the context of the CGP program has allowed to establish shark release times. Since 2016, thanks to involvement of companies in crew training, the release time has been reduced in this group, which could positively affect post-release survival rates (**Fig. 5**).

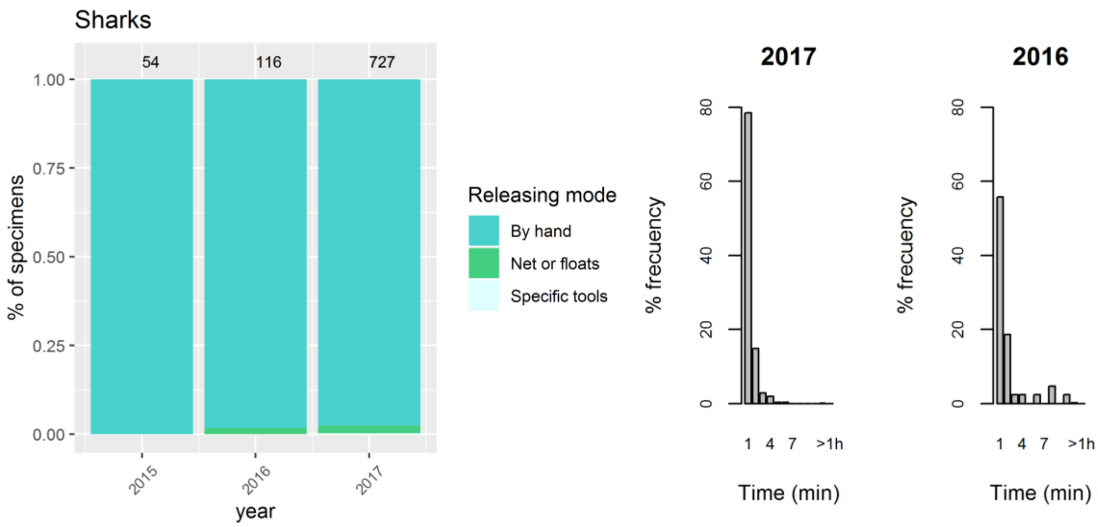

Figure 5. The percentage of sharks released by each handling method and year (left panel) and time dedicated to release sharks from 2016 and 2017 (right panel) in the Pacific Ocean based on the data recorded in the frame of the Code of Good Practices Program. Note that it refers to opportunistically collected data in 11 trips.

In recent years, different tagging studies have been conducted to explore post release survival rates, as well as understanding the contribution of best fishing practices to the reduction of bycatch fishing mortality (**Table 4**). Results on sharks (including hammerheads and other sharks) show that bycatch rates are generally low, but on-vessel mortality in purse seiners is high. i.e. 52% to 72% depending on the study, species and set catch volume (e.g. mortality rates are positively correlated with set size) (Poisson et al., 2014b; Eddy et al., 2016). Post-release survival often depends on whether sharks bycaught are entangled in the purse seine net or not, and on the time spent between net closure and on deck release, (e.g. first or subsequent brails), as well as on the state of the specimen at release (Poisson et al., 2014b; Hutchinson et al., 2015. Filmalter et al., 2015. Eddy et al., 2016). Overall, based on these studies, conformity with the best practices could contribute to increased survival rates, from a minimum of 5% to a maximum of 19% of incidentally caught sharks (**Table 4**). For whale sharks encircled and released following the CGP, the survival was estimated to be 100% (Murua et al., 2014; Escalle et al., 2018) and, thus, the tuna purse seiners' impact on direct mortality of this species is considered negligible if the recommended practices are applied, as is the case of the program's fleet.

Interaction with mantas on purse seine FAD sets is very low, while non-associated sets have higher but still very sporadic mobulid catch rates (Hall and Roman. 2013). One study on purse seiners conducted on mantas in New Zealand showed that from 8 tagged mantas 3 survived (37.5%) which were the ones brailed on board, while the ones entangled in the net and released did not survive. Thus, various authors recommend the adoption of Good Practices to decrease the fishing mortality of mobulids (Poisson et al., 2014a; Francis and Jones, 2017; Hutchinson et al., 2017). However, further tagging work should be developed in tuna purse seiners to assess the post release survival estimates on this species group under various circumstances and in different oceans.

Finally, interactions with marine turtles in the tropical tuna purse seine fishery were shown to be low, with high survival rates based on observed data (Bourjea et al., 2014; Ruiz Gondra et al., 2017); therefore, the impact of the purse seine fishery over species within this group is low (Bourjea et al., 2014) whenever good practices are observed, as is the case of this program.

Table 4. Post release mortality on vulnerable species estimated in previous studies conducted in the Atlantic Ocean (AO), Indian Ocean (IO), Western and Central Pacific Ocean (WCPO) and Eastern Pacific Ocean (EPO)

Species group	Reference	Ocean	fishing stage	mortality rate of the released individual	Overall mortality rate
Sharks	Poisson et al., 2014	IO	entangled in the net	18%	81%
			brailing	48%	
	Hutchinson et al., 2015	WCPO	pre-set	0%	84%
			entangled in the net	31.3%	
			First brail	83.3%	
			posterior brails	93.3%	
	Eddy et al., 2016	EPO	brailing	62%	80% - 95%.
	Sancristobal et al., 2016	AO	pre-set	0%	-
Whale sharks	Escalle et al., 2018	AO	encircled	0%	0%
	Capietto et al., 2014	AO/IO	encircled	1.4%	1.4%
	Murua et al., 2014	AO	encircled	0%	0%
Turtles*	Bourjea et al., 2014	AO/IO	encircled	-	AO = 9% IO = 23%
	Ruiz Gondra et al., 2017a	AO	encircled		1%
Mantas	Francis and Jones., 2016	New Zealand	brailed	-	62.5

**Overall mortality rate on turtles is estimated from observers records and not from tagging studies*

3.3 Future steps: alternative tools for fauna release and the evaluation of the hopper

Bycatch release equipment that has been designed in a collaborative work with the fishing crew is still in prototype phase. It includes cushioned tail velcros to extract sharks from the brail without resorting to ropes or gaffs, holders for small and medium sharks that can be manipulated by a crew member without having to hold directly the animal and manta ray grids to prevent them from going down into the lower deck during brailing and that facilitate their lifting and release operations (**Fig. 6**). The tools have been designed with input from skippers and fishing gear technicians to account for possible flaws. Some of these tools are now in construction process and will soon be distributed to fishers for their test under standard commercial fishing trips. The ultimate goal of the project is to end up with efficient bycatch release tools that are utilized routinely by tuna purse seine fishers, an establish safe and precise release protocols, as now the standard of bycatch releases is highly variable even within fleets and most releases are still done “the old way” by hand often in an inefficient and risky manner.

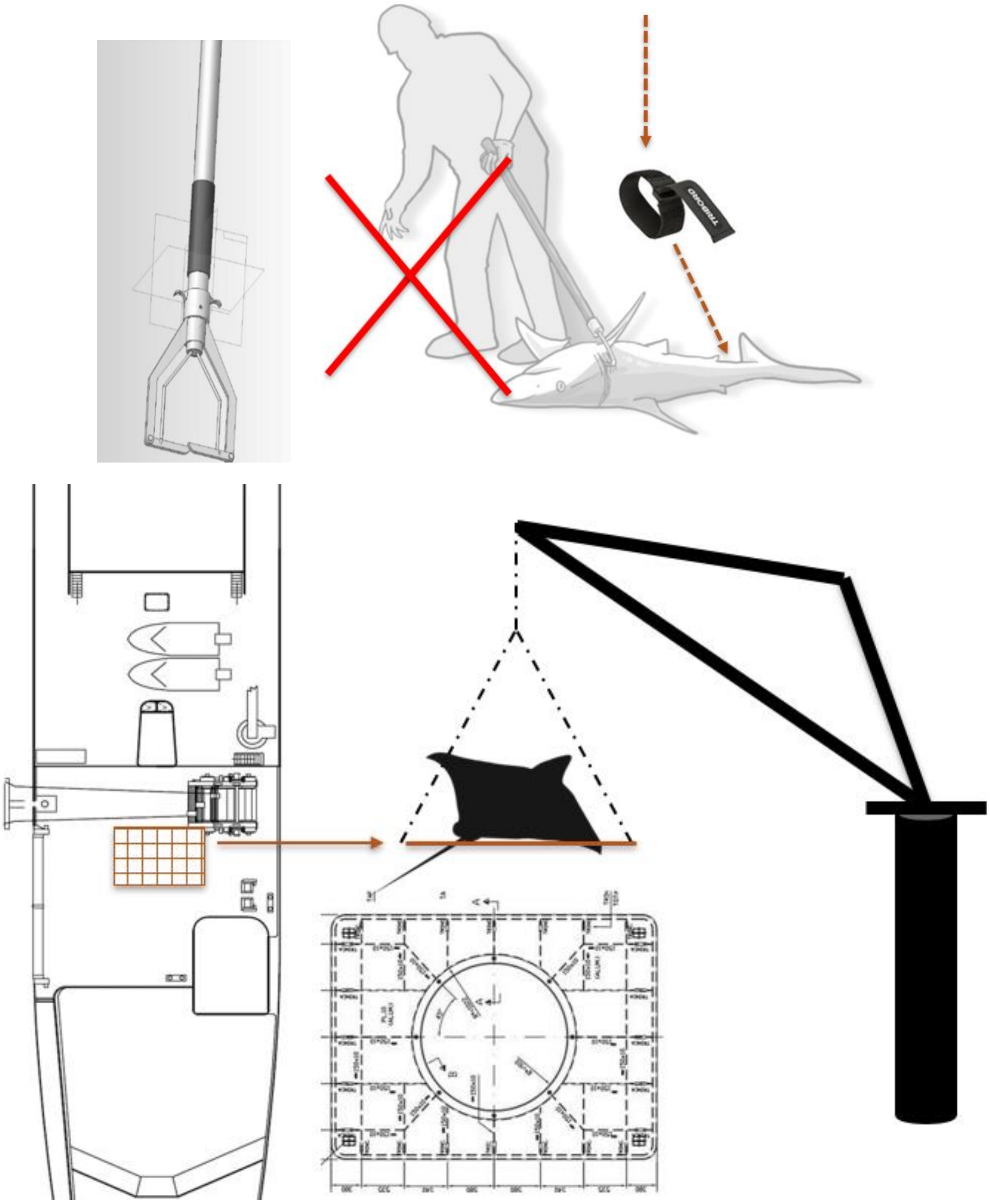

Figure 6. Fauna releasing tools being designed with the feedback of the fishing crew in the frame of the HELEA project

On the other hand, in order to test the hopper (**Fig. 7**), the experimental design has been defined, the trials are being conducted but electronic observer data has not been processed yet, and therefore, there will be no results available until fall of 2019. Captains that have worked in vessels with and without hoppers report that release rates are improved when the hopper is present, with little or no slowing of the brail loading process.

Figure 7. The use of the hopper in a purse seiner vessel fishing tropical tuna

4 Summary and Conclusions

Tropical tunas play a key role in the economy and food security of millions of people globally (Miyake et al., 2010). Purse seiners and other tropical tuna fishing gears need to find mechanisms that ensure the ecological and economical sustainability of tuna fisheries. Some of the potential impacts of FAD fisheries are related to accidental entanglement of sensitive species in its structure or incidental capture of non-target species in the net. Post-release survival studies show that implementation of best available practices on board increased survival of sensitive species by about 5-20% for sharks, 100% for whale sharks, 40% for mantas and 90% for turtles. In addition, if other mitigation measures are applied in stages prior to brailing (e.g. increasing the percentage of free school sets, avoidance of sets on small FAD aggregations, or releasing bycatch in the net with escape panels, etc.) the estimated survival of sharks could potentially increase to 60-65% (Restrepo et al., 2017). Under this scenario, ANABAC and OPAGAC vessels are actively trying to reduce FAD associated impacts in line with the growing demand for sustainable fisheries both by markets and society. The Spanish purse seine fleet industry has addressed this request by developing a voluntary common agreement that ensures best fishing practices in tuna fisheries. The CGP, which was the first program of its kind in the purse seine fisheries, includes the use of non-entangling FADs, best handling practices to release sensitive fauna, 100% observer coverage, sustained training of fishers and observers, and continuous monitoring and data analysis by scientists. In addition, the development of specific tools is being conducted to enhance the survival rate of sensitive species and to further ensure crew safety.

Since the implementation of the CGP program, the commitment of the fleet and continuous training of fishers on the application of the Code has contributed significantly to the improvement of FAD-related sustainable fishing. Traditional FADs deployed by the CGP fleet have been replaced by non-entangling FADs in a relatively short period of time. The percentage of non-entangling FADs at departure and at arrival has continued to increase since 2015 to reach the maximum percentage of non-entangling FADs in the last evaluation here reported in 2017.

Regarding interactions with fauna, based on the IATTC observer data it was established that during the study period the percentage of specimens released alive increased in all species groups or at least was maintained at high levels. For sharks (other than whale sharks) it was observed that the animals are handled by hand and during the study period releasing time decreased, which could contribute positively to survival rates. This was also the case in the Atlantic Ocean for sharks, turtles, mantas and rays (Grande et al., 2019).

Based on the results the following recommendations are proposed:

- Continue with the construction and deployment of non-entangling FADs, avoiding the use of entangling nets (open netting with mesh size >7cm) on the raft and submerged structure, and through replacement of traditional high-risk FADs for non-entangling FADs when encountered at sea.
- In a short/medium term, move to non-entangling FADs constructed with no net and mostly or entirely with biodegradable materials which will help to eliminate the potential entangling risk, marine pollution and other associated habitat impacts.
- Improve release handling methods while ensuring the safety of the crew, using already existing tools for fauna release, including canvas or carriage nets, or through the development of new more efficient equipment to assist in release operations. These should be gradually implemented in all vessels.
- In order to increase the survival of vulnerable species (mainly of sharks) new mitigation approaches should be explored, e.g. the use of releasing tools and procedures as is the case for promoting release from the net, avoidance of shark hot spots.
- Shorten detection time on deck of fauna and aim for immediate release in order to reduce mortality, in particular, in time/area windows with high presence of sharks.
- In sets where high incidence of sharks is observed, avoid loading them onboard by brailing them directly back to sea.
- Strengthen training of the skippers and crew involved in the handling of sensitive species both in the upper and lower decks.
- Further experiments on fauna survival rates should be conducted in order to test the effectiveness of different mitigation measures.

Key recent advances in bycatch mitigation like non-entangling FAD designs, the use of biodegradable materials for FAD construction, or best release practices and equipment are a direct outcome from sustained collaboration between scientists and fishers. The CGP and the new releasing tools developed with direct input from fishers, has led to faster advances in the development of efficient bycatch solutions and higher voluntary adoption by the fleet. Bottom-up programs like this driven by industry are very necessary to minimize the ever-growing environmental impacts of bycatch in fisheries.

Acknowledgments

Authors would like to acknowledge organizations responsible of the data collection funding: Data presented in this paper where collected in the frame of the EU Data Collection Framework, IATTC observer program and the Spanish “Good practices monitoring program” supported by Spanish purse seine associations (ANABAC and OPAGAC). The authors would like to thank to Izaskun Alberdi Landaluze, student of the postgraduate course Scientific Illustration of the UPV/EHU, for the Illustrations/Figures in Annex 2.

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ANNEX 1

17 June

INDICE

INTRODUCTION – CONTEXT AND GENERAL INSTRUCTIONS

The organizations of tuna purse-seiners ANABAC and OPAGAC signed in February 2012 a Code of Good Practices for responsible tuna purse-seine fishing. This code, in force in all the OPAGAC-AGAC and ANABAC-OPTUC fleets, aims to (1) improve the operations performed in the tuna purse-seine fleet by both organizations, (2) improve the selectivity of fishing with FADs and (3) minimize the impact of fishing on the ecosystem. To do this, rules were established regarding the design of fish aggregating devices (FADs) and the release of the fauna that can be found associated with the FADs. Specific objectives are the total replacement of non-conform FADs by non-entangling FADs, and the release of incidentally caught or FAD-associated fauna, ensuring the safety of the crew and maximizing the survival of released animals.

AZTI Foundation is in charge of developing and implementing a system of verification of this Code of Good Practices in tuna purse-seine fishery. In this system, the role of observers will be primordial. You will be in charge of registering information on each FAD that is being planted, visited or on which a fishing event occurs, and on animals that are released. The correct registry of the information will be the base of the functioning of all the system of verification. Just as the forms you usually fill in, for these new ones you will be responsible of the exactness of the data you record. **Falsifying information is MUCH MORE SERIOUS than not recording it.** The information that you record is **STRICTLY CONFIDENTIAL**. You must not make copies, or make any comment or statement in front of others, except for the skipper or captain, both at sea and on land. The skipper or the captain have the right to check every moment the notes that you take.
During the fishing trip, you must not make any personal activity that may hinder your ability to collect the required information.

This manual summarizes the information you need to collect to conduct this project as well as the forms (paper and Excel) and the instructions to fill them. The technical notes to identify species and the protocol for shooting are the same as in the current observers' handbook. <u>Check often and regularly both handbooks</u>. This can avoid repeated errors in the data you collect.

1. RELEASE OF ASSOCIATED FAUNA (Forms B2 and B3)

The aim is to record the operations of release of sharks, whale sharks, rays / skates and turtles. The priority will always be the quick and gentle release of animals. If in some cases the rapid release of an animal does not allow to record all the required information, the release of the animal will be prioritized. If there is little time to observe an animal, observe in priority its release mode, then it's state, then its individual characteristics (size, sex). <u>You should never intervene in the operations performed by the crew</u>.

Two forms need to be completed in conjunction with the current form B on the characteristics of catch: **B2** form in which you record individual shark releases (except whale shark) and **B3** form in which you will record the releases of whale sharks, rays / skates, and turtles.

Next, in paragraphs 1.1, 1.2, 1.3 and 1.4 you will find a description of the practices to be performed for the release of bycatch species to be considered good practice.

1.1. SHARKS

1.1.1. <u>Operations of release</u>

When sharks are dispersed within a tuna aggregation under an object, there is currently no efficient method to remove them from the purse-seine. Sometimes a large shark can be detected at the surface inside the purse-seine; in that case the brailer can be used to remove it. In most cases sharks are released when they appear on deck or entangled in the net. If they are small, the fishermen can manually release them quickly and carefully, avoiding damage to the animal and preserving the safety of the crew during the operation. The crew shall handle the sharks holding (not pulling) the tail and holding the fins (Figure 1).

Medium-sized sharks shall be handled by two crew members. For larger sharks, and depending on the availability of material, the crew can use equipment to help release, such as stretchers, "sarrias" (see 1.3.1.), cargo nets or tarpaulins placed near the brailer. More specific equipment may also be used, such as a hopper or tray with ramp or deck hatches.

Important:

- The crew members **avoid** using ties or poles, to avoid damaging the animal
- They **avoid** dragging, pushing, hitting or squeezing the animal.
- As far as possible, they **avoid** leaving sharks much time on deck under direct sunlight.

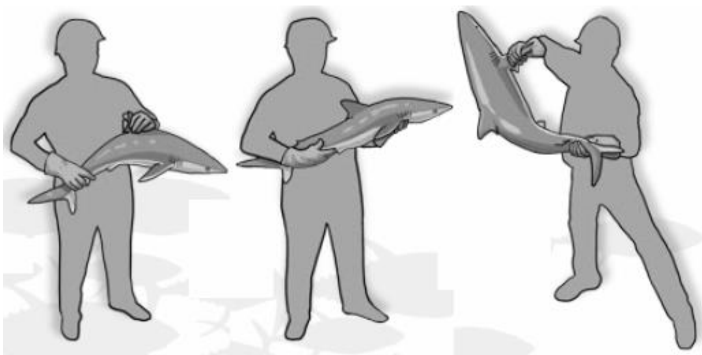
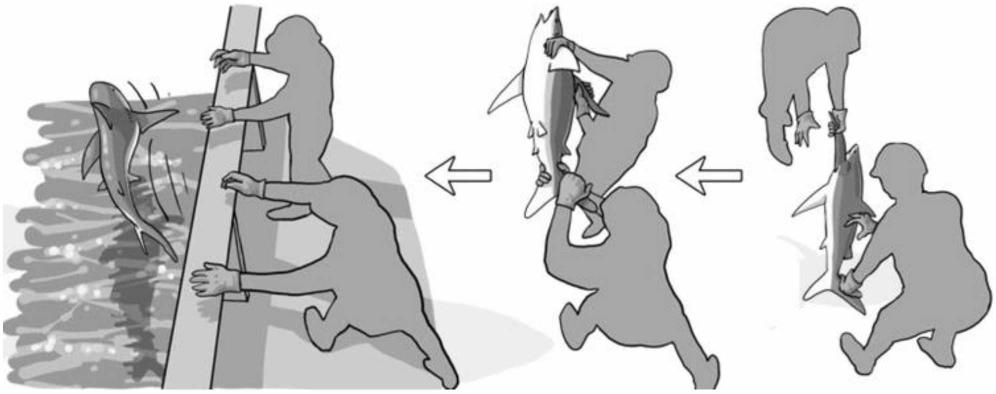


Figure 1: adequate handling of manually released sharks (Poisson et al., 2012)

- They **avoid** lifting the shark by the tail, or handling it by the gill slits (gill operculum). This harms the animal and it can have dangerous reactions.



1.1.2. Registry of the information

You will fill the FORM **B2** (see next page). If you have taken pictures, mention the codes of the corresponding ones (see example page 14).

1.2. WHALE SHARKS

1.2.1. Release operation

If a whale shark is found in the purse-seine, the purse-seine is hauled carefully to isolate the animal in a small area of the purse. Fishermen collect the purse-seine to drive the whale shark near the closest cork line. The purse-seine is always hauled from the tail to the head of the animal and on its underside, trying to make the fish slide to the cork line. The cork line is submersed to ease the exit of the whale shark, and the crew waits for the whale shark to swim out by itself from the purse-seine (fig2).

If the whale shark is pushing with his head against the purse-seine before the cork line could be submersed and if it cannot move back so as to submerse the corks, from the vessel the crew will proceed to submerge the cork line with poles or rods, so that the animal can release its head above the cork (fig2).

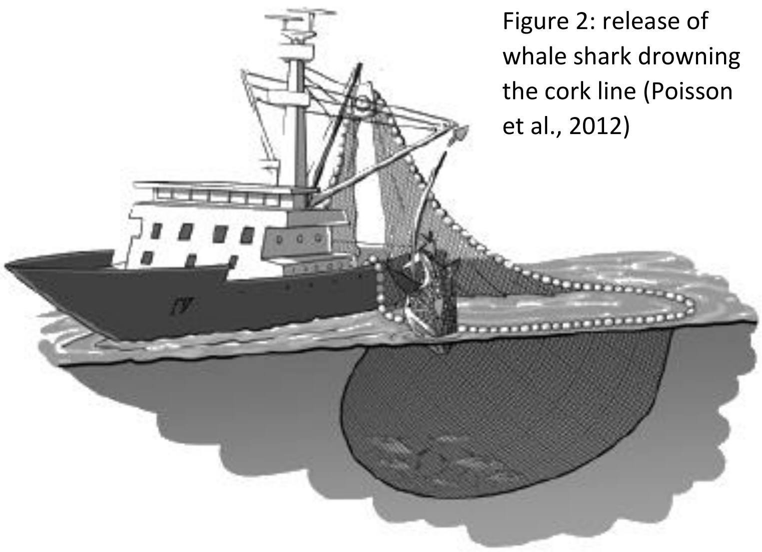


Figure 2: release of whale shark drowning the cork line (Poisson et al., 2012)

Form B2 - Head (identical in B2 and B3)	
tting nº	umber correlatively each of the settings, as in form B
ate	rmat of date: **dd/mm/aaaa**
oute form nº: **oute line nº:**	t the number of form A and the number of the line that corresponds to the set, as form B
elease form nº	t a correlative number for each form, starting with 1 at the beginning of each trip
rip code	e example page 14.
urse shaping start time	hen the fishermen start to strap the purse-seine to concentrate the tuna. Tir MT/UTC (Greenwich Mean Time / Coordinated Universal Time) (4 digits)
Released fauna - sharks	
here is room for 30 individuals. The information of each individual is registered in a same row, following t ample given in row 0. If more than 30 sharks appear in the fishing event, you will use a second form that y ll number correlatively. If you have taken pictures, mention the codes of the corresponding pictures (s ample page 14).	
Individual	
ODE of the species	e species codes (3 digits) in the observers' handbook
ze	timated or measured (if possible) size, in centimeters. If there is no time to easure the animal, you will try to take a picture close from an object of known siz
x	it can be identified. 1: male, 2: female, 3: undetermined.
Release mode	
Following details mentioned in the previous paragraph, the sharks will be released through 5 possible ways	
brailer	ey use the same brailer used to brail the catch onboard, in that case it is used to tract the ray or skate from the purse seine.
stretcher, tarpaulin, arria" or cargo net	is light equipment, if available on the boat, can be found near the brailer.
specific equipment	e specific equipment can be a Hopper or tray with ramp, deck hatches, or other uipment. In notes you will mention the equipment.
anual from deck	e crew members handle the sharks taking them by the fins and sustaining carefully e caudal part.
ter disentangling	hen a shark is entangled in the purse seine the crew members proceed to cut the mes extract the animal.
n conform	e release of the shark is not conform to good practices
eason of non nformity	case of non-conform release, mention the reason: RI (residual unavoidable mortalit e animal comes dead, or is not detected and is kept on board, o is detected in lower ck and cannot be handled safely); M (lack of material); NC (not complying: good actices are not applied although the conditions allow their application
Time	
tection of the animal	hen the shark is detected on deck, or in the net (if entangled) or at the surface o e water (if extracted by brailer). Time in format GMT / UTC (Greenwich Mean me / Coordinated Universal Time) (4 digits)
lease of the animal	hen the shark is released at sea. Time in the same format.
State of the animal	
xcellent, **ood,** **orrect,** **oor,** **nacceptable**	r each animal, you value on a scale of 5 values the general condition of the animal. **xcellent**: Very active and energetic, strong signs of life on deck and when returned to water; **ood**: active and energetic, moderated signs of life on deck and when returned to water; **orrect**: tired and sluggish, limited signs of life, moderate revival time required when returned water, slow or atypical swimming away; **oor**: exhausted, no signs of life, bleeding from gills, jaw or cloaca, long revival time required hen returned to water, limited or no swimming observed upon release; **acceptable**: moribund, no signs of life, excess bleeding from gills, jaw or cloaca, unable to vive upon return to water, no swimming movement, sinks.

Verification of Good Practices ANABAC/OPAGAC

RELEASE OF ASSOCIATED FAUNA

Form **B2**

version 2017

fishing set nº:	
Date:	
fishing trip code	
route form nº:	
route line nº:	
fauna liberation form nº:	

purse shaping start time			
h	h	m	m

Released fauna - sharks (1 line by individual, see example)

	individual			release mode							time		(4) state of the animal				
	(1) species	(2) size	(3) sex	using brailer	by stretcher, fabric, sarria, cargo net	with specific equipment	manual from deck	after disentangling	non conform	reason of non conformity (6)	animal detected	animal released	Excellent	Good	Fair	Poor	Unacceptable
0	FAL	140	2					1			7:35	7:47		X			
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	

Notes (5):

(1) put species code - see usual observers handbook. **(2)** in centímeters

Data verified

(3) sex: 1 male; 2 female; 3 undetermined **(4)** score as shown in the manual: Excellent, Good, Fair, Poor, Unacceptable;

(5) if photos of the individuals were taken, mention code of the corresponding photos **(6)** RI (residual unavoidable mortality: the animal comes dead, or is not detected and is kept on board, o is detected in lower deck and cannot be handled safely); M (lack of material); NC (not complying: good practices are not applied although the conditions allow their application

If more than 30 individuals are released, continue on a new form

If the whale shark is caught in the purse seine with its head facing stern, the crew members localize the junction between two panels that is closest to the head of the animal, proceeding to cut the junction on a couple of fathoms so as to create a window through which the whale shark can escape, pulling down the panels until submersing this window (fig.3).
If the whale shark does not appear at the surface, they start to brail the catch until the whale shark appears at the surface. In that moment they stop brailing the tuna and proceed as indicated initially.
If the whale shark is small (less than 2m) they release it using the brailer.

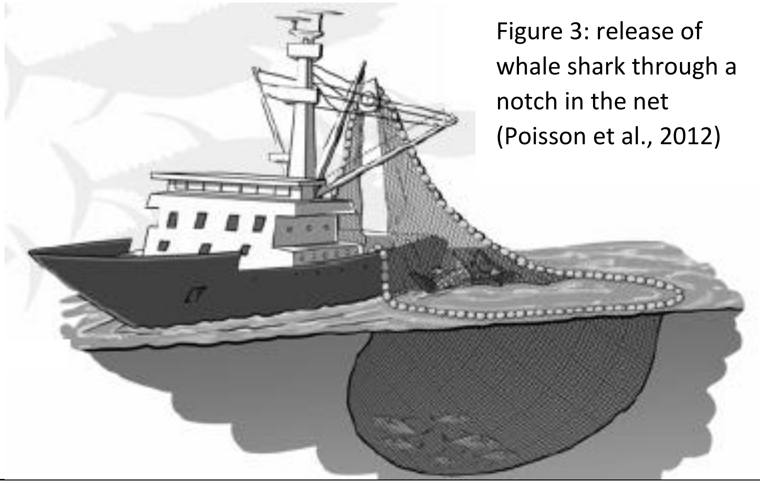


Figure 3: release of whale shark through a notch in the net (Poisson et al., 2012)

1.2.2. <u>Registry of the information</u>

Form B3 - Head (identical to B2, see previous table)	
Released fauna – whale sharks	
There is room for 3 individuals. Very few times you will find more in a same set. The information of each individual is registered in a same row, following the example given in row 0. If more than 3 whale sharks appear in the fishing event, you will use a second form that you will number correlatively. If you have taken pictures, mention the codes of the corresponding pictures (see example page 14).	
Individual	
Code of species	Only one species: *Rhincodon typus*. Code RHN
Size	Estimated size, in centimeters. You will always try to take a picture of the whale shark.
Sex	If it can be identified by the pterygopodes. 1: male, 2: female, 3: undetermined
Release mode	
Following details mentioned in the previous paragraph, the whale shark the sharks will be released through 3 possible ways	
By brailer	If the animal is small (< 2m) they use the same brailer used to brail the catch onboard, in that case it i used to extract the whale shark from the purse seine.
Drowning the cork line	The crew members drown the cork line so that the whale shark can swim above it.
Notch in the purse seine	The crew members make a notch in the purse seine net close to the head of the animal to create a window, through which the whale shark can get out.
Non conform	The release of the whale shark is not conform to the good practices
Reason of non conformity	In case of non-conform release, mention the reason: RI (residual unavoidable mortality: the animal comes dead, or is not detected and is kept on board, o is detected in lower deck and cannot be handled safely); M (lack of material); NC (not complying: good practices are not applied although the conditions allow their application
Time	
Detection of the animal	When the whale shark is detected in the purse seine. Time in GMT / UTC format (Greenwich Mean Time / Coordinated Universal Time) (4 digits).
Release of th animal	When the whale shark gets out of the purse seine. Time in the same format.
State of the animal	
	Same instructions as for form B2, see previous table

Verification of Good Practices ANABAC/OPAGAC

RELEASE OF ASSOCIATED FAUNA

Form **B3**

version 2017

fishing set nº:

Date:

fishing trip code

route form nº:

route line nº:

fauna release form nº:

purse shaping start time			
h	h	m	m

Released fauna - whale sharks, rays (1 line/individual, see example)

	individual			release mode									time		(4) state of the animal				
	(1) species	(2) size	(3) sex	drowning the corks	notch in the net	using the brailer (small shark)	using the brailer	by stretcher, fabric, sarria, cargo net	with specific equipment	manual from deck	non conform	reason of non conformity (6)	animal detected	animal released	Excellent	Good	Fair	Poor	Unacceptable
0	RHN	520	3	1									7:49	8:36	X				
1																			
2																			
3																			
0	RMB	120	2							1			8:44	8:49		X			
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			
11																			
12																			

Released fauna - turtles (1 line/individual, see example)

	individual			release mode						time			(4) state of the animal				
	(1) species	(2) size	(3) sex	after disentang.	manual from deck	through removing net/plastic remains or hook	non conform	reason n.c.	onboard 1d	animal detected	animal released		Excellent	Good	Fair	Poor	Unacceptable
0	TTL	90	1		1					9:04	9:21		X				
1																	
2																	
3																	
4																	
5																	
6																	
7																	

Notes (5):

(1) put species code - see usual observers handbook. (2) in centímeters

Data verified

(3) sex: 1 male; 2 female; 3 undetermined **(4)** score as shown in the manual: Excellent, Good, Fair, Poor, Unacceptable;

(5) if photos of the individuals were taken, mention code of the corresponding photos **(6)** RI (residual unavoidable mortality: the animal comes dead, or is not detected and is kept on board, o is detected in lower deck and cannot be handled safely); M (lack of material); NC (not complying: good practices are not applied although the conditions allow their application

1.3. RAYS AND SKATES

1.3.1. Release operations

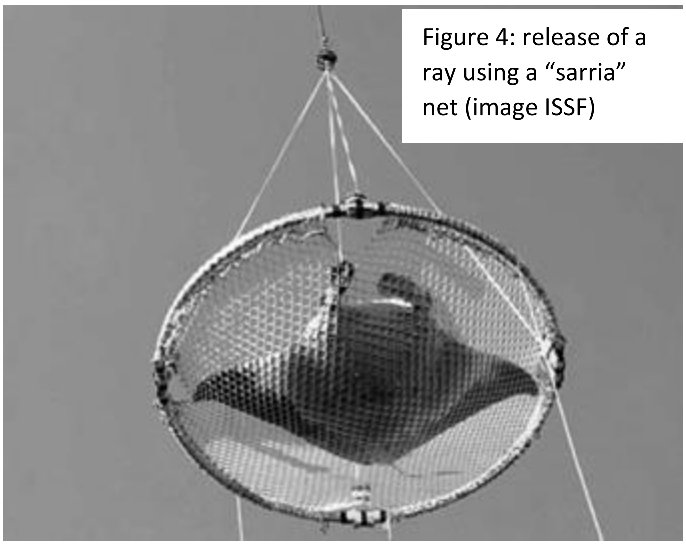


Figure 4: release of a ray using a “sarria” net (image ISSF)

If manta rays or skates appear on the surface when the purse seine is closed or when the crew is brailing the catch, the brailer can be used to take them directly from the purse seine and release them at sea. If not, they will be released when they appear on deck. If they are small, they are manually released by crew members, up by their fins, avoiding damage to the animal and without compromising the safety of the crew. If they are larger, other device type can be used, such as a tarpaulins, stretchers, sarrias (small round nets, Figure 4) or cargo nets, which prevent any damage to the animal and the crew. Depending on availability of materials, more specific equipment may also be used, such as hopper or tray with ramp or deck hatches.

Important:

- Crew members **avoid** dragging, pushing, hitting or squeezing the animal.
- As far as possible, they **avoid** leaving manta rays and skates much time on deck under direct sunlight.
- They **avoid** lifting manta rays and skates by the tail, or manipulating them by the gills or the cephalic lobes. This harms the animal and it can have dangerous reactions. In particular, handle a ray's tail is dangerous for the spine that many of these animals have on their tail.

1.3.2. Registry of the information

Form B3 - Head (same as B2, see corresponding table)	
Released fauna – rays and skates	
here is space for 12 individuals. Information of each individual is recorded in one row, following the examp ven in row 0. If more than 12 rays or skates appear in the set, a second form will be used and consecutive mbered. If you have taken pictures, photos mention corresponding codes (see example page 14).	
Individual	
ODE of the species	e species codes (3 digits) in your usual handbook
ze	timated or measured (if possible) size, in centimeters. If there is no time to measur e animal, you will try to take a picture close to an object of known size.
x	it can be identified. 1: male, 2: female, 3: undetermined.
Release mode	
Following details of paragraph 1.3.1., skates and rays are released by 4 modalities	
brailer	ey use the same brailer used to brail the catch onboard, in that case it is used to extra e ray or skate from the purse seine.
stretcher, “sarria” rpaulin, cargo net	is light equipment, if available on the boat, can be found near the brailer.
specific equipment	e specific equipment can be a hopper or tray with ramp, deck hatches, or other uipment. The equipment will be mentioned in notes.
anual from deck	e crew members manipulate the rays and skates holding them by the fins and avoidin anipulating the tail, the gills slits or the cephalic lobes.
n conform	e release of the ray/skate is not conform to the good practices
eason of non- nformity	case of non-conform release, mention the reason: RI (residual unavoidable mortality: e animal comes dead, or is not detected and is kept on board, o is detected in lower ck and cannot be handled safely); M (lack of material); NC (not complying: good actices are not applied although the conditions allow their application
Time	
etection of the anim	hen the ray or skate is detected at the surface (if extracted using brailer) or on deck. me in GMT / UTC (Greenwich Mean Time / Coordinated Universal Time) (4 digits)
elease of the animal	hen the ray or skate is released at sea. Time in the same format.
State of the animal	

	me instructions as for form B2, see corresponding table

1.4. TURTLES

1.4.1. Release operations

If turtles are encountered entangled in devices or in the purse seine when it is being closed, the crew tries by all means to release them. They avoid above all making turtles pass through the power-block, stopping immediately the operation when detecting a turtle entangled. They proceed to the release of all turtles that can be located inside the purse seine, avoiding damaging them. Turtles are handled by the shell either by one crew member (Fig 5) or by two for large turtles. In this case they will avoid holding the shell right behind the head, to keep their hands safe if the animal retracts its head.

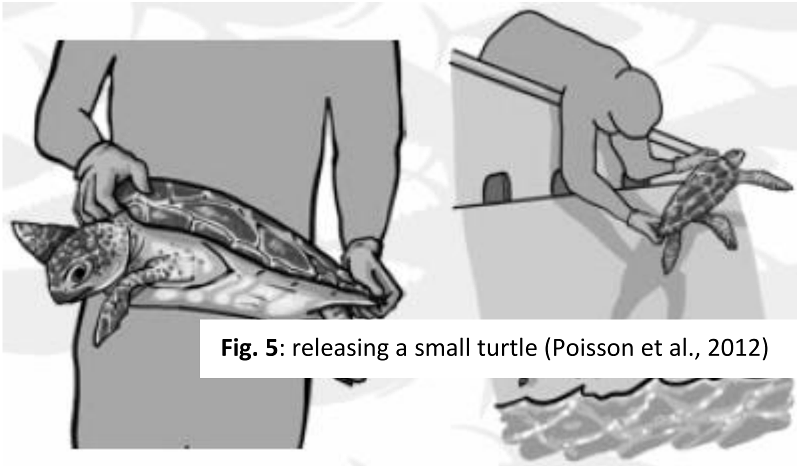


Fig. 5: releasing a small turtle (Poisson et al., 2012)

Important:

- The crew members **avoid** dragging, pushing, hitting or squeezing the animal.
- As far as possible, they **avoid** leaving the turtles much time on deck with direct sun.
- **They avoid** leaving turtles upside down or handling them by the legs.

If any damage to the animal occurs during the operation, if possible the animal is kept one day onboard at shade, periodically wetted and verifying that it recovers before releasing. If the animal carries plastic or net remains or longline hooks inserted, the crew can remove them, even if they do not come from the recent activity of the vessel. Also, if when visiting an object without fishing, a turtle is found entangled, the crew should disentangle and release it in the same way.

1.4.2. Registry of the information

Form B3 - Head (same as B2, see corresponding table)	
Released fauna – turtles	
ıere is room for 7 individuals. The information of each individual is registered in a same row, following t ample given in row 0. If more than 7 turtles appear in the fishing event, you will use a second form that y ll number correlatively. If you have taken pictures, mention the codes of the corresponding pictures (s ample page 14).	
Individual	
ODE of the species	e species codes (3 digits) in your usual handbook
ze	timated or measured (if possible) size, in centimeters. If there is no time to measu e animal, you will try to take a picture close to an object of known size.
x	it can be identified. 1: male, 2: female, 3: undetermined.
Release mode	
Following details mentioned in the previous paragraph, the turtles are released through 4 possible modes	
fter disentangling	ıe turtle is disentangled from the purse-seine or from the FAD
anual from deck	ıe crew members handle the turtle holding it by the Shell and avoiding holding it b e legs.
fter removing net or astic remains / hook	the animal carries plastic or net remains, or a longline hook inserted, the crew can move and / or disentangle them, even if they do not come from the recent activity e vessel
ay onboard	the turtle is kept one day on board to help it recover, put 1 in the corresponding square
on conform	ıe release of the turtle is not conform to the good practices
eason of non-nformity	case of non-conform release, mention the reason: **RI** (residual unavoidable mortality: e animal comes dead, or is not detected and is kept on board, o is detected in lower dec d cannot be handled safely); **M** (lack of material); **NC** (not complying: good practices e not applied although the conditions allow their application
Time	
etection of the animal	hen the turtle is detected in the purse-seine or on the FAD. Time in GMT / UTC rmat (Greenwich Mean Time / Coordinated Universal Time) (4 digits)

elease of the animal	hen the turtle is released at sea. Time in the same format.
State of the animal	
	ıme instructions as for form B2, see corresponding table

2. STRUCTURE OF THE DEVICES (FADs)

2.1. DESIGN

The objective will be to record the detailed characteristics of all the devices that are planted, that are removed and kept on board, that are visited and on which fishing events occur. The goal will be on the one hand to be able to determine precisely the non-entangling nature of the devices, on the other hand to get detailed information on their structure and to be able to know the evolution of the type of devices. You will observe the structure and coverage of the raft (superficial part) of the devices as well as the submersed part. After notifying the captain or skipper, you can also take pictures of the devices.

Same as for fauna release, the observer should never take part in the operations done by the crew members on the devices.

Together with the current form **D** regarding the monitoring of drifting FADs, you will fill the form **D2**, in which you will record the characteristics of each device encountered and/or left at sea.

Note: the submerged part of the devices can be of three types according to the code of good practices:

- made of loose ropes or any other non-entangling material (fig.6)
- made of open nets with a mesh size ≤ 7cm
- made of old tuna nets rolled in “sausages” (fig 7)

If the crew members modify or replace a part of a device, this will be recorded in the form.

Fig 6.Device with uncovered raft and submersed part made of loose ropes

2.2. REGISTRY OF THE INFORMATION

<table>
<tr><th colspan="5">Form D2 - identification</th></tr>
<tr><td>Form D2</td><td colspan="4">Put a correlative number for each form, starting with 1 at the beginning of each trip.</td></tr>
<tr><td>Boat nam</td><td>Full name of the boat</td><td colspan="2">Trip start dat</td><td>Format: dd/mm/aaaa</td></tr>
<tr><td>Observe</td><td>Your full name</td><td colspan="2">Fishing trip cod</td><td>See example page 14</td></tr>
<tr><td>Form D nº</td><td colspan="4">The number of form D corresponding to the device you describe.
REGISTER INFORMATION FOR ALL VISIT, FISHED AT, DEPLOYED OR MODIFIED FADs.</td></tr>
<tr><td>When arriving
when leaving</td><td colspan="4">Tick the square “when arriving” and fill the row with device characteristics when encountering the device at sea.
Tick the square “when leaving” and fill the row with device characteristics when the device is left at sea, if modifications have been done.
If the device is not modified during the operation, fill only one row and tick both “when arriving” an “when leaving”.
If it is a new device deployed, fill only one row and tick “when leaving”.
If the device encountered is kept on board, fill only one row and tick “when arriving”.</td></tr>
<tr><td rowspan="2">Own / else’s</td><td rowspan="2" colspan="2">Note P (personal) if the FAD belongs to the vesse
A (another) if it belongs to another one</td><td>Date</td><td>Format: dd/mm/aaaa</td></tr>
<tr><td>Time (GMT/UTC</td><td>Hour and minutes</td></tr>
<tr><th colspan="5">Characteristics of the FAD</th></tr>
<tr><td>Raft</td><td colspan="4">For each row, put a cross in the relevant options:
Canes/bamboo (canes and/or other vegetal material), metallic or PVC (made of metal and/or plastic elemen or any other synthetic material). Write a cross on both fields if the FAD is made of both natural and synthetic materials.
NET (exterior): covered with net whose mesh whose size is <u>≤ 7cm or > 7cm</u>, above and/or below.
Cover. no mesh: the raft is covered with a non-meshed material, above and/or below
No cover: the superior and/or inferior part of the raft is not covered
Cannot see: it is not possible to see the upper and/or lower coverage of the raft
They modify it: the crew members modify some elements of the raft
They replace it: the raft is entirely replaced by another one</td></tr>
<tr><td>Subsurface structure</td><td colspan="4">For each row, put a cross in the relevant options:
Sausage: the subsurface structure is made of nets rolled in “sausages” (fig 7).
Open net: the subsurface structure is made of open net.
Single pieces: the subsurface structure contains open single pieces of net
For the 3 previous options, <u>tick either ≤ 7cm or > 7cm</u> according to the mesh size.
Rope / no mesh: the subsurface structure contains no mesh and/or is made if loose ropes
Cannot see: it is not possible to see the subsurface structure
Without tail: there is no subsurface structure
They modify it: the crew members modify some elements of the subsurface structure
They replace it: the submersed structure is entirely replaced by another one</td></tr>
<tr><td colspan="5">ther components: If other components are present, put crosses in the corresponding squares (fields). If an animal is tangled, note the species if you can identify it (note the state of the animal in observations).</td></tr>
</table>

g 7: Device with raft covered above with non-entangling materi
d submersed part made with old nets rolled in “sausages” (imag
SF)

g. 8: Raft uncovered (image ISSF)

Verification of Good Practices ANABAC/OPAGAC

Form D2 nº:

1 line by FAD if no modification, 2 lines by FAD if modification (state when arriving and state when leaving)

BOAT name: | **Fishing trip start date:**

OBSERVER: | **Fishing trip code:**

Nº Form D	when arriving	when leaving	own / else's	DATE	TIME	RAFT: Canes / Vegetal	RAFT: Metallic or PVC	RAFT: Superior: Net ≤ 7cm	RAFT: Superior: Net > 7cm	RAFT: Superior: cov. w/o net	RAFT: Superior: non covered	RAFT: Superior: not visible	RAFT: Inferior coverage: Net ≤ 7cm	RAFT: Inferior coverage: Net > 7cm	RAFT: Inferior coverage: cov. w/o net	RAFT: Inferior coverage: non covered	RAFT: Inferior coverage: not visible	RAFT: they modify it	RAFT: they replace it	SUBSURFACE STRUCTURE: net in sausage ≤ 7cm	SUBSURFACE STRUCTURE: net in sausage > 7cm	SUBSURFACE STRUCTURE: open net ≤ 7cm	SUBSURFACE STRUCTURE: open net > 7cm	SUBSURFACE STRUCTURE: single net pieces ≤ 7cm	SUBSURFACE STRUCTURE: single net pieces > 7cm	SUBSURFACE STRUCTURE: rope / no mesh	SUBSURFACE STRUCTURE: not visible	SUBSURFACE STRUCTURE: no subs. struct.	SUBSURFACE STRUCTURE: they modify it	SUBSURFACE STRUCTURE: they replace it	OTHER COMPONENTS: plastic	OTHER COMPONENTS: Corks	OTHER COMPONENTS: Bags	OTHER COMPONENTS: Palms, canes...	OTHER COMPONENTS: Color belts	OTHER COMPONENTS: weights	OTHER COMPONENTS: entangled animal
45	*X*			*14/03/2014*	*13:22*	*X*		*X*								*X*		*X*		*X*														*X*			
45		*X*		*14/03/2014*	*13:22*	*X*				*X*					*X*					*X*														*X*			

3. TRANSMISSION OF THE INFORMATION

3.1. Excel File

The information registered during the day in the forms will also be introduced in the attached Excel file. You will find a common table for the information of forms B2 and B3, and another one for the information of forms D2.

In these tables you will fill **one row by individual** in the case of release operations (forms B2 and B3) and **one or two rows by device** in the case of form D2 (just as in in the paper form).

These tables are composed of three fields (from left to right): one field for general information, one field for event identification, and one field for release characteristics (forms B2 and B3) or device characteristics (forms D2). The subfields to be filled in each one are the following:

eneral information (both sheets):
ɔserver's Name
Boat

ɔat
Observer
p code

lentification of the event (forms B2 and B3)
;hing set nº
ıte
ute form nº
ute line nº
ıadrant sector (same as in ObServe Data Base)
for NE, 2 for SE, 3 for SW, 4 for NW)
:itude (deg and min, degrees South as negative)
ngitude (deg and min, degrees West as negative)
lease form nº
ırse shaping start time

entification of the event (form D2)
rm D2 nº
rm D nº date
ıen arriving / when leaving
vn /else's (write P or A)
te and time
ıadrant sector (same as in ObServe Data Base)
for NE, 2 for SE, 3 for SW, 4 for NW)
:itude (deg and min, degrees South as negative)
ngitude (deg and min, degrees West as negativ

ımber of photos / - code first photo

**haracteristics of release (forms I
ıd B3)**
dividual
ecies
ze
x
lease mode
ing the brailer
ʼ stretcher, tarpaulin, "sarria" or car
ʼt
ʼ specific equipment
anual from deck
ter disentangling
owning the cork line
rough a notch in the net
ter removing net / plastic remains
ɔok
ıboard 1 day
ɔn conform
ason of non-conformity
ːtection time and release time of t
ːimal
ate of the animal – value (P, M, S or
ch part : eyes, head, skin, fins and g
ts (sharks, rays) or legs and sh
ırtles)

haracteristics of the device (form D2
ıft
ınes/vegetal
etal or PVC
t with mesh ≤ 7 cm above
t with mesh > 7 cm above
vered without mesh above
ɔn covered above
nnot see above

ıet with mesh ≤ 7 cm below
ıet with mesh > 7 cm below
:overed w/o mesh below
ıon covered below
:annot see below
hey modify it
hey replace it

ıbmersed part
sausage » with mesh ≤ 7 cm
sausage » with mesh ≤ 7 cm
ɔen with mesh ≤ 7 cm
ɔen with mesh > 7 cm
ıgle net pieces w mesh ≤ 7 cm
ıgle net pieces w mesh > 7 cm

ʼope / no mesh
:annot see
ıo submersed part
hey modify it
hey replace it

:her elements
astic containers
rks
gs

ɔalms / canes
:olor belts
veights

tangled animal (species) (note the sta
the animal in observations).

The data of latitude and longitude will be taken from the usual <u>form A</u>.

The goal is simply to introduce the same information in one single Excel file, always filling **<u>one row by individual</u>** in the case of release operations (forms B2 y B3) and **<u>one or two files by FAD (according to the case)</u>** in the case of device characteristics (form D2).

3.2. After the fishing trip

- **The filled forms must be always under your control during the way back.** They must never be delivered to a third person, or put into a bag that will travel in the baggage hold, or deposited in a left-luggage office.
- Notify, immediately after your arrival, Foundation AZTI (contacts below) and follow the instructions that will be given to you for data sending.
- **You will then deliver all the forms ordered and the material that was given to you, as well as all the samples and pictures you have taken.**

ZTI		
'A - AZTI shing Port, Victoria ahe, SEYCHELLES l + 248 670300 x: + 248 224508	errera kaia portualdea z/g)110 Pasaia (Gipuzkoa) 'AIN l +34 94 657 40 00 x: +34 94 657 25 55	atxarramendi ugartea z/g 395 Sukarrieta (Bizkaia) 'AIN l +34 94 657 40 00 x: +34 94 657 25 55
igo Krug l. +248 278 69 94 rug@azti.es	**n López** l. +34 634 20 97 38 ppez@azti.es	**n Ruiz** l. +34 667 17 43 75 iiz@azti.es

ther addresses where to let the paper forms for sending	
lantic Ocean	**dian Ocean**
entre de Recherche Océanologique (C.R.O.) P V18 BIDJAN **ÔTE D'IVOIRE** x: (225) 21 35 11 55	ychelles Fishing Authority (SFA / AZTI*)* P 449 ICTORIA, Mahé **EYCHELLES** x: (248) 670300
entre de Recherches Océanographiques Dakar-Thiaro .R.O.D.T.) P 2241 AKAR **ENEGAL** x: (221) 33 832 82 62	rres australes et antarctiques françaises (TAAF) ie Gabriel Dejean '410 Saint-Pierre, île of the Réunion **RANCE** l: 0(033)2 62 96 78 78

As specified in the observers' handbook, when finalizing your trip onboard you must provide **a report** of three or four pages summarizing your general impression, as well as problems, observations and suggestions. Apart from this report, you will summarize on one page the following points:

<u>Fauna release</u>:

Eventual problems or difficulties to observe and/or identify the operations, to identify the species, to estimate the state of the animals.

Easiness or difficulties for the crew members to realize release operations that are conform to the code of good practices.

<u>Non entangling devices</u>:

Eventual problems or difficulties to observe and/or identify the non-entangling devices

<u>Suggestions</u>

to solve those problems, if encountered

<u>Other problems or difficulties and other suggestions</u>

4. GENERAL RECOMENDATIONS

- Note down the information right after their observation. Do not rely on your memory.
- All the information will be noted, by pencil (type B1 or HB2), at the moment of their observation.
- The information must be readable and the corresponding forms and spaces must be completed.
- If you are not sure about a given element, leave the corresponding space blank and put an explanatory note in the section **NOTES**.
- At night, check all the information you have taken during the day.
  - If you see you have forgotten to mention an element and can recover it, add it on the form.
  - However, if you are not sure about the exactness of the recovered information, do not mention it in the form.
- Once you have checked that all the data are as complete as possible, tick the square **Data verified**, situated in in the lower part of each form.

HANDBOOKS THAT MUST BE IN YOUR POSSESSION

- Handbook of observers onboard tuna purse-seiners 1
- Handbook of observation of good practices onboard ANABAC and OPAGAC tuna purse seiners (the present handbook) 1

FORMS (in addition to the usual ones):

The following amounts refer to the needs for 1 or 2 trips (60 to 85 days at sea):

- ✓ Forms B2 (release) 80 YES / NO
- ✓ Forms B3 (release) 50 YES / NO
- ✓ Forms D2 (devices D2) 25 YES / NO

CODE of the FISHING TRIP:

It is a 14-digit alphanumeric code. You will make this code using the initials of the observer, of the name of the ship and the trip start date (departure from port) be drawn. Example:
Observer: Gorka Ocio Andrés; Boat Egaluze; start date 2014-april-05: **GOAEGA20140405**

CODE of the PICTURES:

You will use the code of the fishing trip + the FAO code of the species and a correlative number. In the case of devices, you will add FAD and a correlative number, starting from 1. The numbering will be distinct for released species and for FADs. Examples:

Rhincodon typus (shark whale shark): GOAEGA20140405_RHN.01
Device: GOAEGA20140405_FAD.01

OTHER:

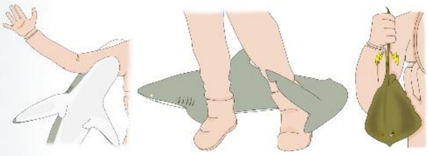
Among your persona effects, you must wear a watch. We suggest including waterproof clothes and shoes for use in the inner rooms (rest).
Japanese-type cotton gloves, helmet and safety footwear for use in working deck and / or lower deck are provided by the owner and should be requested to the supervisor once shipped.

RETURN THE UNUSED FORMS TO SFA-AZTI, do not leave any equipment onboard

ANNEX 2

Código de Buenas Prácticas
Code of Good Practices
Code de Bonnes Pratiques

Riesgos
Risks
Risques



Requisitos Requisites Requises

Material liberación
Release tools
Libèration outil

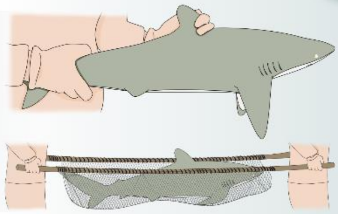
No aleteo
No finning
Pas d´aileronnage

No enmallante
Non-entangling
Non maillants

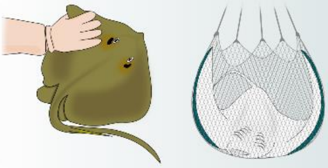
100% Observadores
100% Observers
100% Observateurs

Si Yes Oui

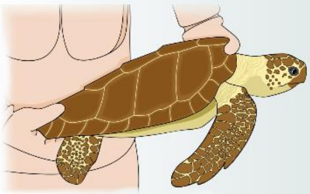
Tiburón
Shark
Requin



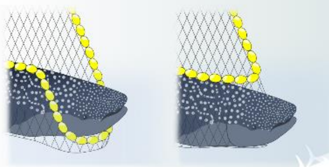
Mantarraya
Manta ray
Raie manta



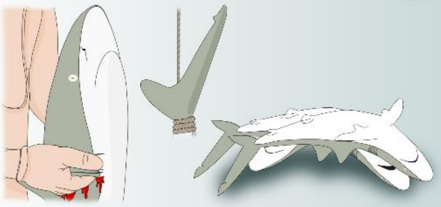
Tortuga
Turtle
Tortue

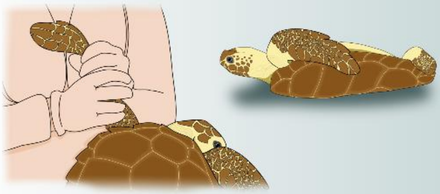


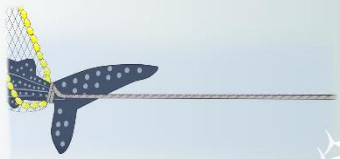
Tiburón ballena
Whale shark
Requin baleine



No Non







Referencias: Poisson F., Vernet A. L., Sèret B., Dagorn L. 2012. Good practices to reduce the mortality of sharks and rays caught incidentally by tropical tuna purse seiners.
https://www.azti.es/atuneroscongeladores/recursos/buenas-practicas-para-una-pesca-atunera-de-cerco-responsable/
Diseño: Izaskun Alberdi Landaluze

azti tecnalia ANABAC OPAGAC