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INCORPORATING BYCATCH RELEASE DEVICES IN GUIDELINES FOR BEST BYCATCH HANDLING AND RELEASE PRACTICES IN TROPICAL TUNA PURSE SEINERS

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SUMMARY

New bycatch release devices (BRDs) are being developed in the tropical tuna purse seine fishery to assist with on deck release of bycatch species. Research shows these tools can increase crew safety and accelerate vulnerable species release for improved post-release survival (PRS). Such equipment is especially important for elasmobranchs, which may be difficult to release in some cases due to their large size and dangerousness. These BRDs have been designed and perfected through trial-and-error tests at sea with the assistance of skippers and deck crew and several fleets have been adopting them on a voluntary basis. Here we present a new updated best practice guideline for handling and release of bycatch in tuna purse seiners which includes past practices proven to work and incorporates new ones employing novel BRDs. The simpler BRDs are low-cost and implementable in almost any vessel. We recommend that management bodies consider including in their recommendations the use of BRDs and crew training programs. This being especially important in the eastern Atlantic Ocean due to the higher incidence of vulnerable bycatch species in sets.

RÉSUMÉ

De nouveaux dispositifs de remise à l'eau des prises accessoires (BRD) sont en cours de développement dans le cadre de la pêche à la senne de thonidés tropicaux afin de faciliter la remise à l'eau des prises accessoires sur le pont. La recherche montre que ces outils peuvent accroître la sécurité de l'équipage et accélérer la remise à l'eau des espèces vulnérables pour améliorer la survie après remise à l'eau. Cet équipement est particulièrement important pour les élasmobranches, qui peuvent être difficiles à relâcher dans certains cas en raison de leur grande taille et de leur dangerosité. Ces BRD ont été conçus et perfectionnés par essais et erreurs en mer avec l'aide des capitaines et du personnel de pont, et plusieurs flottilles les ont adoptés sur une base volontaire. Nous présentons ici une nouvelle ligne directrice actualisée sur les meilleures pratiques pour la manipulation et la remise à l'eau des prises accessoires par les thoniers senneurs, qui reprend les anciennes pratiques ayant fait leurs preuves et en incorpore de nouvelles utilisant de nouveaux BRD. Les BRD les plus simples sont peu coûteux et peuvent être mis en œuvre sur presque tous les navires. Nous recommandons aux organes de gestion d'envisager d'inclure dans leurs recommandations l'utilisation de BRD et de programmes de formation des équipages. Ceci est particulièrement important dans l'océan Atlantique oriental en raison de l'incidence plus élevée d'espèces vulnérables dans les prises accessoires.

RESUMEN

Se están desarrollando nuevos dispositivos de liberación de capturas fortuitas (BRD) en la pesquería de túnidos tropicales con cerco para ayudar a la liberación en cubierta de las especies capturadas de forma fortuita. La investigación demuestra que estas herramientas pueden aumentar la seguridad de las tripulaciones y acelerar la liberación de especies vulnerables para mejorar la supervivencia tras la liberación (PRS). Este equipo es especialmente importante para los elasmobranquios, que pueden ser difíciles de liberar en algunos casos debido a su gran tamaño y peligrosidad. Estos BRD se han diseñado y perfeccionado mediante pruebas de ensayo y error en el mar con ayuda de los patrones y la tripulación de cubierta, y varias flotas los han ido adoptando de forma voluntaria. En este documento se presenta una nueva guía actualizada de mejores prácticas para la manipulación y liberación de las capturas fortuitas en los cerqueros

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atuneros que incluye prácticas anteriores que han demostrado su eficacia e incorpora otras nuevas que emplean BRD novedosos. Los BRD más sencillos son de bajo coste y se pueden implantar en casi cualquier buque. Recomendamos que los órganos de ordenación consideren incluir en sus recomendaciones el uso de los BRD y los programas de formación de los miembros de la tripulación. Esto es especialmente importante en el océano Atlántico oriental debido a la mayor incidencia de especies vulnerables de capturas fortuitas en los lances.

KEYWORDS

Bycatch release device; best handling and release practices; vulnerable species; tuna purse seiner; elasmobranchs; post release survival; fishers; bycatch mitigation

Introduction

Marine megafauna groups such as sharks, rays, and sea turtles, have experienced marked global population declines in recent decades due to anthropogenic activities, particularly fishing (Dulvy *et al.*, 2014; Oliver *et al.*, 2014; Pacoureau *et al.*, 2021). Many of these endangered, threatened and protected (ETP) species have a life history of slow growth and fecundity and late maturation, which makes them more susceptible to overfishing (Couturier *et al.*, 2012; Croll *et al.*, 2016; Stewart *et al.*, 2018; Jorda *et al.*, 2022). To revert this trend preventative steps can be adopted prior, during and after the fishing operations (Hall and Roman, 2013; Booth *et al.*, 2020). Probably the most implementable of these mitigation actions across fisheries is the application of best handling and release practices (BHRP) once bycatch species arrive on deck. Fisheries from artisanal to industrial usually have a set of guidelines on BHRP that describe a series of protocols to try reducing bycatch mortality. Critical for increased post-release survival (PRS) rates is a fast and smooth release operation of individuals to ensure lower exposure to physiological stress on deck (e.g., air exposure, handling stress, etc.) (Madelman *et al.*, 2022). This approach must be customized to the operational needs and vessel characteristics in each fishery (e.g., purse seine, longline, trawling, etc.), often assisted with bycatch release devices (BRDs) to increase release success (Jenkins *et al.*, 2013; Hammer *et al.*, 2015; Poisson *et al.*, 2016).

While some release practices, primarily manual, have long been established others are being developed to improve operational aspects. The field of bycatch mitigation is constantly progressing, as new selective fishing technology and protocols are being designed and tested on a regular basis (Poisson *et al.*, 2022; Murua *et al.*, 2023a). Scientists and fishing gear technologist, often in collaboration with the fishing industry, invest considerable effort in trials to test new solutions to reduce non-target species mortality (Restrepo *et al.*, 2018). One line of work has been the development and improvement of BRDs. Furthermore, some agencies such as the National Oceanographic and Atmospheric Administration (NOAA) have ongoing specific bycatch reduction engineering programs. Therefore, it is important to keep revising and updating BHRPs guides and recommended protocols, to include the latest advances to ensure the most effective state-of-the-art measures are being implemented. Given the critical status of some bycatch species, delays in the adoption of methods that increase their survival rate, will negatively impact their recovery opportunities.

Currently, the largest proportion of tropical tuna catches worldwide originate from purse seine gear and mostly from a relatively small number of large industrial-scale vessels (Justel-Rubio and Recio, 2023). In general, tuna purse seiners show a lower bycatch to target catch ratio than most other tuna fisheries (e.g., Murua *et al.,* 2021; Restrepo *et al.,* 2024). Nevertheless, some groups such as sharks, rays, and turtles can be accidentally caught (Amandé *et al.,* 2010; Clavareau *et al.*, 2020). It is worth noting that the Atlantic Ocean is the region with the highest incidence of bycatch both in free school and FAD sets (Murua *et al.*, 2021a).

Some of these vulnerable groups such as marine mammals, sea turtles and whale sharks are mostly released from the net (e.g., do not arrive on deck), and in general, show very high levels of PRS (Hall and Roman, 2013; Escalle *et al.*, 2015). However, elasmobranchs such as sharks and mobulid rays, exhibit a high post-release mortality rate, even in sets where manual release methods are applied (Poisson *et al.*, 2014; Hutchinson *et al.*, 2015; Stewart *et al.*, 2018). Note that part of the elasmobranchs can arrive on deck in a poor state or even dead, possibly due to suffocation in the sack, associated with their obligate ram ventilator condition (Mandelman *et al.*, 2022). Best practices on deck can at best try to maximize the survival of those individuals which are still alive during the brailing process. Even in fleets which subscribe to best-recommended practices, problems like smaller juvenile sharks inadvertently going to the lower deck or delayed releases with large rays and dangerous sharks have been described (Maufroy *et al.*, 2020). It is believed that such difficulties to handle large sharks and rays on deck are not particular to one fleet or ocean, but instead is a general issue that must be addressed.

More than a decade ago, Poisson *et al.* (2012) produced an influential guide for handling and releasing elasmobranchs in tropical tuna purse seiners that significantly improved previous standards. This guide described very well the actions to avoid (e.g., do not use gaffs, hooks, ropes, leaving animals on deck exposed to sun, etc.) and included some novel techniques at the time such as the use of canvases/cargo nets to help release mobulids. This work was a milestone in bycatch BHRP for purse seiners and has served as a key reference document for many of the recommendations on this subject that RMFOs have adopted in recent years. However, in the last ten years there has been considerable research efforts to design, construct and test new bycatch release, devices (or repurpose existing ones such as hoppers) that assist with safe handling and release efficiency (Grande *et al.*, 2019; Moreno *et al.*, 2023; Murua *et al.*, 2020, 2021 b,c, 2022, 2023 a,b,c). Here, we present a new BHRP guide for tropical tuna purse seiners that includes some of the BRDs that have been designed, tested, and adopted by some fleets in recent years. This updated information can be of interest to industry and managers wishing to improve bycatch release protocol safety and increase ETP species survival rates in purse seiners.

New Best Handling and Release Guidelines

The best handling and release guidelines covered in the new manual are organized by different ETP groups, which include sharks, mobulid rays, turtles and whale sharks and large cetaceans. Smaller cetaceans (e.g., dolphins) are not included in the guideline, as this kind of bycatch is only frequent in a very specific area of the Eastern Pacific Ocean. For these species, customized techniques and equipment, such as the backdown manoeuvre and Medina panel, have been developed and their implementation is supervised by the Agreement on the International *Dolphin* Conservation *Program* (*AIDCP*).

Previous best practice guides often highlighted the actions that should be avoided but did not offer alternatives to deal with the problem of releasing those animals safely. For example, when large sharks come up onboard inside the brail fishers often would tie with a rope a noose around the shark's caudal peduncle to extract it quickly from the brail and lift it with the crane towards the water's edge. This may result in the animal sustaining cuts and abrasive injuries to the caudal peduncle. While this practice should be clearly forbidden, expecting crew to put their health at risk by trying to lift heavy and dangerous sharks embedded in a mass of tunas inside the brail is simply unrealistic. Numerous reports of fishers sustaining severe injuries when trying to carry out this manual extraction from the brail have been documented over the years. Therefore, alternative solutions have been developed that are safe and quick to apply. In recent years, different prototypes of padded lifting aids which can quickly be applied around the shark's caudal peduncle with a velcro and then released, referred to as "Shark Velcros", have provided a new way to deal with this situation onboard without apparent injury to sharks and no need for crew exposing them to a dangerous situation. I Satellite tagged sharks released with "shark velcros" have shown 100% percent PRS so far (n = 4; unpublished data).

Other tools that highly reduce contact time between crew and sharks (and other bycatch) are release ramps which connect from the area where the brail is rested on deck to the water's edge on the starboard. These inclined ramps act as "water slides" where animals are deposited and quickly move down unassisted. The ramps prevent fishers from having to take sharks in their arms for several meters across the deck. Also, ramps minimize stress for the animal as it does not need to be held by fins for long, instead quickly sliding (e.g., 2-6 seconds) with its body rested on the ventral side against the smooth ramp's base. The ramps can be customized in shape, size, and width to fit vessel dimensions and characteristics (i.e., smaller decks will require shorter ramps). Different ramp types have been tested in fleets of the Atlantic, Pacific and Indian Oceans (Murua *et al.*, 2023a). When designing ramps practical aspects such as lightness, durability and storage are considered. Ramps are relatively simple and cheap to build and easily implementable.

Other larger BRDs have been tested on vessels such as hoppers with ramps which greatly prevent sharks and other bycatch inadvertently going down to the lower deck. These hoppers must be large enough so that when the brail is emptied on its tray, contents are spread out and bycatch individuals can be spotted for release (Murua *et al.*, 2021b). The hopper must also have a door mechanism to stop if required, to give time to fishers to handle and release bycatch before it falls to the lower deck. The location of the hopper on deck can be either on the port side, centred over the loading hatch or to the starboard. This will depend on the characteristics of the vessel and the skipper's preference. Hoppers can be somewhat scaled to the size of the working deck space and brail size, but in some instances, may be difficult to install in vessels with reduced deck space.

Some vessels have a double conveyor belt and gutter, or opening door, in the lower deck to release bycatch that accidentally moves down to this area when brailing. Note that unless using a hopper on the upper deck, it is often difficult to spot bycatch species hidden in between the large mass of tuna (e.g., brail size is typically between 4-12 tons), especially if these are juvenile individuals. Studies in vessels where best manual handling practices were

applied on the upper deck and had a gutter in the lower deck have shown an average PRS rates of 40% for silky sharks (Onandia *et al.*, 2021), which approximately doubled that of vessels without gutters and no other BRDs. Most purse seiners with double conveyor belts and gutters had them fitted at vessel construction. Obtaining permits for gutter installation in already built vessels may be complex and expensive, as in many purse seiners the lower deck is below or close to the sea surface, presenting a potential risk for water entry. Note that vessels with a gutter in the lower deck should still need to try to release as much bycatch from the upper deck as possible (i.e., not brail directly on the loading hatch and then start to release bycatch from the lower deck).

Regarding handling and release of mobulid rays, the guide pinpoints the do's and don'ts (e.g., not use hooks or punch holes to lift large mobulids). Methods such as the use of cargo nets or canvases to lift mobulid rays is also included as a good practice, but the manual also includes newer equipment such as sorting grids which are more efficient as the animal does not need to be manually extracted from the brail, which is the case with canvases and cargo nets. Nowadays, many vessels in different fleets have voluntarily adopted manta sorting grids which can be used both directly on the unloading hatch or on the hopper. Release times in trials have averaged about one minute, which is important as time out of the water is considered one of the key factors directly correlated with post-release mortality. Also, the sorting grid protocol avoids the need for crew to enter directly in contact with animals. This not only is safer for crew members, but also prevents undesirable handling events for the mobulid ray (e.g., holding by gill slits, cephalic lobes). The construction of the sorting grids is very basic and economical, only requiring a metal frame and some non-abrasive ropes to form the grid. Different variants in shape (e.g., square, circular) and design (e.g., hinged at the middle for easier storage) have been successfully tested.

Best practices for the handling and release of sea turtles are included in the document, but these are already known manual techniques which have been covered in prior best practice guides (e.g., Poisson *et al.*, 2012) and do not require additional tools to handle, given that releases are safe and simple in the case of this group. Fishers are reminded that for sea turtles some basic handling mistakes such as manipulating them by the flippers or resting them on deck with their ventral side up have detrimental effects and must be avoided. As with sea turtles, for whale sharks and large cetaceans PRS is very high (Escalle *et al.*, 2016, 2019) and no new techniques are added to the guide. Most of these large individuals will escape either by making a hole in the purse seine net or swimming over the net cork line.

At the end of the new guide, an encouraging message is included for fishers, scientists, and managers to continue collaborating in the development and trial of solutions to improve best practices that contribute to a more sustainable fishery.

Discussion

In the last decade, considerable effort has been invested in bycatch mitigation research in tropical tuna purse seine fisheries and best practice guidelines should incorporate successfully developed solutions in a timely manner. The objective of the new BHRP guidelines presented here is to maintain best practices that have proven to work in the past and complement them with novel BRDs that are raising PRS standards of ETP species in purse seiners. These guidelines are not meant to be static, but rather a living document that must be reevaluated on a regular basis, helping keep fisheries industry and managers informed about the state-of-the-art science-based best practices and associated equipment required to implement them.

Part of the mitigatory options studied in recent years have focused on bycatch avoidance or release from the net (e.g., Restrepo *et al.*, 2018). However, the success rate of various trials has been low due to the inherent difficulties of designing bycatch avoidance protocols in multi-species mixed aggregations under FADs that do not affect tuna catches. Nevertheless, this avenue of research should be still considered a priority, as any methods to avoid or release bycatch from the water before the sacking up process would ensure one hundred percent survival of bycatch species involved. However, consultations with fishers since the early 2010s have shown low acceptance for methodologies that involved actions prior or during the set, as they are worried that such activities will disturb tuna schools causing them to escape or entangle in the net. Instead, fishers reported a much better disposition towards activities such as improvements of on deck bycatch releases (Murua *et al.*, 2023d). With this information, scientific groups set out to identify weaknesses in bycatch handling and release protocols and find ways to correct them.

Fisheries data clearly shows that with safe and easy to manipulate ETP species, such as sea turtles, purse seine fishers readily release them. However, in the case of large sharks arriving on deck, releases may be delayed (i.e., until the animal becomes less aggressive) or poor practices employed, such as the use of ropes to lift them by the caudal peduncle. It is important to note that fishers are running against the clock to quickly embark and freeze the

tuna during brailing, as otherwise histamine build up can render the catch unmarketable. This is a key reason why BHRP are in occasions not applied properly, if fishers believe that the release process is going to considerably delay the fish loading operation. As large and dangerous animals are the most difficult and time consuming to handle, the rate of poor practices (e.g., use of nooses, hooks, etc. to lift with the crane) tends to be higher. If BHRPs developed are impractical and greatly hinder normal fishing operations, industry will oppose their implementation. On the other hand, methods that minimize direct contact between deck crew and large or/and dangerous ETP species and accelerates the release process so fishers can continue with the tuna freezing operation are key for voluntary acceptance.

The new best practice guidelines incorporate alternative techniques that can substitute poor practices and have been tested in at sea trials and contrasted by fishers during normal fishing commercial trips. New concepts like the shark velcros offer an alternative to abrasive rope nooses used to lift large individuals by the caudal peduncle. The current design of this device might see improved versions in the future, but for now results indicate that live sharks released with them show long term survival. Ramps are another tool included in the guidelines as numerous vessels have incorporated them in the last five years to assist with bycatch release. If only from a safety standpoint, release ramps clearly minimize contact time between fishers and sharks. Flexibility in ramp designs to accommodate to vessel deck space requirements, means that this equipment can be fitted in virtually any purse seiner. The same happens with mobulid ray sorting grids which can be used in most vessels provided they have a crane to lift it, as is the case with the canvas/cargo net but is more useful because there is no need to extract the mobulid ray from the brail, thus accelerating the release process.

Other larger and more complex BRDs such as hoppers with ramps and lower deck gutters with double conveyor belts might not be implementable in all existing vessels, due to space issues or operational incompatibilities due to the distribution of other fishing equipment on deck (e.g., winches, chokers, etc.). In any case, there is some flexibility in the design, size, and disposition of hoppers, which can help with its installation onboard, and this should be carefully evaluated in a case-by-case study in each vessel. Both these BRDs have potential to significantly increase shark PRS as they either prevent bycatch going to the lower deck in the case of hoppers or speed up release of individuals reaching the lower deck in the case of gutters. The installation of these BRDs in future vessel constructions is highly recommended as their integration with the rest of fishing equipment onboard would be much simpler and efficient if considered in the original building plan. Ship-owners should be encouraged to consider having these BRDs in their vessels as they will minimize crew injury probability, reduce risk of infractions and fines for use of poor practices, and increase the sustainability of their fishing operations.

The inclusion in the new guidelines of novel, but contrasted, solutions for better bycatch handling and release protocols offer industry more options to effectively deal with unwanted catches of non-target species. Nowadays, many tuna purse seine fisheries have recently qualified or are in the process of obtaining Marine Stewardship Council certification. Within the certification standard is Principle 2 which requires the reduction of negative impacts on the environment, especially on ETP species. The new BRDs, having demonstrated higher PRS for elasmobranchs, can assist fishing companies in their objectives of improving their scores for this requirement.

The voluntary implementation of these BRDs has greatly advanced in the last two or three years, but the adoption of these new methods would greatly benefit from the support of fisheries management bodies including them in their conservation measures. Indeed, the number of resolutions by RFMOs specifically addressing BHRP for vulnerable species have substantially increased in recent times. In this regard, ICCAT is no exception and in 2023 it agreed on new protection measures for cetaceans, mobulid rays and whale sharks. Because of its oceanography and biology, the Eastern Atlantic Ocean is the richest tropical region, in terms of ETP species, such as sharks and rays, and purse seine sets have a much higher bycatch rate than in the other oceans. Therefore, it seems apparent that better BHRP, including the utilization of BRDs, would have the greatest positive impact in this region.

Despite the proven advantages of the new BRDs, it is important to acknowledge that they will only be efficient if fishers use them regularly and adequately. Having BRDs onboard does not necessarily mean that fishers will employ them if they are not convinced of their use or reluctant to try new things. It is important that fishers are involved in the design and construction process of the BRDs that will go on their vessels. In this way the new equipment will be customized to their needs and skippers will be more likely to try them. In addition, meetings between fishers and scientists (e.g., ISSF skippers' workshops, Code of Good Practice workshops), can help inform industry about the results obtained in BRD trials across diverse vessels and fleets to raise awareness and acceptance of these new protocols. Frameworks should be established for regular training courses with skippers, captains, and deck crew to discuss BHRPs and other environmental mitigation actions (e.g., biodegradable FADs, juvenile tuna catch reduction, etc.) to promote fisheries conservation objectives.

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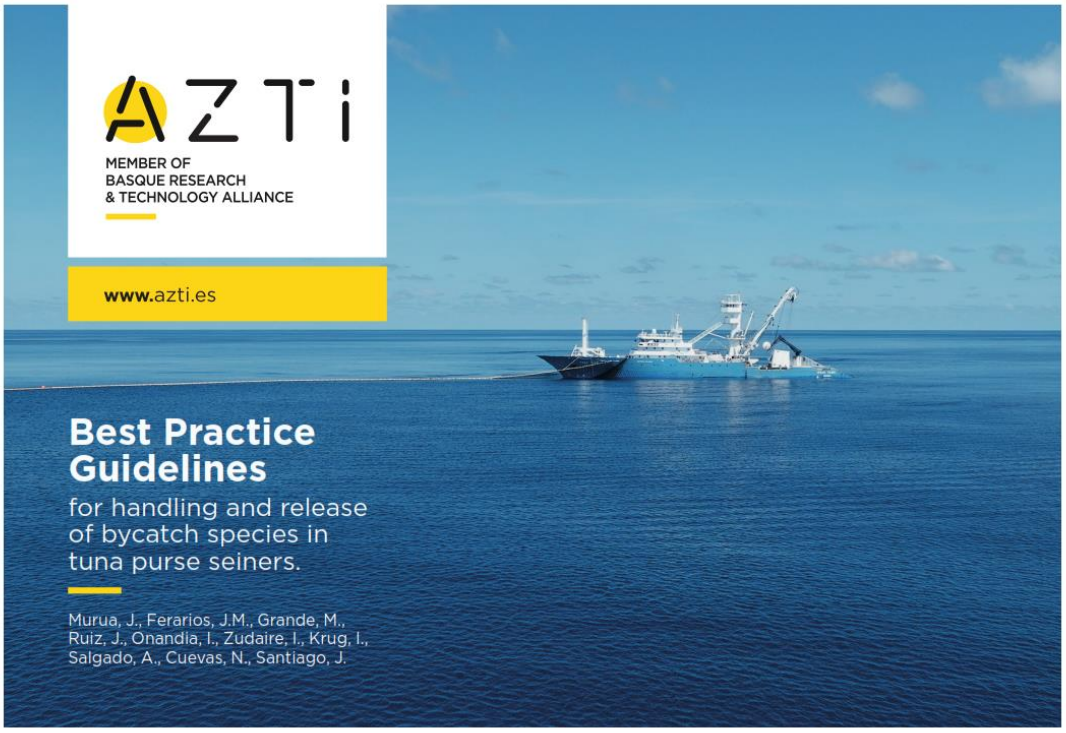
Annex 1

Best practice guidelines for handling and release of bycatch species in tropical tuna purse seiners

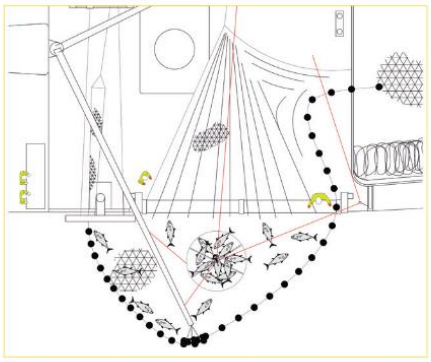


Introduction

Programs to improve tuna fisheries sustainability, such as the Code of Good Practices of OPAGAC and ANABAC, promote the development and implementation of more selective fishing operations. All fisheries generate some type of unwanted bycatch. The tropical tuna purse seine fishery, despite having a low percent of bycatch per ton of tuna (1-3%, ISSF, 2023), it has certain impact on megafauna species such as sharks and mobulids, both belonging to the elasmobranch family.

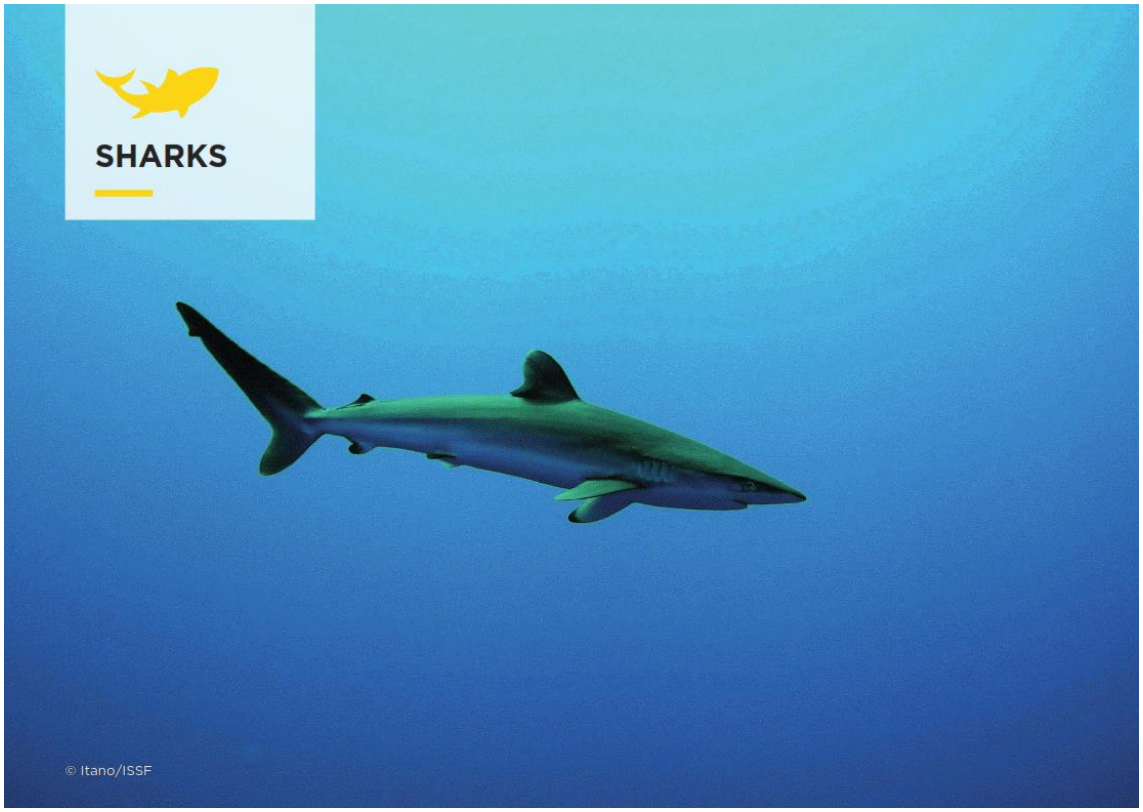
Elasmobranch populations are especially susceptible due to their biology such as late maturation and low rate of reproduction, complicating the recovery from fisherying impacts. Increasingly more shark and mobulid populations are in a critical situation, therefore it is important to make an effort to reverse this tendency. The conservation measures adopted by the Regional Fisheries Management Organizations (RFMOs) are important to protect these vulnerable species.

This guide of best handling and release practices pretends to update the best options available at this time to maximize the survival of bycatch species accidentally captured, always having crew safety as the principal condition. Many



of the new release devices shown are the result of collaborations between fishers and scientists.

The guidelines will be renewed in the future as new solutions are developed to avoid the catch or facilitate a more efficient release of bycatch species.

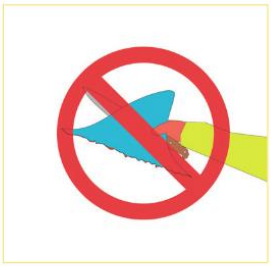


Sharks

While the number of sharks incidentally caught by purse seiners is not significant when compared to the number of individuals caught by other gears, it can be reduced by applying suitable handling and release protocols.

The intentional retention of any shark is forbidden, being strict and inflexible regarding the practice of shark finning. All shark fins must be naturally attached to any unintentionally retained shark.

If any sharks are discovered when the catch is being hauled on board, and following RFMOs recommendations, they must be released from the deck or lower deck as quickly and carefully as possible (provided that they can be handled safely) to avoid harming the animals. The necessary precautions must always be taken to maintain crew safety during the release process of dangerous animals.



Sharks

Particularly, manipulating sharks by the caudal peduncle and one fin (pectoral or dorsal) is suggested **(Fig.1)** and **avoid holding only from the caudal peduncle,** unless it is done with an adequate device such as a padded velcro **(Fig.2)** (if the RFMO allows it), **or by the gills,** to avoid physical harm to the animal, as well as dangerous reactions towards the crew.

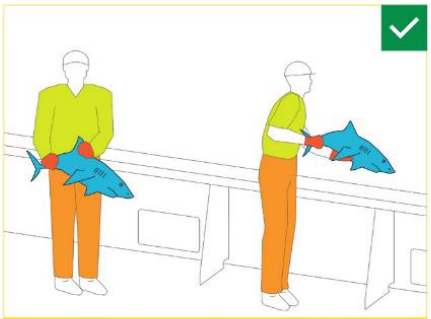


Figure 1. Small shark release by the fin and caudal peduncle.

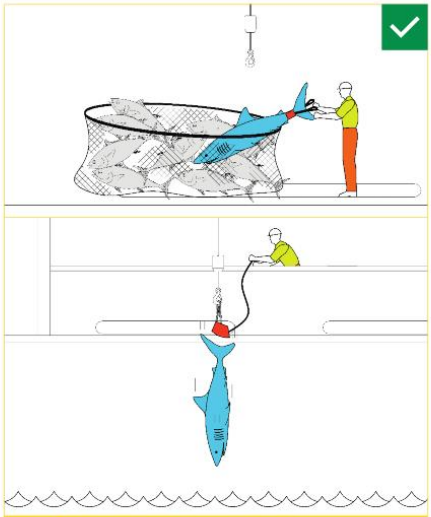


Figure 2. Release of shark with a padded velcro.

Sharks

Also, gaffs and nooses may not be employed **(Fig. 3 and 4)** to release sharks that appear on deck. f sharks are found inside the purse seine net, crew must attempt to get them out of the net using the brail employed to bring the catch on board, even if a certain amount of target fish (e.g., 2-3 tonnes) is lost.

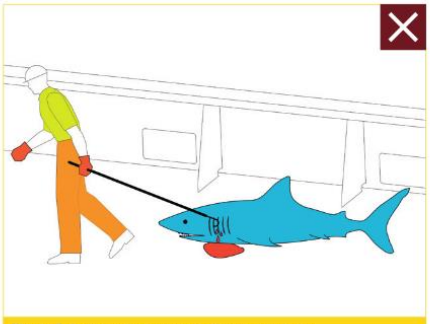


Figure 3. Bad practice using a gaff to move sharks.

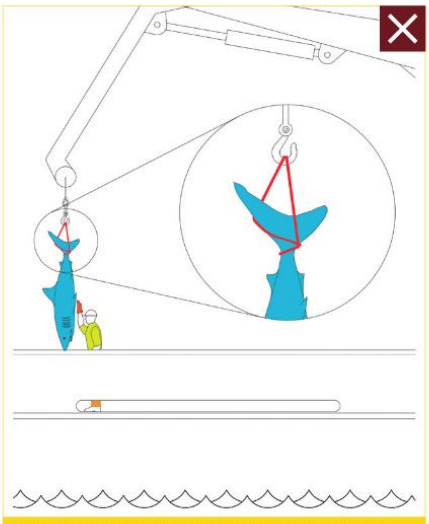


Figure 4. Bad practice using a rope with a noose to lift sharks.

Sharks

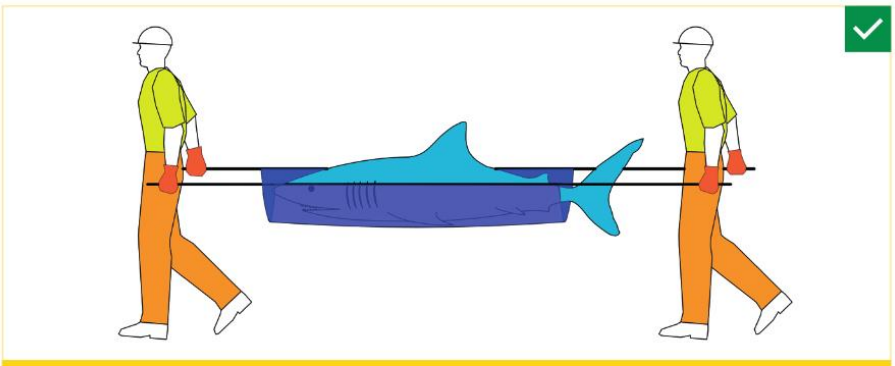


Figure 5. Release of shark with a stretcher bed.

Otherwise, use some cradle-like device, such as canvases or stretchers **(Fig. 5)** to avoid the possibility of injury. Likewise, if sharks cannot be released immediately from deck, it is recommended to keep the animals wet, in the shade and if possible, breathing freely, by introducing a water hose into the mouth for example. Vessels are **vessels should have a net carrier, a stretcher or a canvas on board and/or similar equipment** alongside the brail so sharks found on deck can be handled more easily when detected on deck.

Sharks

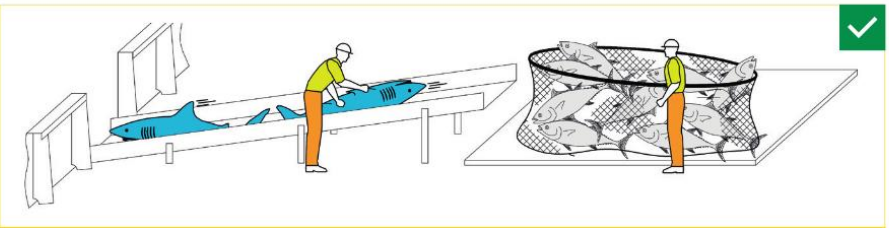


Figure 6. Ramp to release bycatch species.

The use of **selective devices on deck that facilitate releases and reduce direct contact with the crew, such as release ramps for sharks,** are recommended. (Fig. 6).

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Sharks

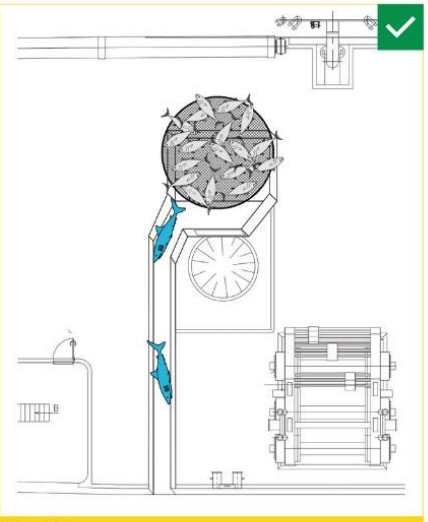


Figure 7a. Hopper with release ramp on the portside.

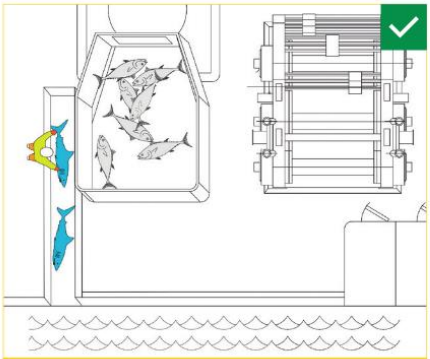


Figure 7b. Hopper with release ramp on the starboard.

Also, the **installation of hoppers (integrated, on portside, on starboard) with ramps is recommended in vessels with sufficient space on deck,** to maximize the fast and efficient release of sharks and other bycatch species from the upper deck, largely avoiding they end up in the lower deck (Fig. 7).

Sharks

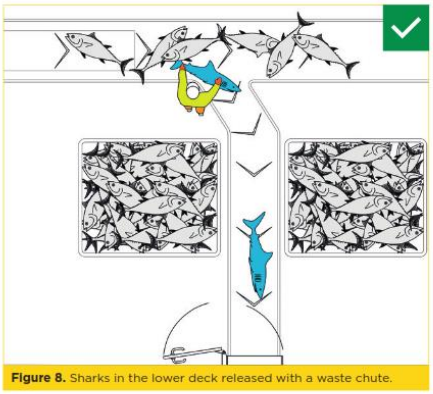


Figure 8. Sharks in the lower deck released with a waste chute.

Likewise, in vessels in which it is possible, **the installation of a waste chute is recommended** (Fig. 8) **in the lower deck,** where tuna is stored in well, to facilitate and expedite the best release of the animals that could not be released from the upper deck and accidentally fell into the lower deck, where the tuna is stored in the wells (Fig. 9).

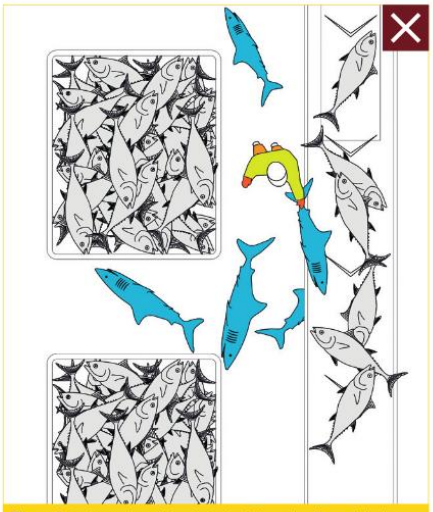


Figure 9. Bad practice of sharks being left on the floor of the lower deck in between the wells.

Sea turtles

Following the recommendations of the 4 RFMOs on sea turtles, despite the fact that interactions with sea turtles are unusual, crew must attempt by all means to release every turtle caught in FADs or in the purse seine net.

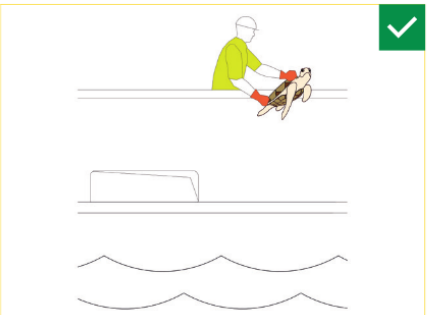


Figure 10. Release the sea turtle holding by the shell.

If a caught sea turtle is found in the net, the net hauling operation must be stopped immediately so that the animal does not accidentally go through the power-block. As soon as possible, the crew must release all turtles they find inside the net, trying to prevent any injury. If an animal is accidentally injured in any way during the operation, it must be kept on board in a wet, cool place, and it must completely recover before it is released. If the turtle is carrying any plastic items or bits of net on it, or if it has any longline hooks embedded, the foreign items must be removed and/or disentangled, even if these materials do not originate from the vessel. Likewise, **if crew find a trapped sea turtle when visiting a FAD, they must unravel the sea turtle and release it** using the same procedures. To handle a sea turtle, crew must hold the animal by the shell but avoiding just the head area, to protect from catching their hands if the sea turtle should retract its head in (Fig. 10).

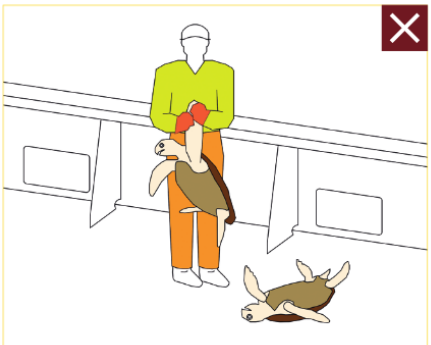
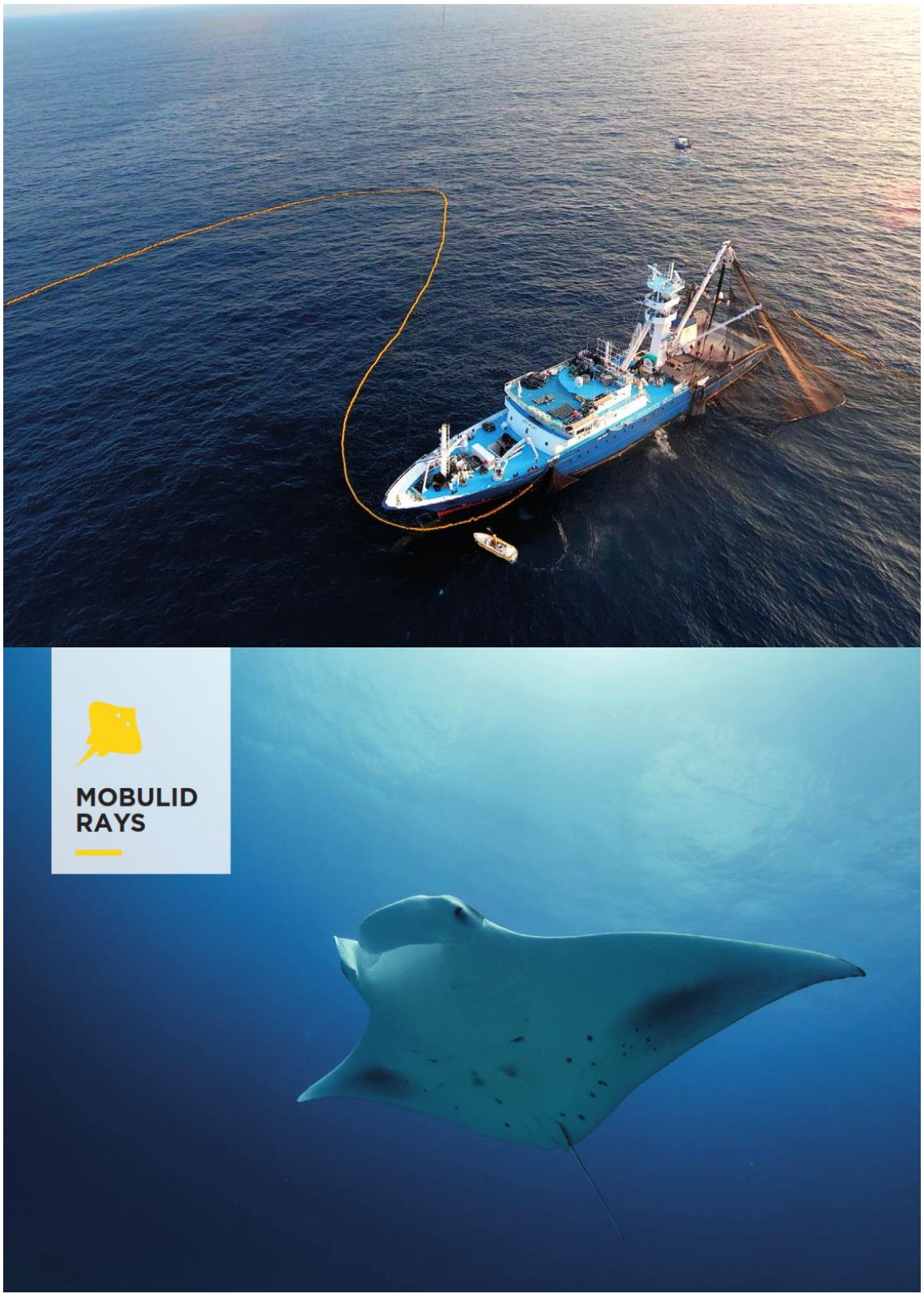


Figure 11. Bad practice lifting sea turtles by the flipper or resting them upside down.

It is important not to hold the animal by its flippers, because turtles' flippers are sensitive and could be dislocated (Fig. 11). If a sea turtle appears not to respond to stimuli or is inactive, it is recommended, if necessary, to place it in the resuscitation position to help it recover more easily. To place a turtle in the resuscitation position, crew must lift the animal by its rear legs about 15 cm, with its head pointing downwards, and place something beneath it to maintain the sea turtle in this position (e.g., tyre, coiled rope). The crew must wet the sea turtle from time to time and keep it out of direct sunlight. If these practices are followed the mortality of sea turtles in purse seine fisheries is practically null.


MOBULID
RAYS

Mobulid rays

Although very few skates and rays are involved in purse seine sets, very simple and safe protocols are in place for their release, in line with RFMO recommendations. This procedure is based on trying to get the animal out of the purse seine either using the brail employed to bring the catch on board, even if a certain amount of (2-3 tonnes) is lost or using some cradle-like device or specific equipment like canvases or sorting grids, to minimise any possible injury. If the animal is not detected or cannot be released before it is brought on board, it must be released from the deck. The use of gaffs, hooks, or ropes to lift the mobulid rays by the gills or wings is prohibited (Fig. 12).

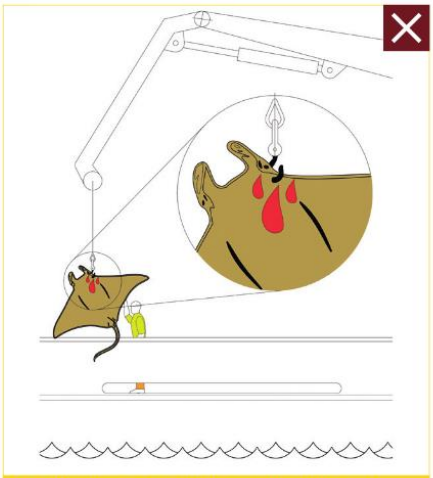


Figure 12. Bad practice of lifting the mobulid ray with a hook.

Mobulid rays

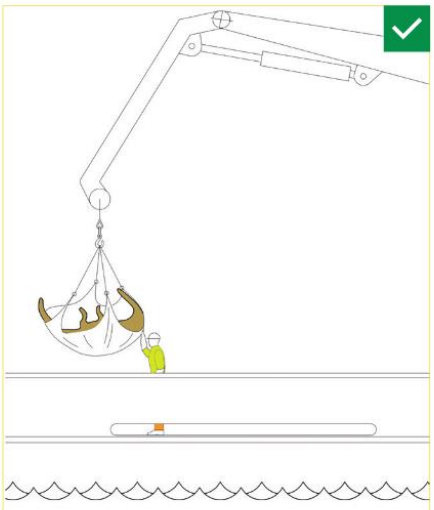


Figure 13. Mobulid ray lifted with a canvas for release.

It is **recommended to have onboard nets, tarps and/or similar equipment alongside the brail** (Fig. 13), for handling large mobulid rays more easily when they are found on deck, and to release them with the aid of the crane.

Mobulid rays

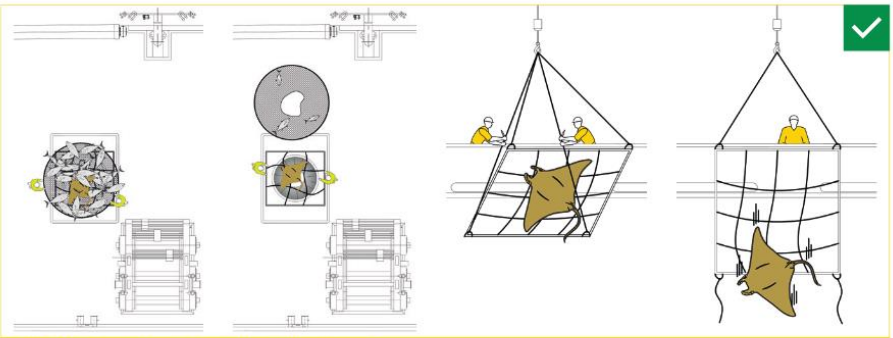


Figure 14. Sequence of mobulid ray release with sorting grid.

Also, new methods like sorting grids with wide spaces, which are placed over the unloading hatch or hopper and allow fish to be unloaded while the ray stays on top to be lifted for release with the crane, accelerating the process and preventing direct contact with fishers (Fig. 14). If on the other hand stakes or rays are released by hand, it is recommended that crew avoid handling the animal by its tail, gills, or the cephalic lobes, to prevent injury and dangerous reactions. It is particularly recommended that crew avoid handling the rear part of stingrays, as many have a poisonous spike at the end of their tail. It is therefore preferable to handle these animals form the front, holding them from the pectoral fins.

Whale sharks and large cetaceans

Some RFMOs have implemented measures prohibiting fishing practices that intentionally target setting on whale sharks *(Rhicodon typus)*. However, these animals may end up in the net unintentionally because they often swim well below the surface, making it difficult for fishers to detect them before setting the net. Although, the whale shark release manoeuvre is complex, crew must take all precautions to avoid injuring the animal. In the same way, cetacean bycatches are regulated by EU, some RFMOs and bilateral agreements for intentional sets on these species' groups. The interaction with cetaceans, principally baleen whales, is rare and non-intentional. Mainly, these rare interactions occur with large cetaceans (e.g., humpback whale; *Megaptera novaeangliae)* which generally escape the net before its closure or by breaking the net.

Whale sharks and large cetaceans

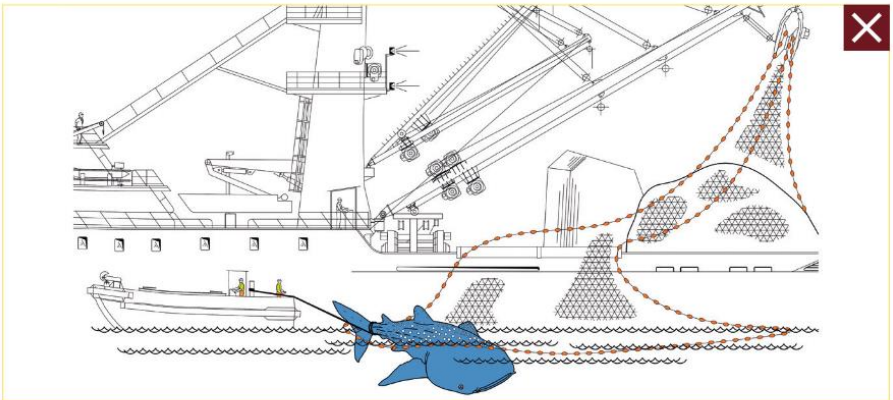


Figure 15. Bad practice of pulling whale shark by the tail.

Following recommendations established, with the objective of minimizing impacts on accidentally trapped individuals, and despite the inherent difficulty of the release manoeuvre, if a whale shark or a whale is found in the purse seine, the crew must take all actions to prevent damage to the animal. The crew should haul the net carefully to isolate the animal in a small area of the bunt. **The use of ropes to pull the animal by the tail to move it out of the net is prohibited** (Fig. 15).

Whale sharks and large cetaceans

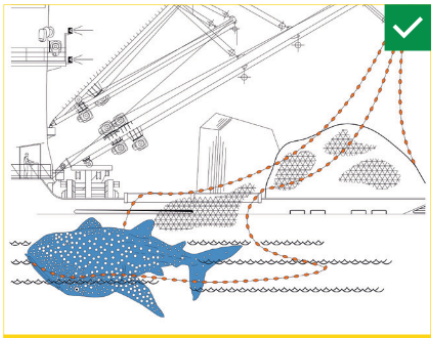


Figure 16. – Whale shark release lowering the purse seine corkline.

If a whale shark or a whale is found in the purse seine, the crew must take all actions to prevent damage to the animal. The crew should haul the net carefully to isolate the animal in a small area of the bunt. After this, crew may take the following measures, depending on the sea conditions and the animal's behaviour. At all times crew safety must be guaranteed.

When the animal is floating on the surface fishers must gradually haul the net to bring the animal towards the closest cork line. The net must always be pulled in a direction from the animal's tail toward its head, along its belly, attempting to make the fish move towards the cork line. If the animal is small (2 metres long or less), it may be released carefully using the brail. **If the animal is bigger, release over the corkline to facilitate the escape, by partially sinking the cork line** and wait for the animal to freely swim out of the net **(Fig. 16)**. The catch may be brought on board only after the animal has been released from the net.

General notes

Regardless of the circumstances occurred and the measures adopted for the release of these animals, the crew will verify that their behaviour is normal and will record the operation in the logbook.

It is recommended to collaborate in trials with new bycatch release devices designed to facilitate safer handling and increased vulnerable bycatch species survival, including tagging initiatives to assess survival after release.

The collaboration between fishers and scientists to co-develop more efficient measures to limit the mortality of vulnerable species will result in better solutions that will be approved by the fleet. It is important to highlight that fishers are the first ones interested in reducing interactions with species like sharks, sea turtles or mobulid rays. It is also critical that ship-owners invest resources into bycatch release devices to increase crew safety and survival of protected species in their purse seiners, to support sustainable fishing, which currently is in demand by consumers and markets.

Acknowledgements

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SUSTAINABLE DEVELOPMENT GOALS

14 LIFE BELOW WATER

Conserve and sustainably use the oceans, seas and marine resources is the responsibility of all of us.