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KNOWLEDGE AND RESEARCH GAPS TO THE IMPLEMENTATION OF BEST HANDLING AND RELEASE PRACTICES FOR VULNERABLE SPECIES

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CONTENTS

SUMMARY

Concerns about the incidental capture (i.e., bycatch) of vulnerable marine species, including marine mammals, seabirds, sea turtles, and elasmobranchs, have resulted in increased efforts to develop conservation and management measures. These measures often require that no retention takes place and that the best handling and release practices (BHRP) are employed to reduce the impacts of fishing on these populations. However, developing safe and effective BHRP guidelines is often a complex and iterative process that involves understanding fishery characteristics, handling and discard methods, and post-release survival rates.

The IATTC is working towards creating a living document of BHRP guidelines for vulnerable species captured by various fishing gears across the convention area. However, several data gaps need to be addressed before this goal can be achieved. To help prioritize research efforts, this document reviews existing literature to identify knowledge and data gaps that impede BHRP development. Additionally, the current vulnerable species Resolutions are reviewed to identify where BHRP guidelines can be implemented into the regulations and where additional research is required. The IATTC staff provides recommendations for the next steps in the development of a BHRP manual.

1. INTRODUCTION

Incidental catch of non-target species (i.e., bycatch) in tuna fisheries can be a significant source of mortality (Lewison et al 2004). Many bycatch species, which are not retained due to low market value and/or retention bans, are from taxa such as marine mammals, seabirds, sea turtles and elasmobranchs, with life history characteristics (i.e., slow growth, late ages at maturity, low breeding productivity, high juvenile mortality) that make populations vulnerable to exploitation and over-fishing (Hall et al., 2017; Hamilton and Baker 2019; Pacoureau et al., 2021). Therefore, anthropogenic activities that increase mortality levels such as fisheries bycatch, can have significant long-term population impacts (Gilman 2011; Lewison et al. 2004; Reeves et al. 2013). As a result, strategies to increase post-release survival become key for protecting vulnerable marine populations (Zollett and Swimmer 2019). One such strategy is the implementation of codes of conduct for releasing vulnerable species in a manner that reduces harm or 'best handling and release practices'. Because post release survival (PRS) rates have been shown to be significantly impacted by handling and discard methods utilized by fishers (e.g., Hutchinson et al. 2021, Swimmer et al. 2014) clear, safe and effective handling and release practice guidelines need to be developed for vulnerable bycatch species and implemented into commercial fishing operations.

Across fishery management organizations there are several conservation and management measures (CMM) in place that promote safe handling or which direct fishers to release animals as quickly as possible and with as little harm as possible. Most of the existing CMMs that require fishers to promptly release vulnerable species unharmed, merely allude to the use of best practices, or provide general common-sense recommendations and lack specific guidance that has been tested for efficacy and measurable impacts on survival. Thus, best handling and release practice (BHRP) guidelines still need to be developed and adopted for several species and fishing gears globally.

The development of best handling and release practices is often an iterative process. It requires *a priori* knowledge of: i) the fishery specific operational characteristics (e.g. vessel sizes and free board, gear composition, mitigation tool availability, handling practices used), ii) behavior and physiology of the bycatch species, iii) data that validates the efficacy of the practice (i.e. post release survival studies), and iv) the engagement of the fleet, and other stakeholders, to assist with the development and testing of practices that are feasible and practical, in other words, practices that can be implemented operationally.

Several CMMs across tRFMOs have called for fishers to use best practices without further guidance, or common-sense guidance was adopted but untested at the time of adoption, and many now require updating as data is revealing the methods may be ineffective or more effective practices have been identified. This review was initiated to elucidate areas where improvements to current BHRP guidance can be made under the existing state of knowledge and to identify the data and research gaps that need to be addressed for the development and subsequent implementation of BHRP guidelines for the vulnerable species captured in fishing gears operating in the Inter-American Tropical Tuna Commission (IATTC) convention area.

To develop BHRPs for the vulnerable species captured in IATTC fisheries (marine mammals, seabirds, sea turtles, sharks and rays), we first review the primary literature for evidence that points towards methods that do improve PRS rates for each of the major fishing gears in the IATTC convention (purse seine, longline, artisanal) (see section 2). We then review the current IATTC vulnerable species Resolutions and the methods adopted under the Agreement on the International Dolphin Conservation Program (AIDCP) to assess where the use of BHRPs is required and whether guidance is provided for each taxon and fishing gear (see section 3). We then assessed whether there is data that points to practices that will improve survivorship or new data has revealed that adopted BHRP guidelines may not be effective and/or require a revision, and these are highlighted for further review (Section 3). Additionally, IATTC staff provide recommendations for data collections that are required for the development and implementation of safe and effective BHRP guidelines (Table 3.)

2. POST RELEASE SURVIVAL (PRS) FOR VULNERABLE SPECIES

As concerns about bycatch in commercial fisheries for cetaceans, seabirds, sea turtles, and elasmobranchs (sharks and rays) continue to grow, fisheries managers have implemented a series of conservation strategies, including no retention measures. No retention measures may help discourage targeting and reduce mortality for some species, but the injuries sustained during the fishing interactions (e.g., hooking, entanglement, the handling and release process) can still lead to mortality and or have population-level effects post-release (Tolotti et al. 2015). Therefore, it is necessary to validate the efficacy of these measures with data that elucidates the post-release fate of discarded animals. Additionally, developing BHRP guidelines requires information on how handling and release methods impact PRS rates for all species and life stages that interact with fishing gears.

This section reviews the available literature to gather information on PRS rates of vulnerable species that interact with IATTC fishing gears and how handling and release methods may have impacted their fate. Vulnerable species, as defined in this document, are species or taxonomic groups that require special interest in preserving population integrity through the reduction of fishery-induced mortality due to their life history characteristics and distribution overlaps with tropical tuna fisheries under the purview of the IATTC. In this context, vulnerable species generally refer to the following taxa: marine mammals, seabirds, sea turtles, sharks and manta and devil rays.

2.1 Marine Mammals

Globally, fisheries bycatch poses a significant threat to many marine mammal species (Read et al. 2006, Baird 2019). However, there is limited data on PRS rates for most marine mammal species resulting from any fishery interaction (Carretta et al., 2014; Fader et al., 2021). In IATTC fisheries, cetaceans are captured in purse seine, longline and artisanal fishing gears (SAC-14-11). Purse seine capture involves both deliberate encirclement of some species of the Delphinidae family (spotted, spinner, and common dolphins: *Stenella attenuata, S. longirostris, and Delphinus delphis*) associated with tuna schools and unintentional interactions on dolphins and other cetaceans. However, the PRS rates for released species from both situations (deliberate encirclement and unintentional bycatch) remains uncertain (Forney et al., 2002; Hamilton and Baker 2019). Additionally, 'cryptic' impacts, including post-escape mortality and potential physiological perturbations from the chase and encirclement, may lead to mortality but are challenging to observe and quantify (Atkinson & Dierauf 2018; Forney et al., 2002; Wells et al., 2008). As such there is insufficient data for estimating the PRS rates of cetaceans released from purse seine interactions (Forney et al., 2002; Hamilton and Baker 2019).

Longline fishery interactions primarily involve toothed cetaceans depredating the bait and the catch (FAO 2020). PRS rates of animals hooked or entangled in pelagic longline gear are also not well understood and likely vary by species and gear configuration (Fader et al 2021; Wells et al. 2008). The fates of cetaceans released with attached gear, particularly in pelagic fisheries, are difficult to predict, but a study of common bottlenose dolphins near Sarasota, Florida, USA, revealed that dolphins with ingested gear or severe entanglements may swim away alive upon release but were likely to die later (Wells et al. 2008). As a precautionary approach, dolphins with ingested gear or severe constrictive entanglements should be considered mortalities (Wells et al. 2008). Cetacean interactions on pelagic longlines can be dangerous for the crew, making it difficult for fishers or observers to collect identifying information (e.g., dorsal fin photos for photo-identification) or deploy satellite-linked archival tags for fate determination. This reduces the opportunity to collect data on survival outcomes of released dolphins and whales (Carretta et al., 2014), which remains an important data gap as we aim to devise the BHRP guidelines for this taxon in hook and line fisheries.

For many smaller cetaceans, as well as other marine mammals such as pinnipeds, the majority of sub-regional (US) fishery interactions are reported from gillnets (Read et al. 2006). Considering the prevalence of gillnet vessels and known marine mammal bycatch rates, gillnets could pose the greatest threat as most marine mammals are unlikely to survive gillnet entanglement (Read et al. 2006; Wells et al. 2008). A study of small scale or artisanal fisheries in Peru found that 97% of gillnet entangled cetaceans were recovered dead (Mangel et al. 2010). One study of Narwhal captured in gillnets for scientific purposes, where interaction times were minimized, and BHARP were used, found that it took tagged animals nine hours to recover physiologically and resume normal behavior (Shuert et al. 2021). As PRS data are almost non-existent for marine mammals captured in gillnet fisheries, it is likely that in normal fishing operations where soak times are long and the animals may not be able to reach the surface to breathe, PRS probabilities would be quite low.

Where human-induced injuries of marine mammals are a concern, increased efforts to photo identify potentially injured animals in the field, and comparisons with subsequent stranding records or observations of living animals could improve our understanding of PRS rates and the identification of appropriate BHRP guidelines for different fisheries (Wells et al. 2008).

Based on the above, the following PRS data and research gaps have been identified for cetaceans (Table 3a):

- Survey all fleets for fishery characteristics (e.g., gear composition, soak times, target depth, bait type, etc), handling and release practice data
- Species specific interaction details including at vessel and release condition data
- PRS data for all species interacting with IATTC fisheries
- Increase efforts to photo identify potentially injured animals in the field and generate a database for regional stranding records and observations of living animals with evidence of fishery interactions.

2.2 Seabirds

Fourteen species of Albatross and four species of petrel are captured in IATTC fisheries (IATTC 2009). Albatrosses and petrels are among the most vulnerable seabird species to bycatch in fisheries (IATTC 2009; Phillips and Wood 2020; Zydelis et al., 2013). Globally, industrial longline and gillnetting result in the death of an estimated 160,000 and 400,000 seabirds respectively per year (Phillips and Wood 2020; Zydelis et al., 2013). While interactions in purse seine fisheries are not perceived to be an issue, and minimum estimates of seabird interactions and mortalities from observer data for industrial longline fisheries are now available for 2021 (SAC-14-11), the extent of seabird mortality in the artisanal fisheries remains unknown (Phillips and Wood 2020). In the EPO, observers from various programs reported minimal seabird bycatch in artisanal longline fisheries during 1,652 trips between 2004 and 2009 (IATTC Working Group on Bycatch, minutes of the 6th meeting). This may be due to certain characteristics of these fisheries that prevent seabird bycatch, such as side setting, setting at night, and vessels with low gunwales that facilitate quick bait submersion (IATTC 2009).

Published data on seabird bycatch shows that between 3% to 75% of seabirds hooked in longline fisheries are alive when hauled back and subsequently released. Crews often release live seabirds by cutting the line, leaving the hook embedded in the animal along with varying lengths and compositions of trailing gear. This trailing gear may have a variety of sublethal effects, but direct measurement of PRS rates has not been conducted (Wilson et al 2014). However, some data from several regions suggest that a portion of released animals do survive post-release (Table 2.a.). For example, observers using the NOAA BHRP guidelines in Hawaii-based longline fisheries targeting tuna and swordfish reported that 13% of banded albatross captured and released were later observed at nesting sites (NOAA Fisheries unpublished data). The Pacific Islands Regional Observer Program also reported that observers often see seabirds captured and released in good condition resuming normal foraging behavior shortly after release using the NOAA Seabird Handling Guidelines (NOAA Fisheries pers com), which involve removing the hook and allowing seabirds to recover on deck until their feathers have dried (ACAP 2021, NOAA 2022).

A long-term bird banding program from Bird Island, South Georgia found that most banded seabird bycatch were alive when brought to the vessel in pelagic and demersal longline fisheries, and that interactions were geographically widespread involving vessels from multiple flag states operating in the high seas and near the islands (Phillips and Wood, 2020). During the 26-year study at the bird colony, several large seabirds were observed foul hooked with longline gear. However, the study found that survival to nesting was significantly lower than expected, raising concerns about the population-level effects of seabirds released with trailing gear (Phillips and Wood, 2020). Similarly, a study using data from a seabird rehabilitation center in Portugal from 2008 to 2018 found that bycatch and entanglement in fishing gear accounted for 42.5% of all admissions, and only 38% of seabirds with evidence of fishery interactions survived to be re-released (Costa et al. 2021).

Generating post-release survival data for hooked and entangled seabirds is challenging, but there is sufficient evidence to suggest that at least a portion of seabirds released alive survive the interaction (Table 2a). If trailing gear is removed or minimized, population-level effects may be minimized as well.

Based on the above, the following PRS data and research gaps have been identified for seabirds (Table 3b):

- Survey all IATTC fleets for species specific interaction rates, at vessel and release condition data, handling and release practice data
- PRS data for all species interacting with IATTC fisheries
- Work with CPCs and NGOs to support bird banding and reporting of banded seabirds and seabirds with fishing gear

2.3 Sea Turtles

Several species of sea turtles including green (*Chelonia mydas*), olive ridley (*Lepidochelys coriacea*), hawksbill (*Eretmochelys imbricata*), leatherback (*Dermochyles coriacea*) and loggerhead (*Caretta caretta*) are frequently caught in IATTC purse seine, longline and artisanal fisheries (SAC-14-11). In IATTC purse seine most sea turtles are detected during encirclement and rescued as required by Resolution C-19-04. While some also become entangled in the net during retrieval they are almost always alive at the vessel and over 90% of the turtles released alive (SAC-14-11). There is no published data on the PRS rates of sea turtles released after interactions with purse seine gear. Sea turtles may also become entangled in the drifting fish aggregating devices utilized in this fishery. Over 99% of those sighted are reported to be released alive, there is also no published data on the PRS for those turtles.

Globally, the biggest threat to sea turtles is bycatch in industrial longline and artisanal fisheries (Swimmer & Gillman 2012). Yet species specific interaction rates, animal condition, and handling method data, which are necessary for assessing the post-release fate of discarded sea turtles, is not well documented in IATTC fisheries (Griffiths et al. 2022). Some PRS data does exist for sea turtles caught in hook and line fisheries (Table 2.b.). Two studies documented 100% survival when all fishing gear was removed, and the animals were handled by scientists (Mangel et al 2011; Swimmer et al. 2006). In several other studies hook position significantly affected mortality rates, with turtles hooked deeper in the gut experiencing higher mortality rates (34-65%) than those hooked in the upper esophagus or mouth (8-18%: Casale et al. 2008; Chaloupka et al. 2004; Sasso & Epperly 2007; Swimmer et al. 2014). In the Mediterranean, a study on loggerhead sea turtles estimated post-release mortality rates ranging from 0.308 to 0.365 within 90 days and was independent of hook location when hooks were left in place with 40 cm of trailing gear to mimic normal fishery conditions (Alvarez et al., 2013).

Data from stranding centers and necropsies suggest that the presence of trailing gear on the hook has the largest impact on PRS rates. While the highest probability of acute mortality is believed to occur when hooks puncture the stomach, lower esophagus, heart, or lung, lines left trailing are by far the most dangerous part of the gear either by entangling flippers which can lead to infection or amputation and more deleterious are the long-term impacts to survival when the line is ingested (Parga 2012). When fishing line is ingested, mortality occurs after several weeks to months due to various gastrointestinal tract problems. Ingested lines can cause intestinal plication, twisting, intussusception, and fecalomas (Alessandro & Antonelli 2010; Di Bello et al. 2013; Lima et al. 2022; Parga 2012; Swimmer & Gillman 2012). Injuries caused by pulling the line have also been observed, mostly when fishermen haul the animals on board without using a dipnet. This technique can embed the hook deeper and cause extensive lesions and even long tears at the point where it is lodged (Parga 2012). Thus, if vessels cannot safely bring the turtle onboard (either no dipnet or the vessel free board is too high to bring turtles up manually) fishers must ensure that the line is cut at the hook or as close to the mouth as possible and this is preferred over removing the hook (Barria et al. 2023; Parga 2012; Valerio et al. 2023).

Removing as much fishing gear from a hooked turtle without causing further damage is critical for improving survival probabilities post-release (Parga 2012). Fishers that handle and release turtles must receive training in BHRP from experienced researchers to reduce sea turtle mortality (Parga 2012, Swimmer & Gillman 2012). BHRP guidelines and training also need to be tailored to specific fleets, and decision trees on when to remove the hook and when to leave it in place and cut the line should be provided to fishers. In general, fishers should be educated on the minimum standards for BHRPs, which should include: (1) cutting the line as close as possible to the mouth if the hook is not removed, (2) always hauling turtles onboard with the aid of a dip-net, (3) taking care of the fragile structures in the mouth when attempting to remove a hook, (4) training of fishers to correctly use dehooking devices, and (5) not attempting to remove hooks unless they are visible (Parga 2012, Swimmer & Gillman 2012).

Based on the above, the following PRS data and research gaps have been identified for sea turtles (Table 3c):

- Gear composition, fishing strategy, handling and release practice data across sectors and regions
- Species specific interaction rates, at vessel and release condition data
- Safe handling tools onboard vessels
- PRS data for all species interacting with IATTC fisheries

2.4 Sharks (except whale shark)

PRS rates for several species of shark captured in both purse seine and longline fisheries targeting tropical tuna and billfish have been well documented. Table 2.c. summarizes the available data from studies that are relevant to IATTC fisheries, excluding studies from fishing methodologies not used in IATTC fisheries, or species that are not present in IATTC data, and studies that were not conducted in a commercial fishery setting.

In global purse seine fisheries, survival data exists for oceanic whitetip (*Carcharhinus longimanus*), silky (*C. falciformis*) and hammerhead (*Sphyrna spp.)* sharks (Table 2.c.). However, at-vessel mortality rates are very high in these fisheries due to the nature of the operation (Eddy et al. 2016). For animals that are still alive when they are brought onboard, the most significant factors influencing PRS rates are the landing stage, such as whether the shark is entangled in the purse seine net, is found in early or later brails, the vessel's use of bycatch release devices (BRDs) (e.g., hopper, ramps) to detect and release sharks from the working deck as opposed to the well decks and the handling and release methods used by the crew (Hutchinson et al. 2015; Onandia et al. 2021; Poisson et al. 2014). Across ocean basins, larger silky sharks that are entangled in the purse seine net have higher survival rates (68-80%: Hutchinson et al. 2015; Onandia et al. 2021; Poisson et al. 2014), highlighting the importance of good handling practices for returning these animals to the sea. Sharks landed via brailing have compromised survival rates, but those landed in the early brails have somewhat higher survival rates than those landed in later brails. Since most sharks are landed in the later brails, which have very low survival rates (~7%: Hutchinson et al. 2015), it is critical to focus on removing animals from the net before sacking up (Eddy et al. 2016; Hutchinson et al. 2015; Onandia et al. 2021; Poisson et al., 2014). Studies have shown that removing silky sharks from the net before sacking up and while they are still free-swimming can lead to 100% survival post-release (Hutchinson et al. 2015; Hutchinson et al. 2020; Sancristobal et al., 2016). Thus, experimentation on methods for removing sharks from the net prior to sacking up is necessary.

For longline fisheries, PRS rates are species-specific and depend on the at vessel condition of the animal at capture, the handling and release methods used, and the amount of trailing gear left on the shark (Bowlby et al. 2020; Francis et al. 2023; Hutchinson et al. 2021; Musyl & Gillman 2018). Some species are more resilient to capture related stress, and at-vessel mortality rates tend to reflect which species are more resilient than others (e.g., Mandelman and Skomal 2009; Musyl & Gillman 2018). A study on the PRS rates of the five most commonly captured shark species in longline fisheries targeting tuna, blue (*Prionace glauca*), bigeye thresher (*Alopias superciliosus*), oceanic whitetip, silky, and shortfin mako (*Isurus oxyrhincus)* sharks discarded in the Hawaii deep-set and American Samoa longline fisheries targeting tuna in the central Pacific Ocean (Table 2.d.) showed that fisher behavior can significantly impact pelagic shark post-release fate (Hutchinson et al., 2021). Where animals that were in good condition at the vessel and left in the water for gear removal (cutting the line as close as possible to the hook) had the highest survival rates. Another study on PRS rates of mako and silky sharks in south Pacific longline fisheries also noted the effects of capture condition and the amount of trailing gear left of discarded sharks (Francis et al., 2023). The study found that larger animals had higher PRS rates. In the IATTC convention area, two studies on PRS of silky sharks captured in Ecuadorian, Costa Rican and Mexican longline fisheries demonstrated high survival rates for sharks in good condition (Schaeffer et al. 2019 & 2021). In these studies fishers developed a safe method to bring sharks onboard for tagging and gear removal using a lasso, and most animals survived, even with the additional handling and air exposure on deck. While a study conducted in the Atlantic Ocean found that the post release mortality rates of porbeagle sharks (*Lamna nasus*) were reduced by nearly half when the animals were left in the water for tagging, as opposed to being brought on board. This study also demonstrated reductions in recovery times after tagging (Bowlby et al. 2020). Other tagging studies have suggested that leaving sharks in the water for gear removal could improve survival rates (Francis et al., 2023; Hutchinson et al. 2021).

In IATTC longline fisheries silky sharks are an important target and non-target species with various no-retention measures for juveniles regionally and sub-regionally. In the above studies most of the tagged silky sharks were juveniles or sub-adults (Francis et al., 2023; Musyl & Gillman 2018; Schaeffer et al., 2021). Further investigation is required to determine the effects of size on PRS rates for this and other species, and this information may also help determine whether it is safe to bring animals on board or if they should be left in water for gear removal. This will be an important investigation since most fishers in IATTC hook and line fisheries attempt to retrieve their hooks.

There is limited information available on at-vessel mortality and PRS rates in gillnet fisheries for sharks (Bach, 2019). In the few existing studies, PRS rates appear to be species-specific and depend on the soak time (see review by Ellis et al. 2016). Most studies of commercial gillnet catch composition show high at vessel mortality rates for elasmobranchs, with particularly high mortality rates for species from the family Sphyrnidae: 62% (Braccini et al., 2012) - 98.3% (Reid & Krogh, 1992). In scientific gillnet studies, soak times were shorter, and at-vessel mortality rates were correspondingly lower for Sphyrnidae: 30.8%-71.5% (Hueter et al., 2006; Manire et al., 2001; Thorpe and Frierson, 2009). At-vessel mortality rates will help us infer how effective a no-retention measure and concomitant BHRP guidelines may be for sharks captured in this fishery. Thus, data on interactions and condition are important for this fishery as well.

Based on the above, the following PRS data and research gaps have been identified for sharks (Table 3d):

- Gear and fleet characterization, species specific interaction rates with condition, handling and trailing gear data
- All studies show that condition on release is a good predictor of post release fate where injured animals have higher mortality rates. Data collections for release conditions for sharks for all fisheries should be expanded from alive or dead to include additional metrics
- Effects of BRDs on PRS rates in purse seine fisheries
- PRS data for silky, oceanic whitetip, all hammerhead species, and pelagic thresher sharks in the longline fleets are urgently needed to improve total mortality estimates from release condition data (released alive) reported to the IATTC. Studies should include how animals are released and if trailing gear is removed (i.e., was animal tagged in the water or on deck)
- PRS data across ontogeny for silky sharks

2.5 Whale Shark

Whale sharks (*Rhyncodon typus*) are occasionally captured in purse seine fisheries (~21 per year between 2013-2022 in IATTC class-6 observer data records. According to document BYC-08 INF-A, the rate of interactions is very low, averaging about 3 per 1000 sets, but quite variable (Observer data 2003-2016 year period). Additionally, they are captured both as individuals and in aggregations. Sets with more than one whale shark, which are typically unassociated sets, occur around inshore areas of the EPO during the first quarter of the year. While catches in longline fisheries never or rarely occur, and interaction rates in gillnet or other artisanal fisheries are unknown in IATTC fisheries. In purse seine fisheries most whale sharks are alive when brought to the side of the vessel during sack-up and the incidence of at-vessel mortality is also extremely low in other regions (~1.38%; Capietto et al 2014).

Currently, a few studies have assessed PRS rates for whale sharks released from tropical tuna purse seine fisheries in the Atlantic Ocean (see Table 2.c). The available PRS data (based on 13 tagged animals during 4 trips in the eastern Atlantic Ocean; Escalle et al., 2014 & 2018; Hutchinson et al., 2020) for large adults show that all animals survived the interaction, which indicates the efficacy of BHRP guidance available in other RFMOs (see Table 1., Appendix 1). Yet some questions remain regarding PRS rates in this region and how release methods and timing may impact survival for different size classes.

All the tagging to date has occurred on larger individuals that may be more resilient to confinement in the sack than smaller animals. Additionally, whale sharks can be released at different stages of the fish loading process-although in the IATTC class-6 purse seine fishery most whale sharks are released prior to brailing-so questions on how the amount of time, set size and confinement in the sack portion of the net may impact PRS still need to be addressed. PRS may also be affected by the orientation of the animals when they get to the side of the vessel in the sack. When animals are facing the stern, as opposed to facing the bow, it is more challenging to roll the net out from under them, and release is more time-consuming. In these situations, fishers often must tow the animals out of the net by the tail (Escalle et al., 2018), a practice that is banned in the IATTC (C-16-05), and survival rates need to be assessed for individuals released in this manner as well.

Therefore, the following data and research gaps have been identified for whale sharks (Table 3e):

- PRS data for adult and sub-adult whale sharks encircled in IATTC purse seine fisheries and released at different stages of the brailing operation
- Additional interaction data are required for the development of BHRPs including: a) When was the whale shark first observed (e.g. after encirclement prior to sacking up, during brailing [indicate brail number]), b) Which direction is the animal facing (bow or stern - if restrained in sack prior to release), c) When is animal released (prior to, during or after brailing), d) How is animal released, e) Condition of animal on release, f) Size of animal (estimated).

2.6 Manta and devil rays

Five species of manta and devil rays from the genus *Mobula* are known to overlap in distribution with IATTC fisheries (SAC-14-11). There are a few published PRS studies for mobulids caught in purse seine fisheries in the Pacific and Atlantic Oceans (Table 2.d.), and one study is currently being conducted in IATTC purse seine fisheries (Stewart et al 2020; Project M.2.c). Among these small datasets, PRS rates range from 17% to 92% and appear to be related to the size of the animal and handling times. Where larger animals that are more difficult to maneuver, require longer handling times and thus extended air exposure, have lower PRS rates (Stewart, pers. comm). However, more species-specific data are required to determine how factors such as set size, time spent in the sack, handling time and release method impact survival.

Mobulid interaction rates are relatively low in industrial longline fisheries, where they are often foul-hooked or entangled rather than hooked from taking baits, since most species are planktivorous (Griffiths & Lezama-Ochoa 2021; Mas et al., 2015). Yet a recent vulnerability assessment of the spinetail devil ray (*Mobula mobular*) to fishing mortality for the IATTC noted that the longline fishery contributed most to the cumulative fishing mortality in the EPO (Griffiths & Lezama-Ochoa, 2021). Currently, no empirical PRS data is known for mobulid rays discarded from longline fisheries (Fernando & Stewart, 2021; Mas et al., 2015). In these interactions, hooks and trailing gear are not usually removed, and injuries that may impact PRS rates during handling have been recorded (Mas et al. 2015, Tremblay-Boyer et al 2019). Thus, species-specific interaction rates, release conditions, and trailing gear, along with PRS studies, are necessary in industrial and small-scale longline fisheries (Fernando & Stewart, 2021; Mas et al., 2015).

In artisanal fisheries, where catch rates are often unreported there is increasing concern over the impact on the mobulid populations globally (Fernando & Stewart, 2021; Mas et al., 2015). Artisanal fleets fish closer to shore, where the probabilities of interactions with mobulids in hook and line gear increase over shallower water (Mas et al 2015). Additionally, some of the smaller mobulid species (e.g., Munk's pygmy devil ray, *M. munkiana*) are known to form large aggregations for feeding and reproduction in inshore areas, making interactions with the artisanal fleet of longline and gillnet gears particularly concerning (Fernando & Stewart, 2021). While there is currently no information on the post-release survival probability of mobulids captured in gillnets, it is likely lower than survival rates in purse seine and longline fisheries due to soak times (Fernando & Stewart 2021).

Based on the above, the following data and knowledge gaps were identified for manta and devil rays (Mobulids; Table 3f):

- Interaction data with gear configuration, at vessel condition, handling and release practices and release condition
- Conduct PRS studies using BRDs (e.g., Manta grid, hoppers with ramps) in the purse seine fisheries, especially mobula sorting grids to reduce handling time and air exposure. This could be possible with additional support for project M.2.c and M.1.b
- Test PRS and ability of PS crew to release mobula directly from brailer to the sea to avoid handling on deck and reduce air exposure.
- PRS studies in industrial and small-scale longline fisheries
- Because catches of these species are seasonal and often aggregated, future tagging experiments should be conducted with the goal of understanding habitat use and movement patterns for predictive spatial management potential.

3. ASSESSMENT OF BHRP GUIDANCE IN THE CURRENT IATTC VULNERABLE SPECIES RESOLUTIONS

This document aims to provide guidance towards the development of BHRP guidelines for all vulnerable species caught in IATTC fisheries. The first step towards this goal is to assess existing data and identify knowledge, data and research gaps to the development of BHRPs (section 2, Table 2 and Table 3) and compare it to the status of the current and relevant measures adopted by the IATTC Members and the AIDCP Parties (Table 1, Table 4).

In this section, we evaluate the current IATTC and AIDCP Resolutions for vulnerable species by taxa in order to: a) identify which Resolutions require CPCs to encourage the live release of vulnerable species in a manner that minimize harm, or using best practices and where such language is missing; b) identify which Resolutions contain specific BHRP guidance and those that do not; c) assess the efficacy of the guidance provided; and, d) highlight the areas where the current measures can be improved if new or updated information exists that has been shown to improve PRS rates (Table 1 & Table 4). In some cases, specific guidance can be borrowed or adopted from other regions to strengthen the current IATTC Resolutions in the absence of regional data and are noted below.

A summary of the IATTC Resolutions for vulnerable species and the AIDCP agreements for cetaceans, as well as the measures that are currently in place in other tuna Regional Fishery Management Organizations (tRFMOs) is provided in Table 1. The table identifies which measures call for fishers to release vulnerable bycatch species unharmed, those that also provide guidance on what the recommended BHRPs are, and finally identifies which Resolutions still require BHRP guidance. It is important to note that there is a difference between stating that fishers should or shall release vulnerable species in a manner that minimizes harm and the adoption of specific BHRP guidelines with data validating that those practices are effective at reducing mortality post release, while also ensuring the safety of the crew. As BHRP guidance is developed crew welfare must be integral in the recommendations.

3.1 Marine mammals

Regarding marine mammals in the purse seine fisheries, two different situations must be addressed separately, since the first cannot be considered as bycatch *stricto sensu*, although it shares many similarities with all those described in the present document.

a. The case of the tuna fisheries associated with dolphins:

In the EPO, yellowfin tuna frequently associates with marine mammals, particularly spotted, spinner, and common dolphins (AIDCP-45-01 Rev; Scott et al., 2012). For many years, purse seine vessels have been taking advantage of this association to locate and catch tuna through setting upon herds of dolphins. This resulted in a significant amount of dolphin mortality until the early 90s when a growing awareness of the need to adopt measures to drastically reduce this mortality resulted in management actions. First, in 1992, a voluntary framework called the La Jolla Agreement was adopted, which in turn led to the negotiation of a treaty in 1998 which would serve as a basis for the adoption of binding measures, the [Agreement on the International Dolphin Conservation Program] (AIDCP). The provisions of the AIDCP, its annexes, and the measures adopted by its Parties pursuant to the AIDCP set forth strict equipment and operational requirements, Dolphin Mortality Limits (DMLs), and training requirements for vessel captains authorized to fish on dolphin schools. In addition, the AIDCP Parties, through the International Review Panel and other specialized bodies, monitor the implementation and performance of qualified captains and the vessels and crew relative to the measures and procedures adopted with the objective of eliminating dolphin mortality and serious injury in the purse seine fishery (Documents: [IRP-30-09]/AIDCP-07 2002).

The main technique utilized to release dolphins from encirclement by purse-seine nets is the "back-down" maneuver and the corresponding *dolphin safety panel* in the net, as described by Coe et al. (1984) and Hall and Roman (2013), and which allows for an area of the cork line to be submerged and facilitates the release of the encircled dolphins. In addition, as required in the above stated Annex VIII, speedboats with towing bridles and a raft inside the net are also used to help keep the net properly spaced and facilitate manual rescue, if necessary.

The methods enshrined in the AIDCP have been extremely successful, reducing the observed mortality of dolphins by more than 99% (Ballance et al. 2021). Some scientists have hypothesized that the backdown maneuver itself may result in stress to the dolphins and decrease their overall welfare and fitness, either individually or collectively (Dolman & Moore 2017). However, field reports and practical observation of dolphin behavior during the backdown suggest that some dolphins have become familiar with the fishing process and the background maneuver and do not exhibit panicked behavior. Additional research may be warranted to clarify this issue.

As observed above, this is not a situation of bycatch *stricto sensu*, as referred to at the start of this document. In addition, this matter is dealt with through a specific treaty other than the Antigua Convention, the AIDCP, by the Parties to the Agreement. But, as stipulated by the AIDCP and by the Antigua Convention, the IATTC provides the Secretariat of the Agreement and therefore this is part of the programmed activities of its staff, particularly when new research is needed: a current example of such research is the study currently underway to assess potential disruptions to calf-cow pairings during the chase and after release ([SAC-14 INF-K]).

In addition, without trespassing upon the AIDCP and the competence of its Parties, consideration of this issue by the Ecosystem and Bycatch Working Group along similar ones, with the participation of a broad range of stakeholders, can contribute to provide elements susceptible to enrich the discussion, to the benefit finally of the AIDCP itself and its implementation, in particular through the possible development and adoption of better handling practices, among others.

b. Marine mammal bycatch

Smaller purse-seine vessels, which are prohibited under the AIDCP from fishing for tuna in association with dolphins, do not carry the same gear (e.g., dolphins safety panel) and the operational requirements established in the AIDCP and its annexes do not apply. When smaller purse-seine vessels interact with members of the Delphinidae family, they must release them alive, but the requirements are less stringent and specific than those elaborated for vessels authorized to fish for tuna in association with dolphins, in view of the difference in the operation and the relative rarity of these occurrences.

Additionally, intentional and unintentional sets on large cetaceans is uncommon in IATTC purse seine fisheries. When they are encircled they typically break through the net, or the net is cut to release them. Here, a similar question than the one raised above regarding the potential effects of such an encirclement on the affected marine mammals: for now, it may only be stressed that reducing interaction times and releasing them early during the operation is important.

Globally, the largest impacts on marine mammal populations are due to longline and gillnet fisheries (Fader et al., 2021; Lewison et al., 2014; Read et al., 2006; Reeves et al., 2013). In the IATTC convention area the AIDCP guidance applies only to purse-seine fisheries and the current IATTC Resolutions lack BHRP guidance for incidental marine mammals captured in longline and gillnet fisheries, creating significant room for improvement. In the absence of PRS data validating the efficacy of BHRP methods in these fisheries, guidelines that are in use in other regions could be explored and marine mammal welfare organizations can be consulted to strengthen the IATTC's Resolutions for incidental capture of marine mammals in regional longline and gillnet fisheries. A best practice standard for the safe and humane handling and release of small cetaceans bycaught in any fishing gear is to decrease the risk of further injury or stress (Hamer & Minton 2020). Releasing small marine mammals in the water will typically pose less risk of further stress or injury than lifting them out of the water (Hamer & Minton 2020). Data suggests that hooks left embedded and trailing gear often lead to mortality in some cetacean species (Reeves et al. 2013). Therefore, encouraging fishers to remove as much trailing gear as possible without injuring the animal further is crucial for hook and line fisheries. In gillnet fisheries, disentangling live animals as quickly as possible without further injury to the animal may be the only option for improved survival. Given that soak times are long, and most mortalities occur shortly after entanglement (if the animal can't reach the surface to breathe), research into mitigation options is paramount.

Based on the above, the following regulatory, knowledge and research gaps were identified (Table 3a):

Research

- Assessment of PRS rates after escape or release from all IATTC fishing gears
- Review of BHRPs from other regions for application to IATTC fisheries other than purse seine fisheries
- Test cork line weighting for release of both small and large cetaceans encircled in purse seine fisheries (e.g., ACCOBAMS 2018)
- Techniques to facilitate early release of larger marine mammals encircled in purse seines.

Recommendations to improve existing measures

- Develop BHRP guidelines for cetaceans captured in the longline and artisanal fisheries. In the absence of PRS data, we can use the guidelines available in other regions (e.g. UNEP/CMS for small cetaceans, USA, see Appendix 1 for a list of existing BHRP guidelines by taxon).

3.2 Seabirds

The Agreement on the Conservation of Albatrosses and Petrels (ACAP, 2004) has identified fishery interactions as a key threat to seabirds and has recommended collaborations with RFMOs to minimize these interactions. IATTC Resolution C-11-02 'Resolution to Mitigate the Impact on Seabirds of Fishing For

Species Covered By The IATTC' calls for CPCs to develop BHRPs in Paragraph [9], which encourages the adoption of measures to ensure that seabirds captured alive during longline fishing operations are released alive and in the best condition possible. The International Plan of Action on Seabirds, which calls for states to release live seabirds also emphasizes that reasonable efforts should be made to ensure that birds brought onboard alive and that hooks are removed without jeopardizing their lives.

Seabird bycatch and entanglement in IATTC purse seine fisheries are infrequent and not considered an issue. While it is a significant problem in both industrial and small-scale longlines in other regions, in the absence of sufficient data the precautionary approach should be taken in the IATTC. Since seabirds are often alive when they are brought to the vessel in longline fisheries, adopting specific guidelines for the safe handling and release of incidental seabirds is essential to slow population declines. Several agencies and other RFMOs, in accordance with ACAP, have developed and adopted measures to ensure seabirds are handled safely. Across these agencies, the guidance consistently emphasizes the need to remove as much of the gear as possible.

Since there is a lack of PRS data and information on how fishers handle and release seabirds captured in IATTC fisheries, a minimum set of standards for BHRP guidelines should include guidance on removing the hook, tools required, and release methods (see Annex 1 for example text, Appendix 1 for a list of BHRP guidelines). Since some data has shown that removing the hook and as much trailing gear as possible reduces the risk of entanglement and likely improves survival outcomes, fishers should make all efforts possible to safely remove fishing gear from bycaught seabirds. Hooked seabirds should be brought on deck using a dipnet if the vessel is too high to reach them manually. If a net is not available, the line should be cut at the hook or as close to it as possible using a long-handled line cutter. Because seabirds can't fly if their feathers are wet, revival and resuscitation guidance should also be included. Following resuscitation, animals can be released after their feathers are dry, they are energetic, they can hold their head erect, and they stand with their wings in a normal folded position (ACAP, 2019; Elliott and Gillman 2002). Release guidance should require vessels to stop the engines, ensure the animal is safely lowered back onto the water, and not thrown into the wind. Illustrated guides and text examples are available in Appendix 1.

Based on the above, the following regulatory, knowledge, data and research gaps have been identified for seabirds:

Recommendations to improve existing measures

- Adopt BHRP guidelines and resuscitation recommendations for seabirds captured in longline fisheries. Hook removal and resuscitation recommendations are available from ACAP or other RFMOs. Example text, adapted from ACAP, USA, NZ guidelines, is provided in Annex 2.
- Ensure Resolutions contain requirements for training of fishers in best handling practices (e.g., Res C-04-07).
- Ensure all vessels carry the required tools for the safe release of seabirds as is required in the sea turtle Resolutions (C-19-04 [2.a., 3.a.])

3.3 Sea Turtles

In addition to the normative and institutional framework established by the 1996 Inter-American Convention for the Protection and Conservation of Sea Turtles ("IAC"), the United Nations Food and Agriculture Organization (FAO) has adopted the Guidelines to Reduce Sea Turtle Mortality in Fishing Operations (2009) and recommended their implementation by regional fisheries bodies and management organizations. The IATTC has three Resolutions, namely C-04-05, C-04-07 and C-19-04, that aim to reduce sea turtle mortality, including BHRP guidelines. Resolution C-04-05 Rev2 [paragraphs 4 and 8] requires CPCs to ensure that longline and purse seine fishers release sea turtles safely and carry the tools necessary for safe release. It also requires IATTC staff to compile safe handling recommendations and make those available to CPCs along with education and information dissemination for fishers. Resolution C-04-07 [C] calls for industry education in treating sea turtles properly to improve their survivability. Resolution C-19-04 requires all purse seine and longline vessels to utilize best practices and prioritize safe release [paragraphs 1.a., 2.b-c, 3.b.], carry safe handling tools [paragraphs 2.a., 3.a.], and ensure fishers are trained in best handling measures [paragraph 1.b.] (Table 1). Appendix 1 of this measure contains the adopted handling and safe release guidelines for both purse seine and longline fisheries. It requires fishers to allow comatose sea turtles to recover on deck prior to release and provides instructions for resuscitation in accordance with the FAO (2009) guidance. Implementing and enforcing these measures could help improve survival outcomes for discarded sea turtles, based on the best available information on sea turtle post-release fate (Table 2).

These guidelines lack validation for efficacy with PRS data for all species captured in the distinct tuna fisheries across the IATTC convention area, and research for the individual fleets is necessary. An ongoing study of the gear characteristics of the longline fleets in Costa Rica and Panama has found that guidance for BHRPs of sea turtles in these fisheries is nuanced and depends on vessel size, fishing strategy, fisher behavior, hook size, shape and material and the tools onboard (Valerio et al. 2023, Barria et al. 2023). The branchline is the most dangerous part of the gear, particularly when the lines are left long and with the hook still attached to the sea turtle, which together predicts the highest probability of mortality. Therefore, it is imperative that fishers have training on BHRPs that are relevant to their fishing strategy and are carrying the tools necessary to cut the line at the hook or as close to the mouth as possible. Although Resolutions C-04-05 Rev2 and C-19-04 require CPCs to ensure that longline and purse seine fishers release sea turtles safely, carry the tools necessary for safe release and are trained in BHRPs, training and vessel inspections are not usually reported to the secretariat so the degree to which these Resolutions are enacted remains unknown.

In gillnet fisheries, the fate of sea turtles is predicated on the amount of time the animal is entangled and whether it can reach the surface to breathe. Therefore, the best handling and release practices for animals landed alive is to return them to the sea as rapidly as possible and allow the animal time to recover onboard via the recommended resuscitation techniques if they are alive but comatose.

The bones and joints of sea turtles are relatively fragile so they must be carried by the carapace and not the flippers (Parga and Andraka pers com). Due to this fragility, there are concerns regarding injury to the animals when released from large longline and purse seine vessels where freeboards are greater than 2 meters from the water line. To reduce any trauma to the animals that may occur from hitting the water at great heights, sea turtles should be lowered into the water using a canvas sling or a long-handled dip-net.

Based on the above, the following regulatory, knowledge, data and research gaps have been identified for sea turtles:

Recommendations to improve existing measures

- Develop procedures for the safe return to the sea from large vessels with free-board heights > 2 m from the water line, to lower the animals to the water with a canvas sling to prevent injuries upon discard (e.g., broken bones, concussions) (C-19-04 [Appendix 1.c.])
- Ensure CPCs report on their progress towards the requirements for training of fishers in best handling practices (e.g., Res C-04-05, Res C-04-07).

- Ensure CPCs report on their progress towards requiring all vessels carry the tools for the safe release of sea turtles (C-19-04 [2.a., 3.a.])

3.4 Sharks

As concerns about declining shark populations due to overfishing continue to grow, the IATTC has adopted several conservation measures aimed at reducing mortality, including no retention requirements and calls for the safe release and development of techniques to release non-retained animals unharmed (Table 1).

The Consolidated Resolution on Bycatch C-04-05_Rev2 [paragraph 2] requires fishermen on purse-seine vessels to release non-target species unharmed, including sharks, to the extent practicable. Under paragraph [3.b.] of this measure, fishermen are encouraged to develop and use techniques and equipment to facilitate the rapid and safe release of such animals, whether there is a no retention requirement or animals are released alive.

Resolution C-05-03 [paragraph 7] encourages CPCs to release live sharks, especially juveniles, that are caught incidentally. Resolution C-16-04 on the management of sharks contains an amendment to Resolution C-05-03 that mandates CPCs to conduct research to improve handling practices for live sharks to maximize PRS in cooperation with the IATTC scientific staff.

Resolution C-16-05 requires CPCs to ensure that purse seine vessels use the recommended BHRP. Paragraph [3] of the Resolution stipulates that, 'purse-seine vessels should follow safe release requirements for all sharks, except those retained aboard the vessel. Any shark, whether alive or dead, caught in the Convention Area and not retained must be promptly released unharmed, to the extent practicable, as soon as it is seen in the net or on the deck, without compromising the safety of the fishing crew. If a shark is alive when caught and not retained, it must be released using the following procedures, or equally effective means':

a. Sharks must be released out of the net by directly releasing them from the brailer into the ocean. Sharks that cannot be released without compromising the safety of persons or the sharks before being landed on deck must be returned to the water as soon as possible, either utilizing a ramp from the deck connecting to an opening on the side of the vessel, or through escape hatches. If ramps or escape hatches are not available, the sharks must be lowered with a sling or cargo net, using a crane or similar equipment, if available.

b. The use of gaffs, hooks, or similar instruments is prohibited for handling sharks. No shark may be lifted by the head, tail, gill slits, or spiracles, or by using bind wire against or inserted through the body, and no holes may be punched through the bodies of sharks (*e.g.*, to pass a cable through for lifting the shark).

Data has shown that survival rates for sharks caught in purse seine fisheries are low, but BHRP for the small proportion of sharks that are landed alive is important. Landing stage is also influential on PRS rates, and Project M.2.b is currently underway in the IATTC to assess how the use of BRDs, specifically the use of a hopper or sorting tray with a ramp to facilitate quick release may improve survivorship and reduce on deck handling times (see also Murua et al. 2023). Resolution C-16-05 [paragraph 3.a.] requires fishers to release animals directly from the brailer or using BRDs (hopper and ramp). We suggest that CPCs report on their efforts to utilize methods mentioned above as required in the measure.

Additional species-specific measures have been adopted for oceanic whitetip (Resolution C-11-10), whale sharks (C-19-06 discussed in the next section), and silky sharks (C-21-06). For instance, Resolution C-11-10 pertains to oceanic whitetip sharks and includes a retention ban for all IATTC fisheries, as well as calls for fishers to promptly release sharks unharmed. PRS data from both PS and LL fisheries in other regions suggest that following BHRP guidelines for this species can result in high PRS rates (Bach et al., 2021, Hutchinson et al., 2021). Thus, this measure could be further strengthened with the addition of specific BHRP guidelines for both fishing methods.

Resolution C-21-06 focuses on conservation measures for shark species, with special emphasis on silky sharks. It contains a retention prohibition for purse seine fisheries, as well as retention prohibitions for silky shark bycatch in non-shark target longline fisheries after 20% of the total catch by weight has been reached [paragraph 3]. Additionally, the Resolution [paragraph 4] includes a limit on the catch of silky sharks smaller than 100 cm (total length) to 20% of the total number of silky sharks caught during the trip in multi-species fisheries using surface longlines. Paragraph 14.b calls for research on the mitigation of bycatch of sharks, especially in longline fisheries, and survival of sharks caught by all types of gears, giving priority to gears with significant catches and survival experiments that include studies of the effects of shorter sets and the use of circle hooks. Paragraph 14.c requires improved handling practices for live sharks to maximize PRS.

Various studies have shown that fishers' handling and release methods significantly impact shark post-release fate (Table 2c). Because at-vessel and subsequent discard mortality rates are very high for silky (and hammerhead) sharks captured in purse seine fisheries, due to the nature of the fishing operation (Eddy et al., 2016; Hutchinson et al., 2015), a retention ban in this fishery may not be as effective as in longline fisheries. Instead, a requirement to remove sharks from the net prior to sacking up in purse seine fisheries would more effectively reduce mortality in this fishery. For the small proportion of sharks brought on board alive, all efforts must be made to safely release them, including the use of BRDs, Velcro, and stretchers. PRS studies are necessary to validate these efforts across vessel and shark size classes.

In longline fisheries, the use of BHRP guidelines identified in the PRS literature (from Table 2.c.) can result in high PRS rates for silky sharks that are alive and in good condition at the vessel. The recommended guidelines include leaving sharks in the water and cutting the line at the hook, leaving less than 0.5 meters of trailing gear attached to the animal (Francis et al., 2023; Hutchinson et al., 2021). Since many fishers prefer to retain their hooks, it is important to work with them directly to devise strategies for safe handling and release during hook removal. For example, a handling method developed by fishers using a rope noose to lift silky sharks aboard longline vessels (as opposed to gaffing them or electrocuting them) followed by removal of hooks and minimizing the amount of trailing gear resulted in high PRS rates (Schaefer et al., 2019 & 2021).

Based on the above, the following regulatory, knowledge, data and research gaps have been identified for sharks:

Research

- Facilitate the development of BRD and early release strategies in all purse seine vessel size classes and ensure that PRS experiments are incorporated
- Add handling and release methods to data recorded by observers to document progress towards the BHRPs outlined in Resolution C-16-05 [3.a.]
- Conduct PRS experiments for FAL of all size classes and fishing gears for impacts of Resolution C-21-06 on mortality mitigation
- Optimization of safe gear removal techniques with fishers using different gear configurations
- Research on the effects of soak times and circle hook sizes on survival rates will require *a priori* data on gear characteristics, fishing strategy and the number of bite-offs by hook type per set (branchlines that come back without a hook).

Recommendations to improve existing measures

- Require CPCs to report on how many sharks were successfully released using the techniques described in Resolution C-16-05 [3.a.].
- Add BHRP guidelines for all sharks and specifically for species with no retention measures (i.e., silky sharks and oceanic whitetip sharks) in Resolutions C-21-06 and C-11-10
- Guidelines that are imperative to **preventing** injuries such as bans on rolling sharks and other discarded species through the power block in purse seine fisheries, or electrocuting, or gaffing any animals that will be discarded should be incorporated into the current Resolutions.

3.5 Whale Shark

Whale sharks are sometimes found in association with tuna schools and are occasionally encircled by purse seines in the IATTC. The intentional setting on whale sharks has been prohibited in the IATTC since July 2014 (Resolution C-13-04) due to concerns about the impacts of the purse seine fisheries. The active Resolution for whale sharks, C-19-06, requires CPCs to prohibit their vessels from setting on schools associated with live whale sharks and to take all reasonable steps to ensure their safe release, including a prohibition on towing them out of the net [paragraph 3.c.].

Most whale sharks are released alive (~93% between 2003-2016) in IATTC class-6 purse seine interactions (Roman et al., 2018) and in other regions with high interactions (Capietto et al., 2014), suggesting they are relatively robust to capture in net fisheries. However, BHRP guidance is not provided in the IATTC measures, and because there is some data showing that PRS is high (Table 2c; Escalle et al., 2018; Hutchinson et al., 2020; Stewart et al., 2021) when fishers follow the best practices as outlined by Poisson et al. (2014b), it is reasonable to adopt similar guidance for IATTC fisheries in the absence of additional data on the various factors that may impact PRS of whale sharks during purse seine interactions. The current whale shark resolutions could also be enhanced with additional guidance to prioritize the release of bycaught whale sharks prior to loading catch and ensuring that small whale sharks are not brought onboard the vessel.

Interaction rates in longline fisheries are not perceived to be an issue for this species (Rice et al 2018). However, interactions with small-scale fisheries may have significant impacts on both adult and juvenile life stages, including ship strikes and entanglement in gillnets (Speed et al. 2008, Prebble et al. 2018). Thus, BHRP guidelines should also be generated for artisanal fleets.

Based on the above, the following regulatory, knowledge, data and research gaps have been identified for whale sharks:

Research

- Generate handling data including when (i.e., prior to brailing, during, after) and how vessels release whale sharks by size and orientation, time to release for each situation and release condition
- PRS data for the scenarios identified in the data acquisition study above
- Interaction and PRS data for artisanal fisheries.

Recommendations to improve existing measures

- Ensure the safe release of whale sharks is prioritized over the loading of fish and ensure that small whale sharks are not brought onboard the vessel
- Develop BHRP guidelines for artisanal fisheries (e.g. Razzaque et al., 2020)

3.6 Mobulid Rays

Resolution C-15-04 aims to conserve mobulid rays caught in association with fisheries in the IATTC convention area. It includes a retention ban, a requirement to promptly release rays unharmed, and provides a list of banned practices to avoid harm in purse seine fisheries. In purse seine fisheries, mobulid rays are typically brought onboard using the brailer. Because of their large size (e.g., > 4m disc width and weighing > 1000 kg) and body shape, manipulating larger animals to use the adopted best practices for purse seine fisheries (from Poisson et al., 2014b), such as maneuvering them out of the brailer and onto a cargo net by hand for 'quick release', is difficult and can take several minutes (2- 14 min; Hutchinson pers obs., Murua et al., 2022). The existing PRS datasets (Table 2.d.) show that survival rates for animals released using best practices are species (or possibly size) specific, depend on how long they were confined in the sack and/or exposed to air on deck, and are generally relatively low (Francis et al., 2018; Hutchinson et al., 2020; Stewart et al. 2021; Table 2d). This highlights the need for iterative development of BHRPs as current guidelines for purse seine fisheries may be insufficient to significantly reduce mortality.

Researchers in the Atlantic Ocean have found that using a sorting grid positioned over the unloading hatch when a mobula is spotted in the brail can reduce the time on deck and in air to just over a minute, without direct handling by the crew and leaving the brail free to continue operations (Murua et al., 2022). Future experimentation on this sorting grid in IATTC purse seine fisheries should be explored and include tagging to assess the efficacy of the device in improving PRS rates. A survey of IATTC purse seine fishers noted that mobulids are often observed in the tuna schools prior to encirclement by helicopter pilots and spotters and can be seen at the surface after encirclement prior to sacking up (Waldo et al., 2023). If this information is required to be communicated to the crew, they can be prepared with BRDs such as the sorting grid before brailing (Murua et al. 2023). Another method that could be tested is the practicality of releasing mobulids directly from the brail as is recommended for sharks in Resolution C-16-05, which could potentially reduce handling times on deck and improve PRS rates for larger individuals and species.

The retention ban in Resolution C-15-04 also applies to industrial longline fisheries in the IATTC convention area, with an exclusion for developing CPCs' small-scale[1] and artisanal fisheries exclusively for domestic consumption. In longline fisheries, most mobulids are alive when brought to the vessel but are often injured due to handling practices (Mas et al., 2015). Observer data from WCPFC longline fisheries also show that most individuals are alive at the vessel and subsequently discarded in a weakened condition. Specifically, conditions at release are most often reduced from "alive" and "alive healthy" to "alive injured", "alive but dying" or "dead" (Tremblay-Boyer & Brouwer, 2016). This indicates that the handling and discard practices utilized by fishers are inflicting injuries that compromise mobulid PRS potential and that BHRP guidelines specific to each fishing gear and strategy are required.

While Resolution C-15-04 calls for prompt release of mobulid rays in a manner that will result in the least possible harm to them, Griffiths and Lezama-Ochoa (2021) found that mortality in longline sectors is having the largest impact on some species of the genus Mobula and that improving PRS rates can reduce the status of these populations from 'Most Vulnerable' to 'Least Vulnerable'. Developing BHRP guidelines specific to each fishing sector and ensuring their use is therefore crucial to improving PRS and reducing the impacts of fishing on these populations.

Based on the above, the following regulatory, knowledge, data and research gaps have been identified for mobulid rays:

Research:

[1] Less than 1.99 net tonnage, as defined by the 1969 International Convention on Tonnage Measurement of Ships

- Species specific interaction and handling information is required for all fleets.
- Encourage CPCs to explore methods that reduce handling times for larger animals and explore different BRDs for practicality and improved handling times for different vessel configurations.
- As the requirement in Res C 15-04 [paragraph 4] contains reporting requirements for the status upon release (alive or dead), and PRS survival data is showing high rates of delayed mortality for animals released alive, PRS studies across fishing sectors are required for each species.
- Work with fishers to develop a decision tree for hook removal (i.e., leaving hooks when they are embedded near the eye or in the cephalofoil)

Gaps in Resolutions

- Resolution C 15-04 could be modernized for the Conservation of Mobulas as new survival data is indicating low survival probabilities for larger mobulid species using techniques outlined in Annex 1.
- Resolution C-15-04 could be modernized to include guidance for LL fisheries adopted from other regions (e.g., leave the animals in the water and cut the line as close to the hook as possible, disentangle and or remove as much fishing gear as possible).

4. DISCUSSION, PLANNED ACTIVITIES AND RECOMMENDATIONS

Reducing the impacts of tuna fisheries on non-target and vulnerable populations is not only a mandate of the Antigua Convention but also essential for maintaining biodiversity and the integrity of ocean ecosystems. While mitigating interactions is crucial for achieving this goal, it is equally important to equip fishers with the tools necessary that can reduce harm through clear and effective BHRP of discarded species to improve their chance of survival post-capture. This review aims to create a living compendium of available information on BHRPs, their impacts on PRS rates, and to identify the data and regulatory gaps that may be preventing the adoption of effective and safe BHRP guidelines for vulnerable species in IATTC fisheries. This review will inform research prioritization to address important knowledge gaps and experimentation of technologies and strategies that can improve PRS rates for the vulnerable species captured in the various fisheries throughout the IATTC convention area.

4.1 Fishery characteristics

Developing BHRPs requires a comprehensive understanding of various fisheries operational characteristics, such as vessel sizes and designs, freeboard, gear configurations and materials, fishing strategies, handling techniques, and tools available for safe release. However, one of the biggest data challenges encountered in this review was the lack of complete information on the fishery characteristics and vulnerable species interactions, condition, and handling data for certain fishing methods, such as class 1-5 purse seine vessels, industrial longline, small-scale longline, and artisanal fisheries (as shown in Table 3). Unfortunately, many of the IATTC fisheries are frequently unmonitored, and important fishing effort and operational data is often missing. This widespread challenge creates an obstacle to developing meaningful BHRP guidelines and other conservation efforts for vulnerable species, which needs to be addressed. Table 3 in this document presents the data gaps identified through this review by species and fishing method to help facilitate the prioritization of research endeavors and improved data acquisition.

Considering that BHRP guidance for vulnerable species are dependent on gear configurations, fishing strategies, tool availability and fisher practices, the following activities for the IATTC staff have been identified, which would facilitate the development of BHRPs:

1. Through the ongoing data improvement workshops, among others, expand data collection regarding operational fishery characteristics for all the fisheries under the IATTC, and in particular for class 1-5 purse seines, longline vessels, and gillnet vessels.
2. Review existing IATTC data collection processes to improve and ensure the collection of information on handling and release methods used, trailing gear and the condition of the animal at different stages of the fishing operation, for vulnerable species across IATTC fisheries.

4.2 Post Release Survival

To ensure the effectiveness and safety of BHRP guidelines for vulnerable species, it is crucial to have comprehensive data on PRS rates for every prioritized species captured by different gear types. This review has identified some common themes in PRS rates for vulnerable species captured in major industrial fisheries such as purse seine and longline, which can inform where PRS and BHRP research should be focused.

In purse seine fisheries, most vulnerable species, excluding marine mammals, sea turtles and whale sharks, are usually brought onboard via the brailing operation or after becoming entangled in the net. Animals brought onboard via brailing are often dead or in poor condition with low probabilities of survival due to the injuries that occur during confinement in the sack (Table 2). Therefore, mortality mitigation and BHRP efforts for this fishery should focus on avoiding encirclement and releasing animals directly from the net while they are still free swimming, and the use of BRDs for the animals that are brought aboard the vessel.

In hook and line fisheries, time on the line, condition at the vessel, hook location (i.e., external, in mouth, ingested), species (physiology predicts resilience for some taxa), and handling and release methods are the factors that have the largest impact on PRS rates for vulnerable species.

PRS data can also illustrate where no retention measures may effectively reduce mortality and where they may not, thereby informing conservation strategies. For example, PRS rates for silky sharks captured in purse seine gear, where no retention measures have been implemented, are relatively low. Therefore, these measures may not be effectively reducing mortality and slowing population declines as intended. On the other hand, silky shark PRS rates from longline fisheries where BHRPs are utilized are demonstrably high (Table 2.c.) suggesting this may be where efforts to reduce fishery impacts should be focused through regulations such as no retention.

The development of effective BHRP guidelines requires data on PRS rates per species, size, and fishery. Each section in the document and Table 2 illustrates where the data gaps remain for PRS of the species that are captured in the IATTC convention area. Since the list is extensive, prioritizing research efforts in collaboration with CPCs, industry and NGOs to fill these data gaps is desirable. Therefore, the following activity has been identified to be planned and carried out by the IATTC staff:

Prioritize and conduct, in collaboration with relevant stakeholders, research on PRS by species across life-history stages, fishery and handling or release methods to identify BHRPs.

Obtaining PRS data be challenging, as it often requires the use of expensive satellite linked or other telemetry technologies for marine species and conducting telemetry studies in fishery settings can be logistically difficult. Because meta-analyses that use data from several studies with small sample sizes have proven informative in understanding the impact of handling methods on survivorship (e.g., Ellis et al., 2017; Musyl et al. 2019). Therefore, the IATTC staff recommends the development of a shared regional data repository for tag data, similar to those established by the Ocean Tracking Network (https://oceantrackingnetwork.org/what-we-do/) and Animal Telemetry Network (https://ioos.noaa.gov/project/atn/).

A regional telemetry database could reduce redundancy and assist with effective allocation of resources towards filling data gaps that are preventing the implementation of meaningful conservation measures. This could also improve the capacities of CPCs for study design and funding agencies' abilities to identify proposals that can generate information for the following regional research priorities, as identified by the IATTC staff.

1. Develop a regional database for telemetry data with fisheries survival implications for vulnerable species to enhance mortality estimation and the identification of BHRP.
2. Generating PRS for some vulnerable species is challenging, particularly marine mammals and seabirds. Therefore, alternative technologies for identifying fate of the individuals interacting with IATTC fisheries (e.g., photo-identification of marine mammals, seabird banding network) should be explored, along with the development of a regional network for reports on strandings and injured animals with evidence of fishing interactions.

4.3 Review Resolutions

PRS studies have demonstrated that mandatory release requirements for vulnerable species must be accompanied by mandatory BHRP guidelines. For example, most of the available information indicates that trailing fishing gear can eventually cause mortality for animals released in good condition if it is not removed prior to release. Therefore, adding recommendations or requirements to remove trailing gear in hook and line fisheries for all vulnerable taxa could significantly reduce the impacts of fishing on vulnerable populations.

This review analyzed the current Resolutions for vulnerable species to assess whether release requirements had associated guidelines for fishers to release animals in a way that reduces harm or using best practices. In Section 3, Resolutions that did not have requirements to use best practices were flagged for review. Additionally, Resolutions that lacked identified best practice methods or required updating were also highlighted for review and updating. Therefore, the IATTC staff plans to carry out the following activity:

A thorough review of current Resolutions to identify where updates are needed to ensure vulnerable species are handled and released using the most up to date BHRPs.

Several IATTC Resolutions call for CPCs to encourage their fishers to release vulnerable species in a manner that minimizes harm. Therefore, the staff recommends:

Unless or until official BHRPs are adopted, methods that prevent injuries should be implemented as a minimum, such as banning the rolling of sharks and other discarded species through the power block in purse seine fisheries and leaving as little trailing gear on discarded species as possible in longline fisheries.

4.4 Collaboration, Engagement and Successful Implementation of BHRPs

To develop BHRP guidelines for all vulnerable species interacting with the diverse fisheries under the purview of the IATTC, it is crucial to obtain input and guidance from fishers, vulnerable species biologists and experts in regional fishery characteristics. Studies have shown that fishers are usually willing to alter their handling techniques and behavior if they are provided with practical suggestions that are safe, simple, and efficient (e.g., Iwane et al., 2021; Murua et al. 2023; Poisson et al. 2014b). The adoption of procedures where fishers were integral in their evolution is often implemented into practice more efficiently, as fishers feel a sense of stewardship over the method and its success (Murua et al., 2022 & 2023).

There are several common themes to the successful development and implementation of bycatch mortality reduction measures, as seen throughout the literature: i) long-standing collaborations among the fishing industry, scientists, and resource managers; ii) mandatory guidelines; iii) consistent outreach, education, and training; iv) pre and post-implementation monitoring; and v) compliance via enforcement and incentives (Cox et al., 2007; Murua et al., 2023; Swimmer & Gillman 2012).

Based on the above, the IATTC staff recognizes the need to:

Ensure continuous engagement and collaboration with CPCs, fishing industry personnel, and other relevant stakeholders during the development of BHRP for IATTC fisheries.

The IATTC staff believes that it is desirable that CPCs, fishing companies and other relevant stakeholders work together to compile existing BHRP guidelines and training materials across vulnerable taxa and fisheries as a starting point for the development of efficient, regional BHRP guidelines. In this regard, the IATTC staff recommends that:

1. CPCs and other relevant stakeholders support the IATTC staff in a survey to gather details on national efforts or programs that can help elucidate post-release survival rates in fisheries and the identification of BHRPs for vulnerable species.
2. A small *ad-hoc* group of experts be established to begin drafting BHRPs for vulnerable species captured in IATTC fisheries.

4.5 BHRP Development Framework and Minimum Set of Standards

As we develop BHRP guidelines for IATTC vulnerable species, it is important to ensure that they are clear, concise, and include specific practices that can easily and safely be implemented into current fishing practices. They should also include practices that must be avoided and the tools required for safe release.

The BHRP guidelines adopted by the IATTC should set a minimum set of standards for CPCs to formulate appropriate measures for their specific vessel configurations.

To provide a framework of minimum standards for BHRP guidelines for vulnerable species, the IATTC staff suggest the following:

I. General recommendations;

II. Specific (high-level) safe handling practice guidance for purse seine, longline (large and small scale) and gillnet fisheries;

III. Practices that should be avoided;

    i. Tools required for safe handling and release by fishery and vessel configuration, including a clause that requires CPCs to develop more specific BHRP guidelines with consideration of the effect of vessel configuration that encourages individualized training of crews;

IV. Ensure that guidelines are legally binding with requirements for regular training, monitoring and enforcement; and

V. Produce dissemination material, including illustrations and videos to accompany the adopted guidelines and provide them to CPCs and fishing companies, requesting that they are posted in the galley or wherever crew members can view them.

Several IATTC Resolutions (Res. C-04-05 Rev 2,Res. C-04- 07 [C], C-19-04) call for training of fishers on best handling and release practices by CPCs. Resolution C-04-05 Rev 2 [8.b.] requires CPCs to: *'educate fishermen through information dissemination activities, including distributing informational materials and organizing seminars on, inter alia, reducing bycatches of sea turtles and safe handling of incidentally caught sea turtles to improve their survivability.*

Therefore, the IATTC staff believes that the adoption of a framework and minimum set of standards for BHRP as outlined above is desirable and should ensure that BHRP are harmonized with regional efforts, feasible, and enforceable across all CPCs, as appropriate. Specific vessel configurations must also be considered to encourage individualized training of crews. These operational requirements would be the subject of regular training, monitoring, and enforcement. Additionally, BHRPs must also be accompanied by training materials to provide clear instructions for the crews, including illustrations and videos of the adopted requirements.

Based on the above, the IATTC staff recommends that:

A framework and minimum set of standards for BHRPs be adopted and implemented, including the tools required to be carried on board for their implementation.

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TABLE 1. Active Conservation and Management Measures for Vulnerable Species with No Retention and or Best Handling and Release Practice Recommendations.

IATTC and AIDCP requirements and resolutions				Conservation and Management Measures in other tRFMOs		
Species	**Active Resolutions Requiring 'best practices'**	**Are BHRP Guidelines provided?**	**Relevant Content**	**WCPFC (CMM)**	**IOTC**	**ICCAT**
Consolidated Resolution on Bycatch	C-04-05 (Rev 2)	Yes, for Sea turtles in PS and LL	2, 3a,3b, 4a, 4di, 4diii,4dv, 4e, 4f, 7a,7b,8			
Marine Mammals	AIDCP Annexes II, III, IV, VII, and VIII	Yes, for small cetaceans in class-6 PS vessels	Annex II: Establishes the mandatory observer coverage with a participation of at least 50% of observers managed by the IATTC staff. Observer's duties include reporting compliance. Annex III: establishes cap of mortality limits per stock Annex IV: establishes individual vessel dolphin mortality limits (DML) and its management. Annex VII: Definition and function of the International Review Panel, a group that, under the guidance and advise of the IATTC staff, reviews compliance with operational requirements. Annex VIII: Operational requirements for vessels fishing tunas associated to dolphins or when dolphins are accidentally captured in the tuna PS fishery	CMM 2011-03; Large & small cetaceans; PS & LL; suppl CMM 2011-03-01/-02	Resolution 13/04	
Seabirds	C-11-02	No	9. 'CPCs are encouraged to adopt measures aimed at ensuring that seabirds captured alive during longline	CMM 2018-03; LL; suppl_CMM 2018-03	Resolution 12/06	Seabird mitigation measure doesn't call for BHARP

			fishing operations are released alive and in the best condition possible, and that, whenever possible, hooks are removed without jeopardizing the life of the seabird.'			
Mitigate impact of fishing on sea turtles	C-04-07	No	C. 2. 'Convening meetings for fishermen' CPCs and the IATTC should continue and expand organization of seminars for fishermen to enable them to treat incidentally caught sea turtles properly to improve their survivability.			
Sea Turtles	C-19-04	Yes	Requires all PS & LL vessels to utilize best practices and prioritize safe release [1.a., 2.b-c, 3.b.], carry safe handling tools [2.a., 3.a.], ensure fishers are trained in best handling measures [1.b.] Appendix 1 contains handling and safe release guidelines for PS and LL, and resuscitation techniques	CMM 2018-04; LL & PS; suppl CMM 2018-04-01/-02	Resolution 12/04	Recommendation 2010-09 (points to FAO 2009 Guidelines), Recommendation 2013-11 (Addendum to 2010-09 with specific guidelines)
Management of Sharks	C-16-05	Yes (PS)	CPCs shall require PS vessels to release sharks (except retained sharks) promptly and unharmed as soon as it is seen on deck or in the net [3]. Sharks must be released out of the net by directly releasing them from the brailer to the ocean. Sharks landed on deck must be released as soon as possible using a ramp or escape hatch. If unavailable sharks must be lowered using a sling or cargo net using a crane [3.a.] The use of gaffs, hooks or similar are prohibited, no holes may be punched through the body or bind wires for lifting and no shark may be carried by the head, tail, gill slits or spiracles [3.b.]. No RHN may be towed out of the purse seine net [3.c.]			Recommendation 2007-06-Take measures to reduce fishing mortality to Porbeagle and North Atlantic SMA. Recommendations 2019-07 NA BSH & 2019-08 SA BSH (calls for PRS data, imposes catch limits, no BHARP). Recommendation 2021-09 Min standards for safe release provided for NA SMA

Sharks	C-05-04	No	CPCs shall encourage the release of live sharks, especially juveniles, to the extent practicable, that are caught incidentally and are not used for food and/or subsistence [7]	CMM 2022-04; PS & LL; suppl_CMM 2022-04-02	Resolution 17/05	Recommendation 2004-10-Encourage live release of non-target sharks. Recommendations: 2015-06 Porbeagle, & 2010-08 Hammerhead, 'release unharmed'
	C-16-04	No	Amendment to C-05-04 adds content to Paragraph 8 and calls for improved handling practices [8.d.]			
Silky Shark	C-21-06	No	Conduct survival experiments. Improve handling practices for live sharks to maximize PRS. [14.b & c.]	CMM 2022-04 PS & LL; suppl CMM 2022-04-02		Recommendation 2011-08
Whale Shark	C-19-06	No	Prohibition on deliberate encirclement [1], requirements for all CPCs to ensure reasonable steps are taken to ensure safe release [2.a.], reporting status of animal and release methods used [2.b.].	CMM 2022-04 PS; suppl_CMM 22-04-01	Resolution 13/05 [6]	None
Oceanic Whitetip	C-11-10	No	No retention [1], CPCs require vessels to release all alive OCS in a manner that minimizes harm [2]	CMM 2022-04 PS & LL; suppl_CMM 2022-04-02	Resolution 13/06	Recommendation 10-07 (no retention but no BHRP requirements)
Thresher Shark	None			None	Resolution 12/09	Recommendation 09/07
Conservation of Mobulid Rays	C-15-04	Yes Annex 1 (specific to PS)	No retention [1], CPCs require vessels to release all alive mobula [2], Release in a manner that minimizes harm [3]	CMM 2019-05; PS & LL; suppl_CMM2019-05	Resolution 19/03	None

TABLE 2. Relevant post release survival data for vulnerable species captured in purse seine, longline or artisanal fisheries targeting tuna and billfish. There is no PRS

Table 2.a. Seabirds

Fishery	Region	Flag	Species	Sample size	Best Practices Used	Survival	Citation	Notes
Demersal LL Pelagic LL	South Atlantic	Regional	Wandering Albatross	NA	NA	Survival for foul hooked ALB as observed in a bird colony, was 40% of the expected for the population that did not have fishing gear.	Phillips & Wood 2020	Foul-hooking indices at colonies can reflect relative risk for different species over time and be a useful adjunct to vessel-based monitoring of live-capture rates. Taking into account age and status when reported, and annual survival probabilities, subsequent survival of live-caught and released wandering albatrosses was around 40% of that expected for the wider population.
LL	Atlantic Ocean	Portugal	Mixed	201	NA	38% Survived to release from a seabird rehabilitation center	Costa et al. 2021	201 seabirds admitted to a seabird rehabilitation center with entanglements, 187 were alive and 14 were dead. From the alive admissions 43% of the seabirds were released into the wild, while 57% did not survive the rehabilitation process-entanglement material “fishing line” had the lowest release rate with 38% and “other marine debris” had a higher release rate 53%
Pelagic LL	Central Pacific Ocean	USA	ALB	55	Yes	13% of banded birds were later observed at seabird colonies	NOAA Fisheries Unpublished Data	13 of 55 banded seabirds released in longline fisheries were later seen at nesting beaches

Table 2.b. Sea turtles								
Fishery	**Region**	**Flag**	**Species**	**Sample size**	**Best Practices used?**	**Mortality rate**	**Citation**	**Notes**
LL	ETP	Costa Rica	LKV	9	Yes	0	Swimmer et al. 2006	14 animals were tagged (5 of these were free swimming for comparison and one of these was a mortality. None of the LL captured turtles died).
			TUG	1		0		
LL	WCPO	USA	TTL	40	Yes	34% Deeply hooked, 8% shallow hooked	Chaloupka et al. 2004	Significant difference between shallow hook and deep hook survival function within 90 d of release, but no difference between survival functions after this time
LL	NW Atlantic	USA	TTL	10	Yes, all gear removed	10%	Sasso & Epperly 2007	9 of 10 lightly hooked turtles survived to 60 days
LL	Mediter ranean	NA	TTL	409	NA	65% deeply hooked	Casale et al 2008	Sea Turtle Rescue Centre of WWF Italy by tourists and local authorities who found them stranded along the coast or floating at sea (64) and by fishermen who found them caught in drifting longlines (341) or other fishing gear (5)
						18% shallow hooked		
LL	EPO	Peru	TTL	14	Yes	0%	Mangel et al. 2011	The turtles were captured by collaborating fishers during the final set of each fishing and brought to port for transmitter attachment. turtles were released within 24 h of their original capture. All loggerhead turtles used in the study were active at time of capture (not moribund or comatose) and fishers were given detailed instructions on how to safely handle and maintain the turtles aboard. All visible fishing hooks and entangling line were removed from the turtles before release
LL	WCPO	USA	TTL	29	Yes	28%	Swimmer et al. 2013	Tag data – used days at liberty, anatomical hooking location, and gear removal were evaluated with inferences about the extent of injuries and rates of infection to estimate an overall post-release mortality rate of 28% (95% bootstrap CI: 16–52%).
LL	Mediter ranean	Spain	TTL	26	No	31-37%	Alvarez et al 2013	The hooks were not removed, and 40 cm of line from the mouth was left in place, mortality rates were independent of hook location. Mortality measured to 90 days

Species 3 Alpha FAO codes: LKV = Olive Ridley (Lepidochelys olivacea), TTL = loggerhead (Caretta caretta), TUG = Green (Chelonia mydas)

Table 2.c. Sharks (including whale shark)

Fishery	Region	Flag	Species	Sample size	Best practices/BRD?	Post-release mortality rate	Citation	Notes Key Conclusions
PS	IO	FRN	FAL	221 sharks, 48 sets, 3 trips, 31 tags	IOTC weren't adopted at the time of the study, Hopper was used	81% Total mortality [Sharks that were entangled in the net = 18% mortality, sharks that were landed via brailing = 85% mortality]	Poisson et al. 2014	This study used satellite tags to assess survival rates in sharks that were entangled and sharks that were brought on board via the brail. Mortality was significantly higher for sharks that were removed from the lower decks than those that were removed from the hopper. It also showed high post release survival for entangled animals and emphasized the importance of best handling practices.
PS	WCPO	US	FAL	295 sharks, 31 sets, 1 trip, 26 tags, 87 blood chemistry	WCPFC guidelines weren't adopted at time of study, but this vessel did handle sharks inline with current guidelines, Hopper was used	84% Total mortality. [Sharks entangled in net = 31.6% mortality, Sharks from the top of the sack in first few brails (1-3) = 83.3 % mortality, Sharks brought on board from later brails or bottom of sack = 93.3% mortality]	Hutchinson et al. 2015	This study used both blood chemistry and satellite tags to validate fate for mortality prediction by condition and landing stage. Study found that the largest proportion of sharks are landed in the last brails (75%). Study also showed no relationship between set size (tonnage) and shark mortality rates. Indicating sharks die once they've been confined in the sack. To reduce mortality avoidance or removing them from the net while they are still free swimming will be most effective.
PS	ETP	ECU	FAL	53 sharks, 2 trips, 13 tags	No hopper was used. Most shark bycatch was sorted on the lower deck and then brought to the upper deck for release.	91.5% Total mortality (62% post release mortality)	Eddy et al. 2016	This study used satellite tags and release condition indices to estimate total mortality for two species, silky shark (FAL) and scalloped hammerhead shark (SPL). Showed animals released in better condition when entangled. Mortality was higher for sharks that were sorted from lower deck. Found lower at vessel mortality when set sizes were smaller.
			SPL	6 sharks, 2 trips, 3 tags		75% Total mortality (100% post release mortality)		
PS	IO	EU	FAL	278 sharks, 41 sets, 1	Yes, Hopper was used	57% Total mortality [Sharks entangled in net while hauling =	Onandia et al. 2021	This study used survival tags, blood lactate and condition indices to predict survival rates by operation stage. This study did not tag

				trip, 28 tags, 45 blood samples		20% mortality, Sharks brought on board from the top of the sack in first 3 brails (1st brail =43%, 2nd brail =63%, 3rd brail =75% mortality, later brails = 56%)]		animals brought on board in later brails. Survival was set to 15 days.
PS	IO	EU	OCS	15 tags, several vessels	U	7% PRM (1 mortality, 1 tag did not report)	Bach et al. 2021	Tagged animals in ‘alive’, ‘alive good’ & ‘alive injured’ conditions. No data on landing stage and BRDs in report.
PS	EAO	FRN	RHN	11 sharks, 3 trips	Yes, 1 towed by tail	0%	Escalle et al. 2018	Of 11 tags, 7 individuals survived at least 21 days after release,3 tags detached after 3 - 7 days and the fate of these individuals remains unknown, one tag failed to report.
PS	EAO	Curacao (Spain)	RHN	2 sharks, 1 trip	Yes	0%	Hutchinson et al. 2020	2 sharks tagged, sharks released using best practices.

Table 2.c. Sharks (cont.)								
Fishery	**Region**	**Flag**	**Species**	**Sample size**	**Best practices or BRDs?**	**Post-release mortality rate (Simple proportion) [2]**	**Citation**	**Notes & Key Conclusions**
LL	NWA	Canada	BSH	40	No	19%	Campana et al. 2009	All surviving sharks exhibited recovery behavior for 2 to 7 d after release. All healthy sharks survived, while 33% of injured or gut hooked died. Overall BSH bycatch mortality was 35%, estimated discard mortality for sharks that were released alive was 19%. 95% of the mortality occurred within 11 d of release
LL	NWA	Canada, 76 trips, 496 sets	BSH	37	No, some sharks were hauled on deck for tagging and gear removal.	24%	Campana et al. 2016	AVM ranged from 15 to 44%, POR and SMA had higher mortality than BSH. PRM rate of all three species differed with condition at release. BSH & POR tagged on deck, some SMA tagged in water-no difference in survival for tagging location for SMA
			SMA	26		30.8%		
			POR	33		18.2%		
LL	S. Pacific	Palau 13 trips, 1 vessel	FAL	35	No	20%	Musyl & Gillman 2018	Mean PRM rates were 0.17 [95% CI 0.09–0.30] for blue shark and 0.20 [95% CI 0.10–0.36] for silky shark. 87% of mortalities occurred within 2 days of release. PRM rate was 31% (.12-.59) for injured sharks (n = 13) & 11% (.04-.27) for healthy sharks (n = 35). Random sample, animals brought onboard for tagging some were gaffed. Released with trailing gear (0-2 m). Close correlation (~ 83% accuracy) between condition at capture and survival outcomes. Reliable methods to classify at-vessel condition represent an inexpensive and simple metric for estimating PRM rates.
			BSH	48	No	16.7%		
LL	ETP	ECU (4 trips, 1 vessel)	FAL	21	NA	11.1%	Schaeffer et al. 2019	PRS rate estimated from Kaplan–Meier survival analyses for combined dataset was 94.3% (95% CI: 87.0%–100%) to 20 days. Wire leader &

[2] PRM rates reported in this column are a simple proportion of mortalities to total tagged animals. In the notes are the estimated PRS rates and data on influential factors in the study. Where possible we used the data reported to 30-days (tag deployment period) which should comprise 90% of possible mortalities in pelagic sharks (Musyl and Gilman 2019).

		CR (3 vessels)		17		0%		circle hooks in CR, mono and Japanese tuna hooks in ECU. All sharks tagged onboard vessel. Crew developed lasso method to haul sharks up and did not use gaffs.

Table 2.c. Sharks (cont.)

Fishery	Region	Flag	Species	Sample size	Best practices or BRDs?	Post-release mortality rate (Simple proportion) [3]	Citation	Notes & Key Conclusions
LL	NWA	ND	POR	18	Yes	14%	Bowlby et al. 2020	Tag data was combined with data from Campana and total sample sizes were 48 healthy and 15 injured POR and 41 healthy and 7 injured SMA. Estimated mortality rates were 14% for porbeagle (6% for healthy and 40% for injured), 28% for shortfin mako (27% for healthy and 33% for injured), which is ~ ½ of the previous estimate for POR and the same for SMA (from Campana et al.2016). The difference for POR is likely due to handling during tagging, which switched from bringing animals on board to tagging in the water. Median recovery times for surviving animals was 1 day (shortfin mako) or 1.5 days (porbeagle) longer when the shark was tagged onboard as compared to in the water even though gills were irrigated during tagging on deck. Trailing gear was either removed completely or minimized
			SMA	15		28%		
LL	ETP	Mex (6 trips, 3 vessels)	FAL	63	NA*	15.2%	Schaeffer et al. 2021	*This study used observers to tag animals, they were brought onboard using the lasso method described in Schaeffer et al 2019, gear removed or cut as close to hook as possible and returned to sea. The PRS rate estimated using Kaplan - Meier survival analyses was 84.8 % (95 % CI: 71.0 %–100 %). Wire leaders.
LL	IO	EU	OCS	9	U	0%	Bach et al. 2021	1 mortality after 58 days but it was not considered a mortality in the study. Animals were only tagged in

[3] PRM rates reported in this column are a simple proportion of mortalities to total tagged animals. In the notes are the estimated PRS rates and data on influential factors in the study. Where possible we used the data reported to 30-days (tag deployment period) which should comprise 90% of possible mortalities in pelagic sharks (Musyl and Gilman 2019).

								alive or alive good condition. This figure will be the most optimistic estimate of PRS. 2 premature tag releases on days 9 & 14.
LL	AS	USA 128 trips, 76 vessels	FAL**	30	No	3%	Hutchinson et al. 2021	This paper uses Bayesian methods to project survival rates across several metrics over time. At vessel condition, handling method and trailing gear were all influential on survival outcomes. Leaving sharks in the water and removing as much trailing gear as possible by cutting the line improves survival. **All silky sharks were tagged in American Samoa where leader materials are mono and trailing gear lengths are shorter. All sharks were in good condition, so this PRM rate should be considered the 'most optimistic scenario'.
	CPO		OCS	62	No	15%		
			BSH	69	No	37.7%		
			SMA	20	No	6%		
			BTH	43	No	18%		
LL	S. Pacific	Regional	FAL	57	No	10.5%	Francis et al. 2023	KM survival estimates: FAL = 92.3% (CI: 85.3–99.9%), SMA = 90.2% (CI: 82.3–98.9%). Factors affecting survival: Size, catch condition, trailing gear lengths Most sharks were tagged in the water.
			SMA	60	No	11.6%		

Species 3 Alpha FAO codes: BSH = Blue (*Prionace glauca*), BTH = Bigeye thresher (*Alopias superciliosus*), FAL = Silky (*Carcharhinus falciformis*), OCS = Oceanic whitetip (*C. longimanus*), POR = Porbeagle (*Lamna Nasus*), SMA = Shortfin mako (*Isurus oxyrhincus*). Sample sizes are the total number of sharks encountered during a study for the total mortality estimations in the PS studies. In the LL studies sample sizes are the number of sharks with tags used in the survival estimations (Tags that did not transmit and data that was dropped due to tagging effects or other are not reported here). Best practices recommendations for sharks were adopted in 2018 most of the studies the Best Practices for sharks for the region had not been adopted at the time of the study.

Table 2.d. Mobula

Fishery	Region	Flag	Species	Sample size	Best practices used?	Post-release mortality rate (Simple proportion) [4]	Citation	Notes Key Conclusions
PS	S. Pacific	NZ	RMM	7	No	57%	Francis et al. 2017	Observers tagged nine rays with popup archival tags Seven of the nine tags reported data, and four of those rays died within 2–4 days of release. All four rays that died had been brought aboard entangled in the bunt. The three surviving rays were all brailed aboard with the tuna catch.
PS	E. Atlantic	EU/ Curacao	RMT	6	Yes (with violations on handling)	83%	Hutchinson et al. 2020	5/6 died after 2-11 days. All animals were lively and swam away well upon release. Vessel used the cargo net to release animals but used some poor handling methods when moving the animals from the brailer onto the nets. Release times were 2-14 minutes
PS	IATTC	Regional	RMM	16	Yes	8%	Stewart et al. 2020	Study is ongoing
			RMT	5	Yes	60%		
			RMO	8	Yes	80%		
			RMB	2	Yes	50%		

Species 3 Alpha FAO codes: RMB = Oceanic Manta Ray (Mobula birostris), RMM = Spinetail devil ray (M. mobular), RMO = Bentfin devil ray (M. thurstoni), RMT = Sicklefin devil ray (M. tarapacana)

[4] Where possible we used the tag data reported to 30-days (period for tag missions) which should comprise 90% of possible mortalities in pelagic sharks (Musyl and Gilman 2019).

TABLE 3. Knowledge gaps by taxon and fishery that are required for the development of BHARP guidelines.

Taxa	Fishery	Data Gaps	Priority	Research Needs	Priority	Feasibility	Cost	Rank
Table 3a. Marine Mammals	*PS*	PRS rates for large and small cetaceans by release method	High	Handling data collections, test BRD devices, test other methods for rapid release (e.g. weighting corks to release large cetaceans, feasibility study for abandoning set), does encirclement impact survival for large and small cetaceans, Stranding Network Data	High	Easy - Data collections	Low	Med
				PRS data	High	Difficult	High	Low
	LL >20m	Species specific interaction rates, at vessel condition, handling and release practices used, trailing gear, mitigation tools available, release condition, PRS rates	High	Interaction data collections (EM), survey for fleet characterization (e.g., gear configuration, bait types, vessel free-board, bycatch mitigation tools on-board), Stranding Network Data	High	Easy	Low	High
				PRS data	High	Difficult	High	Low
	Artisanal	Species specific interaction rates, at vessel condition, handling and release practices used, release condition, PRS rates	High	*Longline (< 20 m):* Interaction data collections (EM), survey for fleet characterization (e.g., gear configuration, bait types, vessel free-board, bycatch mitigation tools on-board), Stranding Network Data	High	Easy - data collections, EM, ABNJ2, survey CPCs for existing datasets and research programs	Low	High
			High	*Gill net:* Data is needed to determine if this fishing modality is impacting cetaceans, Stranding Network Data	High		Low	High

Taxa	Fishery	Data Gaps	Priority	Research Needs	Priority	Feasibility	Cost	Rank
Table 3b. Seabirds	*PS*	Species specific interaction rates, at vessel condition, handling and release practices used, release condition, PRS rates	Low	Continue data collections (Interaction rates are not perceived as an issue), Bird Banding Network and PRS	Med	Easy	Low	Med
	LL > 20m	Species specific interaction rates, at vessel condition, handling and release practices used, hooking location, resuscitation techniques, release condition, PRS rates, fleet characterization (e.g., gear configuration, bait types, vessel free-board, bycatch mitigation tools on-board)	High	Interaction data collections (EM), > Observer coverage, survey for fleet characterization. Stranding/Bird Banding Network Data	High	Medium (Observer)	High	High
				PRS study	High	Difficult	High	Long term goal
	Artisanal		High	*Longline (< 20 m):* Interaction data collections (EM), fleet survey, Stranding/Bird Banding Network Data	High	Easy - data collections, EM, ABNJ2, survey CPCs for existing datasets & research programs	Low	High
			High	*Gill net*: Interaction data collections (EM), fleet survey, Stranding Network Data	High		Low	High

Taxa	Fishery	Data Gaps	Priority	Research Needs	Priority	Feasibility	Cost	Rank
Table 3c. Sea turtles	*PS*	Species specific interaction rates, improved at vessel and release condition indices, resuscitation, handling and release practices used, effects of release from high vessels, PRS rates	High	Improved data collections for class 1-5 vessels (EM), Stranding Network Data	High	Difficult - data collections, EM	Low	High`
				PRS data	High	Easy - Telemetry	Med	High
	LL >20m	Species specific interaction rates, improved at vessel and release condition indices, handling and release practices used, hooking/ entanglement location, resuscitation techniques, trailing gear composition, PRS rates, fleet characterization	High	Improved data collections, Stranding Network Data	High	Easy - data collections, EM	Low	High`
				PRS data	High	Easy - Telemetry	Med	High
	Artisanal		High	*Longline (< 20 m):* Interaction data collections (EM), Stranding Network Data	High	Easy - data collections, EM, ABNJ2	Low	High
				PRS data	High	Difficult without observers	High	Low
				Gill net: Interaction data collections (EM), Effects of soak times on at vessel condition, Stranding Network Data	High	Easy - data collections, EM, ABNJ2	Low	High

Taxa	Fishery	Data Gaps	Priority	Research Needs	Priority	Feasibility	Cost	Rank
Table 3d. Sharks	*PS*	Species specific interaction data by size, sex, at vessel condition, landing stage (e.g. entangled, brail number, wet deck, fish deck) handling and release practices used, release condition, PRS data	High	Test BRD technologies, Size, sex and species-specific interaction data for class 1-5 vessels, PRS rates across species, size classes, landing stages, handling methods	High	Difficult	High	High
	LL>20 m	Species specific interaction data by size, sex, at vessel condition, handling and release practices used, release condition, PRS data, fleet characterization	High	Improved data collections	High	Easy – EM, > observer coverage	High	High
	Artisanal		High	*Longline (< 20 m):* Interaction data collections, fleet survey	High	Easy - EM, ABNJ2	Low	High
				Gill net: Interaction data collections (EM), fleet survey	High	Easy - EM, ABNJ2	Low	High
Table 3e. Whale shark	*PS*	Interaction rates, at vessel condition, handling and release practices used, release condition, PRS rates	High	Improved data collections for all vessel classes	High	Easy	Low	High
				PRS across size classes and orientations at the vessel	High	Easy	Med	High
	LL >20m	Interaction rates	Low	Not perceived as an issue in other regions	Low	Easy – data collections	Low	Low

Taxa	Fishery	Data Gaps	Priority	Research Needs	Priority	Feasibility	Cost	Rank
Table 3f. Mobula	*PS*	Species specific interaction rates, at vessel condition, handling and release practices used, release condition, PRS rates	High	Test BRDs across vessel classes with PRS data	High	Easy	Med	High
				Improved data collections	High	Easy - EM	Low	High
				Test strategies for avoidance (ie when helicopter pilot or spotters have seen them)	Med	Easy	Low	High
	LL >20m	Species specific interaction rates, size and sex catch data, at vessel condition, handling and release practices used, release condition, PRS rates	High	Improved data collections	High	Easy – EM, > observer coverage	Low	High
				PRS data	High	Easy - telemetry	Med	High
	Artisanal		High	*Longline (< 20 m):* Interaction data collections (EM) & PRS	High	Easy – ABNJ2, EM	Med	High
				Gill net: Effects of soak times on at vessel condition & PRS	High for *M. munkiana*		Med	High

TABLE 4. Qualitative assessment of existing BHRP guidelines and identification of areas for improvement.

Fishing gear	Handling practices well documented[1]	Do approved IATTC BHRP guidelines & PRS data exist for each taxon and fleet segment? [2]							
		Marine Mammals	Sea birds	Sea turtles	Whale shark	Silky shark	Oceanic whitetip	Sharks	Mobula
Purse Seine									
Class 6	100% (observer coverage); M.1.d, M.2.c	AIDCP (cetaceans in PS associated fishery)	No	No	Yes	Yes (M.1.d)	Yes	Yes	Yes (M.2.c)
Classes 1 - 5	M.2.e (new)	No	No	No	No	Yes (M.1.d, M.2.e)	No	No	Yes (M.2.c)
Longline									
>20m	5% Observer coverage - but handling and release practices are not included in min. data standards fields.	No	Yes	Yes	NA	Yes (M.2.b)	Yes	Yes	No
Artisanal									
Longline (< 20 m) / gillnet	C.4.b, C.4.b, C.4.c, M.2.a, M.2.b	No	No	Yes	NA	Yes (M.2.a, M.2.b)	Yes	No	No

[1]Definitions for 'well documented' classifications and color coding: Red = No data on handling methods used in the fleet segment for any vulnerable species, Orange = More than 0% and less than 33% of the fleet has been surveyed on their handling methods for one or more vulnerable species, Yellow = Roughly two thirds or 66% of the fleet has been surveyed on their handling methods for all vulnerable species, Green = All handling methods utilized in this fleet segment for all vulnerable species are known. [2]Definitions and color codes for taxa specific handling practices: Red = No BHRP guidelines, Orange = BHRPs are suggested but lacks guidance, Yellow = BHRP guidance is provided but it may lack important components or requires updating based on new data, Green = BHRP guidelines are adopted and based on best available data. Alpha Numeric Numbers in the cells refer to IATTC projects relevant to the data gap for that fishery or taxa. For taxa with data on PRS (from IATTC and other regions) that validates the efficacy and safety of recommended guidelines are indicated with ‘yes’ or ‘no’ in the cells.

APPENDIX 1. Existing BHRP Guidelines for Vulnerable Species[5]

Taxon

Marine Mammals

- § IATTC / AIDCP Large herd guidelines: https://www.iattc.org/getattachment/d6543e6b-28bf-4d17-878e-a64f284a6d26/Large%20herd%20guidelines
- § FAO Food and Agriculture Organization of the United Nations. Good Practice Guide for the Handling of Cetaceans Caught Incidentally in Mediterranean Fisheries. https://www.fao.org/3/ca0015en/CA0015EN.pdf
- § Food and Agriculture Organization of the United Nations [FAO] (2021). *Fishing Operations. Guidelines To Prevent and Reduce Bycatch Of Marine Mammals In Capture Fisheries.* Rome: FAO, doi: 10.4060/cb2887en
- § Hamer, D. and Minton, G. (2020). Guidelines for the safe and humane handling and release of bycaught small cetaceans from fishing gear. UNEP/CMS Secretariat. Bonn, Germany 50 pages. CMS Technical Series No. 43. https://www.cms.int/sites/default/files/publication/TS43_Safe_Handling_Release_Guidelines.pdf
- § National Marine Fisheries Service (NMFS). Protected Species Workshop Handling, Release, and Identification Guidelines. NMFS Pacific Islands Regional Office. NMFS. Marine mammal handling/release guidelines: A quick reference for Atlantic pelagic longline gear. NMFS/ARFO Marine Mammal Handling Guidelines. NMFS Greater Atlantic Regional Fisheries Office.
- § WCPFC. 2021. Best Practices for the Safe Handling and Release of Cetaceans. Suppl_CMM 2011-03-01 https://cmm.wcpfc.int/supplementary-info/supplcmm-2011-03-1

Seabirds

- § https://www.catchfishnotbirds.nz/post/how-to-handle-a-seabird
- § https://www.fisheries.noaa.gov/resource/document/seabird-handling-guidelines-hawaii-pelagic-longline-fisheries
- § ACAP https://www.acap.aq/bycatch-mitigation/hook-removal-from-seabirds-guide
- § https://www.acap.aq/resources/bycatch-mitigation/hook-removal-from-seabirds-guide/3536-acap-hook-removal-guide-a3-print/file
- § Guía rápida autoreporte y mitigación, pesquería de cerco jurel, sardina y anchoveta centro-sur (ATF-Chile):
- § https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/S2ISCEBI%20-%20Suazo%20-%202020%20-%20Gu%C3%ADa%20r%C3%A1pida%20autoreporte%20y%20mitigaci%C3%B3n%2C%20pesquer%C3%ADa%20de.pdf
- § WCPFC: https://cmm.wcpfc.int/supplementary-info/supplcmm-2018-03
- § https://www.iccat.int/en/RecRes.asp

[5] This list is not exhaustive. We welcome input to build a living compendium of existing illustrated BHRP guidelines.

- Elliott L, Gilman E (2002) Safely releasing seabirds and avoiding bird capture. International Bird Rescue Re - search Center (IBRRC) and the National Audubon Society. http://w.bird-rescue.org/pdfs/NAS%20English. pdf

Sea turtlesFAO Fisheries and Aquaculture Department. Guidelines to reduce sea turtle mortality in fishing operations. Rome, FAO. 2009. 128pp https://www.fao.org/3/i0725e/i0725e.pdf

- FAO Fisheries and Aquaculture Department. Guidelines to reduce sea turtle mortality in fishing operations. Rome, FAO. 2009. 128pp https://www.fao.org/3/i0725e/i0725e.pdf
- ISSF International Seafood Sustainability Foundation: Sea turtle handling and hook removal - YouTube
- WCPFC: https://www.wcpfc.int/doc/supplcmm-2008-03/wcpfc-guidelines-handling-sea-turtles-graphics
- IOTC (same guide as WCPFC): https://iotc.org/documents/marine-turtles-identification-cards

Sharks

- https://meetings.wcpfc.int/index.php/node/11305
- ICCAT. Minimum Standards for Safe Handling and Release of N Atlantic SMA https://www.iccat.int/Documents/Recs/compendiopdf-e/2021-09-e.pdf
- Justel-Rubio A, Swimmer Y, Hutchinson M (2019) Graphics for best handling practices for the safe release of sharks. In: WCPFC Scientific Committee 15th Regular Session. WCPFC-SC15-2019/EB-WP-14, Pohnpei, Federated States of Micronesia, p 10 https://meetings.wcpfc.int/index.php/node/11305
- https://www.afma.gov.au/sites/default/files/2023-02/Shark-Handling-Guide-2016-Update.pdf
- GFCM FAO-UN Mediterranean https://www.fao.org/3/ca0015en/CA0015EN.pdf

Whale shark

- IOTC Shark and Ray Identification in Indian Ocean Fisheries https://www.fao.org/3/ca3440en/CA3440EN.pdf

Mobula

- IOTC, Safe Handling & release for Gillnet Fisheries for Whale Shark, Manta & Devil Rays and Sea. In: IOTC - 16th Working Party on Ecosystems and Bycatch. IOTC-2020-WPEB16-26_Rev1, Online: https://iotc.org/documents/983/Mobulid_guides
- WWF, Razzaque SA, Moazzam Khan, Shahid U, et al (2020) Guide for Handling and Safe Release in Gillnet Fisheries. Manta & Devil Rays, Whale Sharks and Sea Turtles: https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/450hxyiz2j_Guide_for_Handling_Safe_Release_in_Gillnet_Fisheries_Final.pdf?_ga=2.72993428.648534499.1680869037-82155328.1680869037

Multi taxa

- Handling and Release Guide For protected species interactions within New Zealand fisheries.

  https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/marine-conservation-services/resources/protected-species-handling-guide-2022.pdf

Taxa = Seabirds, Seals and Sealions, Dolphins and Whales, Sharks, Rays, Turtles, Sea Snakes

Fishery = Longline, purse seine, set net (gillnet), trawl

- NOAA Pacific Islands Regional Office. Protected Species Workshop, Handling, Release and Identification Guidelines for longline fisheries.

  https://media.fisheries.noaa.gov/2020-10/handling-release-all-fnl-508.pdf

  Taxa = Sea turtles, sharks, large mobulid rays, small whales and dolphins, seabirds

  Fishery = Longline

- Skippers Resources & Certification - International Seafood Sustainability Foundation: https://www.iss-foundation.org/fishery-goals-and-resources/skippers-workshops-and-guidebooks/skippers-resources-certification/

  Taxa = Sea turtles, sharks, large mobulid rays, small whales and dolphins, seabirds

  Fishery = Longline

ANNEX 1. Seabirds

(Text adopted from NOAA Fisheries, New Zealand Fisheries and ACAP guidance).

Illustrated guide available via: www.ACAP.aq https://www.acap.aq/resources/bycatch-mitigation/hook-removal-from-seabirds-guide/3536-acap-hook-removal-guide-a3-print/file

Tools required: Dipnet, Towel or blanket, Pliers & bolt cutters, box or bin and gloves

1. Bring seabird aboard

If a seabird is noticed on a line, stop the vessel to reduce drag on the line. When the bird is within reach, gently bring it on board by hand or using a net. Do not pull the bird up on the line as this may cause further injury. Do not handle birds by wingtips as it can break the wing.

2. Restrain bird and hold securely. (Never restrict the bill or legs with tape or bands.)

Once a seabird is on board, carefully fold the wings into the bird's body. Wrap the bird in a towel/blanket (not too tightly). Cover the bird's eyes and head with a loose cloth to help calm it, making sure to keep nostrils exposed. For gannets, which do not have nostrils, allow the bill to stay slightly open. If the bird vomits, loosen hold on bill so the bird does not suffocate.

Make sure the bird doesn't come into contact with oil on deck.

Keep the bird's bill away from your face to avoid injury.

With one crew member holding the bird, another crew member can detach the fishing gear from the animal.

3. How to remove a hook:

If the hook is visible -

Use pliers or bolt cutters to cut through the hook shaft and pull hook back out of the bird. Flatten the barbs with pliers or cut off barbs with bolt cutters if it is necessary to pull the hook back through the tissue to remove it.

If the hook is swallowed and removal is possible -

Never try to extract the hook backwards.

If you can find the hook position in the neck and it is possible, push the hook tip through the skin and remove it.

If hook removal is not possible -

Cut the line as close to the mouth as possible. Do not try and pull hook out from inside the bird.

Untangle and cut away any line caught around the bird's wings, body or legs.

4. Resuscitation (Applies to seabirds entangled in purse seine gear as well as hook and line fisheries):

If birds are wet and exhausted, place them in a ventilated box with airholes or a clean, dry, safe area to recover. Seabirds cannot fly when waterlogged. Do not try to feed them or give them water during resuscitation.

Bird can be released to sea surface when:

• Feathers are dry. (approximately 1/2 to 4 hours)

• Bird is alert and head is erect.

• Breathes without noise.

• Wings can flap and retract onto back.

• Stands on both feet with toes forward.

5. Release

To release a bird, slow or stop vessel, sit it on the deck railing and when wings open allow it to fly off. If it does not fly off on its own, gently lower it over the side of the vessel with a hand net.