Food and Agriculture Organization
of the United Nations

GUIDE OF GOOD PRACTICES FOR CARIBBEAN PELAGIC LONGLINE FISHERS

Promoting the sustainable and efficient use of pelagic resources to mitigate climate change impacts and secure future fishery livelihoods

Cover photograph: © FAO/Roy Bealey

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Promoting the sustainable and efficient use of pelagic resources to mitigate climate change impacts and secure future fishery livelihoods

Roy Bealey
Fishery operations and value chain improvement consultant
Food and Agriculture Organization of the United Nations

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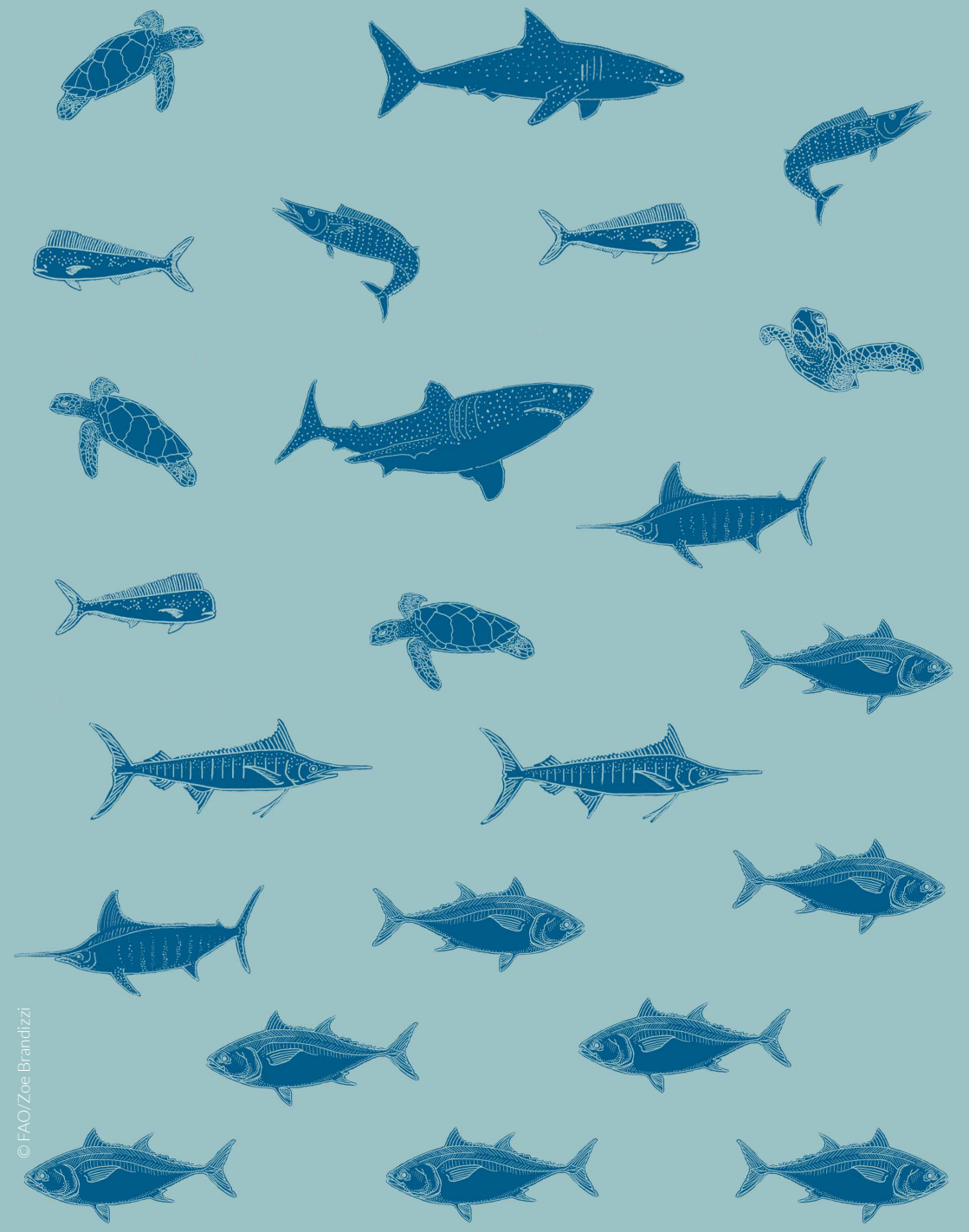

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Local insights allowing some regionally tailored suggestions were also made possible through proactive collaborations with various Caribbean government authorities, value chain stakeholders and active fishers throughout the region. It is hoped that the suggestions provided will help Caribbean pelagic fisheries sustainably continue to provide critical livelihood support, especially to those Caribbean citizens who are most in need of healthy marine ecosystems to support their nutrition and livelihoods.

Figure 1
Damage caused to fishing vessels and other infrastructure by Hurricane Maria in 2019

1 INTRODUCTION

Climate change threatens the future ability of fisheries to support the food security and livelihoods of millions of Caribbean citizens. Climate-change-intensified natural disasters such as hurricanes provide shocking evidence of Caribbean fisheries exposure to environmental changes. Such disasters have severe consequences for fishers and other stakeholders throughout the related value chains. Caribbean pelagic fishers are also travelling farther to avoid larger expanses of green water that result from increased river flows in South America. They also face increased abundance of floating sargassum seaweed, which has practical influences on their fishery operations while also affecting the species and size compositions of harvests. Adapting fisheries and their associated value chains can help all fisheries stakeholders become more resilient to climate change effects.

Furthermore, nearshore-fishery harvest declines due to overfishing, pollution, reef fishing closures and ongoing climate change impacts are causing many fishers to travel farther from shore and target pelagic species to maintain their livelihoods. Therefore, increasing numbers of Caribbean fishers are targeting large pelagic fish stocks to continue making a profit. However, this may not be a sustainable solution, as many of the targeted large pelagic fish stocks already have a long history of being overfished. Climate change may also have largely unknown influences upon the availability of these highly migratory stocks to many fisheries in future. Climate change will continue to influence the harvest efficiencies of many fisheries, and potentially shorten their fishing seasons in future, while natural disasters will also continue to destroy vessels and equipment.

Modern fishery best practices can help reduce the influence of climate change. Such practices can promote the efficient harvesting of marine resources, while also minimizing waste and unnecessary negative impacts upon the supporting marine ecosystem. The triple-bottom-line efficient use of marine resources can therefore provide a critical buffer for Caribbean fishers' livelihoods when their operations are negatively impacted by climate change, including when their equipment is suddenly destroyed by natural disasters (Figure 1).

Caribbean fishers who implement these modern practices to promote their profitability, while also improving the sustainability of their fishery, will be more capable of withstanding future climate change and overfishing impacts. Efficient and sustainable resource use will also ensure these benefits remain available to future generations.

The relatively small scale of the Caribbean longline tuna sector provides an opportunity to sustainably prioritize the quality and value of each harvested fish. This is far more sustainable than some industrial methods used elsewhere that seek to catch as many fish as possible for lower average profits per fish.

However, some current longline practices increase harvest wastage while reducing the possible economic value, nutrition potential and social benefits available from the catch. Moreover, some practices cause unnecessary harm to non-targeted species and to the ecosystems upon which fisheries and all their associated stakeholders' livelihoods ultimately depend.

This guide provides information on how to efficiently, and more specifically, target tuna, while reducing the impact on bycatch species and marine ecosystems. It aims to promote the adoption of modern methods for more efficient and targeted use of longline gear, and the slaughtering and handling of captured fish in ways that maximize their quality and value. It also highlights the importance of recording catch information in relation to market access. Implementing the proposed methods will improve the ability of fishers to withstand the current and future impact of climate change and the challenges of overfishing while promoting both profits and sustainability.

Although focused on the longline sector and particularly vessel owners, skippers, crew and technical specialists (whether they be working in the public or private sector), it is anticipated that the practical and low-implementation-cost practice improvements described will have potential benefits for other fishers targeting large pelagic species in the region. The guide also provides links to sources of further information for readers keen to study any of the practices in more detail (see Bibliography). Finally, many fishing authorities, including the International Commission for the Conservation of Atlantic Tunas (ICCAT), already promote implementation of the best practices described in this publication. Many seafood markets are also increasingly requiring implementation of these sustainable best practices before they will purchase fish. Because the species and sizes of tunas mainly targeted by longline fleets are not uniformly distributed, some current focus areas within the Caribbean region are also mapped and highlighted in Figure 2.

Figure 2
The Caribbean region with the key longline regions highlighted by orange rectangles

Adapted from © United Nations: Map No. 4170 Rev. 19 October 2020

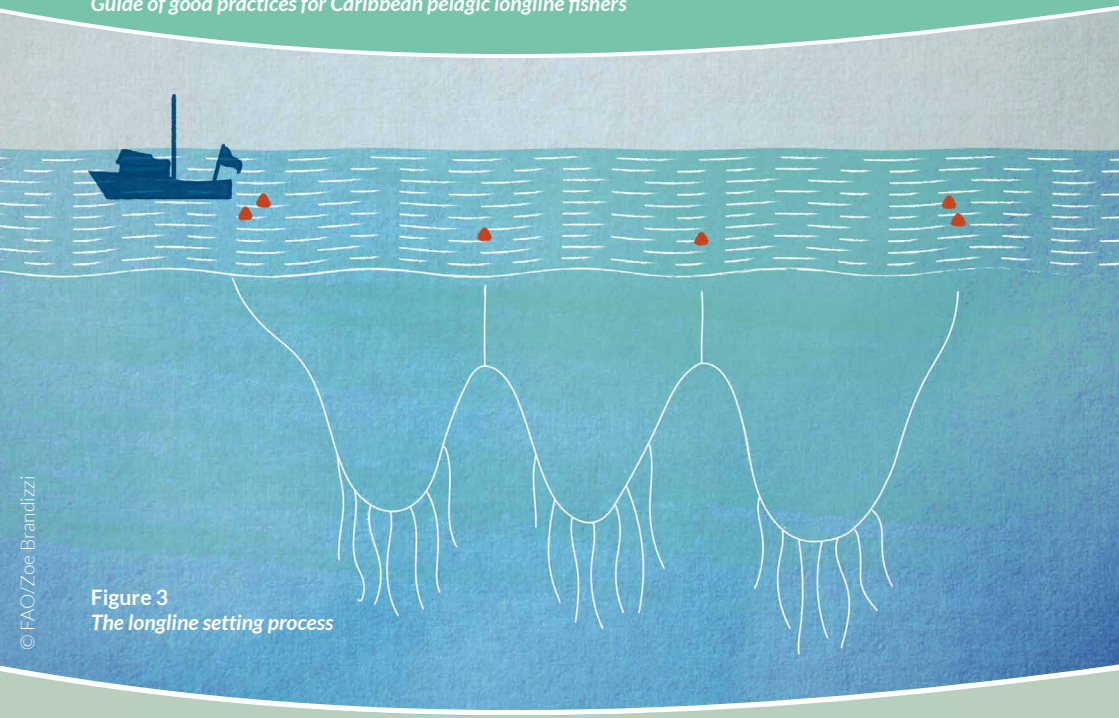


Figure 3
The longline setting process

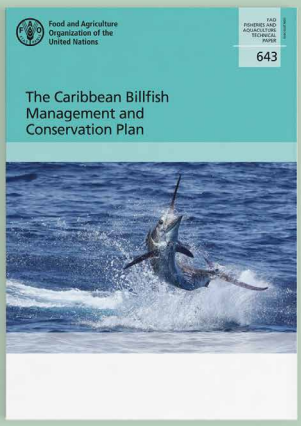


Figure 4
Cover page of the Caribbean Billfish Management and Conservation Plan

2 OPTIONS TO IMPROVE TARGET CATCH AND MINIMIZE BYCATCH IMPACTS

Longline fisheries set long mainlines to which surface buoys and hooks are attached (Figure 3). Longline fleets currently produce most of the Caribbean region's pelagic fishery harvests. They primarily target high-value tunas for export, but often also catch other species as bycatch (billfishes, sharks, turtles, birds and marine mammals). Many pelagic species still harvested by Caribbean longline fleets are already overfished, incaluding some tunas, while various sharks and other species are now internationally protected. All assessed Atlantic billfish species have been overfished for at least a decade, but they remain as common secondary targets in Caribbean longline fisheries. Billfish species are genuinely treated as bycatch by some foreign fleets, and both marlin species now also fall within a dedicated stock rebuilding programme through ICCAT.

Many Caribbean fishing fleets already need to change their practices to stop exceeding nationally allocated fishing quotas for internationally shared pelagic fish stocks. It is also important to recognize that even non-ICCAT member States have implied yearly quota allocations of 10 tonnes for blue marlin and 2 tonnes for white marlin and longbilled spearfish combined.

The Caribbean Billfish Management and Conservation Plan (Figure 4) supports regional implementation of billfish recommendations from ICCAT (Bealey, Pérez Moreno and van Anrooy, 2019). It also suggests various regionally endorsed improvements to the sustainability of all Caribbean pelagic fisheries that capture billfish species.

The complete plan is available online at: www.fao.org/3/CA3366EN/ca3366en.pdf

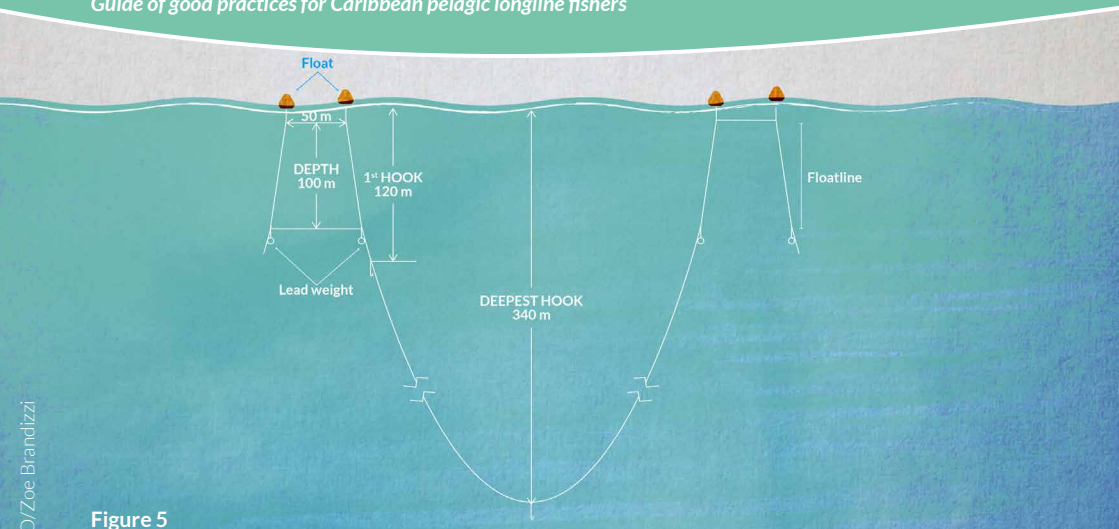


Figure 5
Configuration of weighted gear with 20 hooks per basket and target depthof shallowest hook of 10 m using a sagging rate of 0.85

Source: Adapted from Beverly and Robinson, 2004.

Fishing deeper

Longlines set near the water surface capture many species without specifically targeting premium-value tunas. Bycatch can be reduced by following best practices. This also benefits fishers by leaving more baited hooks available to capture the higher-value targeted tunas. The most-valuable large tunas can be more efficiently targeted by fishing at greater depths than are currently typical among many Caribbean fleets. Fishing deeper, near or below the thermocline, also reduces impacts upon many bycatch species that spend more time close to the water surface. Catching large tunas in cooler, deeper waters also keeps their meat fresh and minimizes losses that can be expected from surface-oriented scavengers.

Longlines set at or near the water surface tend to:

- Capture a greater diversity of lower-value species alongside lower expected catches of premium-value tunas. This increases bycatch concerns, reduces potential profits and causes unnecessary damage to the supporting marine ecosystem.
- Retain hooked animals in warmer surface waters, where they die more quickly and decompose faster in the warm Caribbean sun. Therefore, these fish lose quality and value at a faster rate even before they are hauled onto the fishing vessel.

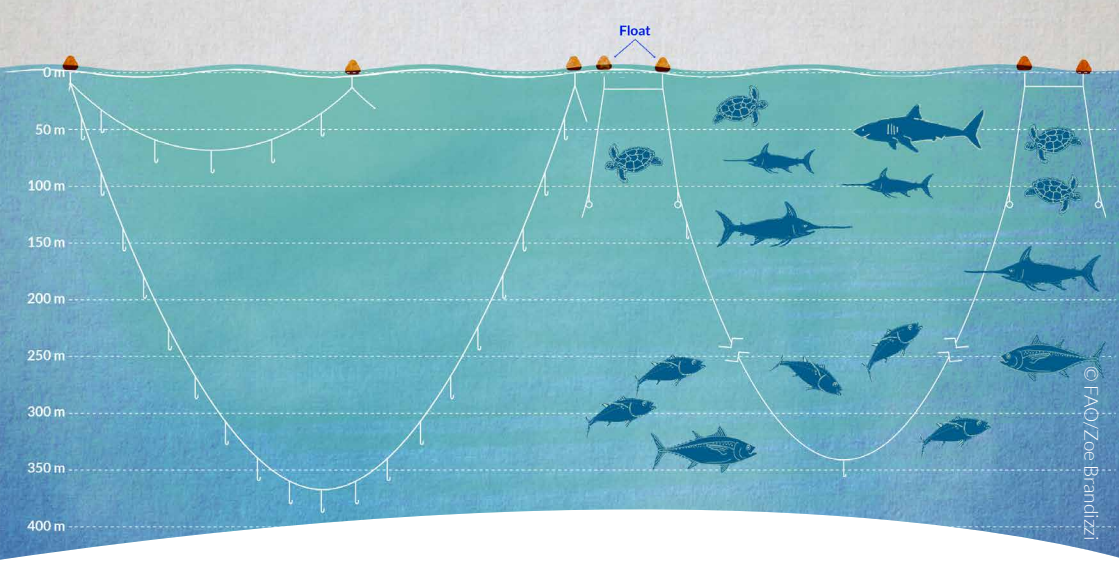


Figure 6
Different depth-set configurations illustrating buoy spacing and line sagging effects as well as the typical vertical habitat use of some commonly encountered species

Source: Adapted from Clarke *et al.*, 2014.

- Increase the likelihood of having some of the harvest mutilated by or lost to various sharks, pilot whales and other surface-oriented scavengers. Losses to scavengers reflect direct losses to fishers' profits and can also result in damaged or lost equipment.

Longlines can be set at greater depth by:

- Increasing the length of "floatlines" to only start fishing below a chosen depth. This can be further promoted by clipping weights onto the mainline between the buoys and the first hooks on either side of the deployed section.
- Increasing the distance between surface buoys, to increase the sag between them.
- Setting hooks at greater distance from the surface buoys and setting the line with more slack to promote deeper sag in the line between buoys.

These options can also be used in combination to maximize their effectiveness. Some illustrations of options are provided in Figures 5 and 6.

Avoid bycatch-prone areas

Bycatch can most easily be reduced by avoiding areas where bycatch species are commonly caught, and fishers should communicate with one another to avoid high-bycatch-rate areas. Such ways of minimizing how often bycatch interact with fishing gear in the first place are ideal solutions, but none can guarantee zero interaction with bycatch yet. Therefore, other options described in this publication aim to reduce the wasteful killing of bycatch species and tunas before fishing gear is retrieved, making it possible to release unwanted species alive while also harvesting premium-quality tunas from the same line.

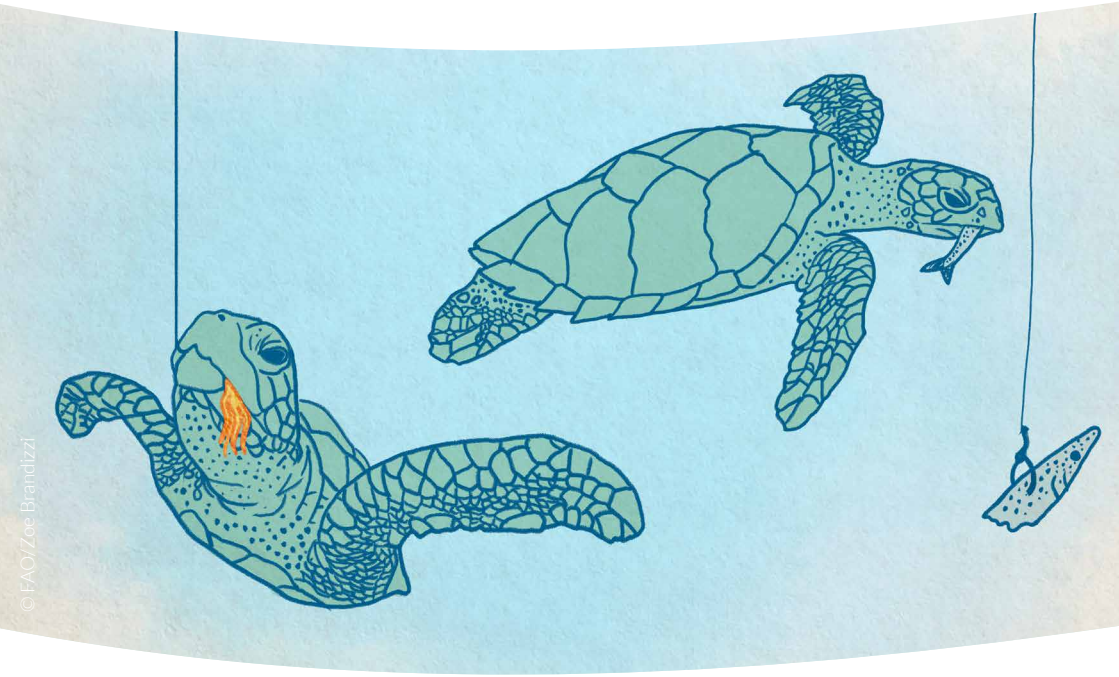


Figure 7
Turtle–bait type interactions

Adapted from © NOAA Southeast Fisheries Science Centre (SEFSC)

3 BYCATCH MITIGATION AND HANDLING RECOMMENDATIONS BY SPECIES GROUP

Because implementing best fishing practices and avoiding areas of high bycatch cannot guarantee that bycatch species will never be encountered and captured, fishers should ensure the appropriate handling of all bycatch species that are captured. This reduces the unnecessary killing of these animals during capture, or even after they have been released (termed post-release mortality).

Billfish (marlin, sailfish and spearfish) bycatch

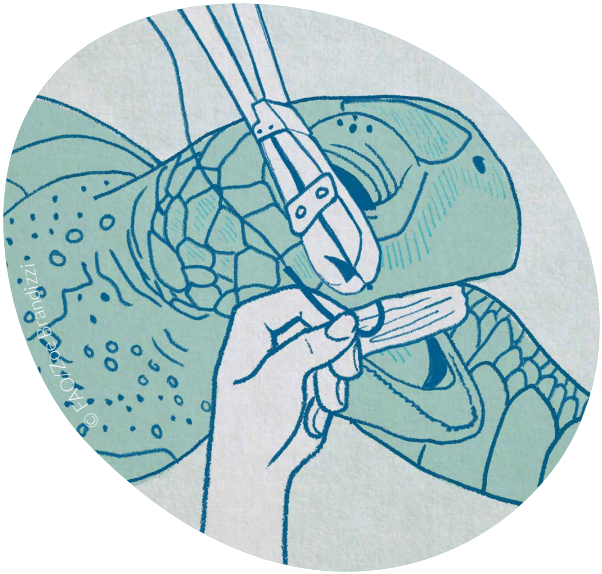
To avoid exceeding sustainable harvest limits, international authorities recommend the use of non-offset circle hooks (Figure 15) and the immediate release of live billfishes by cutting the leader as close to the hook as possible during gear retrieval, without hauling the fish onboard if possible. Both Atlantic marlin species already have an ongoing stock rebuilding programmes and national quota allocations from ICCAT, so such methods should help avoid exceeding sustainable harvest limits for these already heavily overfished species.

Turtle bycatch

Large non-offset circle hooks are recommended in order to reduce turtle bycatch. The bait used also changes the risk of capturing turtles on hooked gear. Turtles tend to bite chunks from fish baits while avoiding the hook, but they typically swallow squid baits whole, with the hook, and then become caught as bycatch (Figure 7).

Figure 8
Turtle hook removal

Source: Adapted from Clarke *et al.*, 2014



Captured turtles can sometimes be easily released with minimal harm by cutting the barb off the hook and removing it entirely from the turtle's mouth. A piece of wood or pipe can be placed into the turtle's mouth during this procedure to avoid the fisher being bitten (Figure 8). If the turtle is hooked deep in its throat or stomach, try not to pull hard on the line, do not remove the turtle from the water, and cut the line as close to the mouth as possible.

Figure 9
Keep turtles facing downward, wet and cool

Source: Adapted from GFCM, 2018

If the turtle is not moving, the recommendation is to lift it into the boat using both hands and holding its shell, not its fins. Then, place it in a shaded section of the boat deck with a cool damp cloth over its back. Raise its hind legs about 20 m off the deck to also let potential water drain from its lungs (Figure 9). Give the turtle time to recover and then release it gently back into the water.

Shark bycatch

Many shark species are already endangered and under international protection or no-take regulations. Shark numbers are declining throughout the Caribbean owing to overfishing. The use of monofilament leader lines can reduce shark capture rates because the sharks simply bite through the lines when hooked. Using monofilament lines also increases the capture of target tunas, because such lines are harder to see than cable leaders. Thus, improved tuna catches can improve profitability despite losing some hooks bitten by sharks.
When sharks are captured, they should be released using a de-hooker on a long handle, or the line should be cut as close to the mouth as safely possible. This should ideally be done boat-side without actually hauling the shark on board.

Sharks brought on board a vessel should be handled with extreme caution and care to avoid injuries to both the shark and crew. Sharks are very powerful, and serious injuries can result from either the sharp-toothed mouth or from the thrashing body or tail. Moreover, some species will flip and violently thrash their tails out of the water when brought alongside a boat. If a shark is brought on board:

- Seek help from another crew member if a shark is too large to handle alone.
- When required to move or handle a shark, do not use a gaff (or other sharp object) or kick it.
- Place a damp, dark cloth over the sharks' eyes to calm it. You can also place a fish or soft object in its mouth to avoid it biting you or other objects.
- Support the shark's' body with both hands when handling it, and gently return it to the water head first as soon as safely possible.
- Do not throw, kick or squeeze the shark, as all these can damage its internal organs.
- Do not carry or drag the shark by inserting hands in its gill slits.
- Do not lift the shark by its tail or head.
- Do not expose the shark to the sun.

Some of these suggestions are illustrated and further explained in Figure 10.

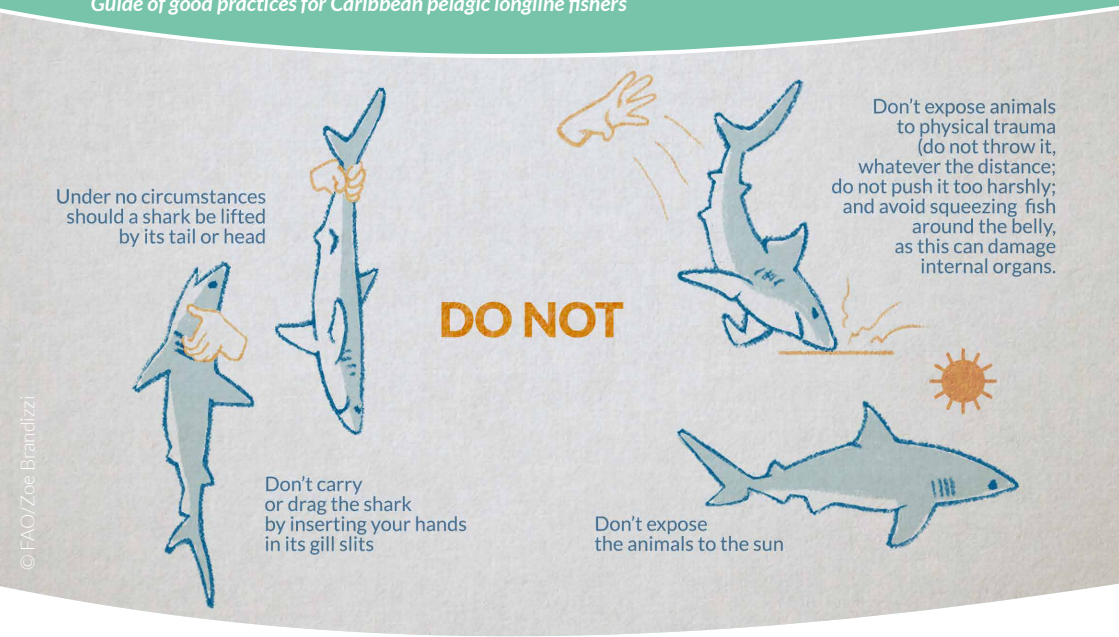


Figure 10
Handling procedures that are safe for both people and sharks

Source: Adapted from Poisson *et al.*, 2012.

Seabird bycatch

Most seabirds are captured during the setting of baited hooks and drown as a result (Figure 11). Seabird catch reductions are important and generally popular because fishers prefer that their baited hooks capture fish that can be sold.

Seabird bycatch can be avoided by:

- setting lines from the side of the boat or only at night;
- using large baits, or dying baits blue to make them less visible to birds;
- dragging brightly coloured streamer lines that scare the birds behind the vessel during bait setting;
- using weighted lines to more rapidly drop the baits beyond the birds diving depth;
- using "hook pods" that only release the hooks at a programmed depth.

Some of these methods are illustrated in Figure 12.

Figure 11
Seabird bycatch

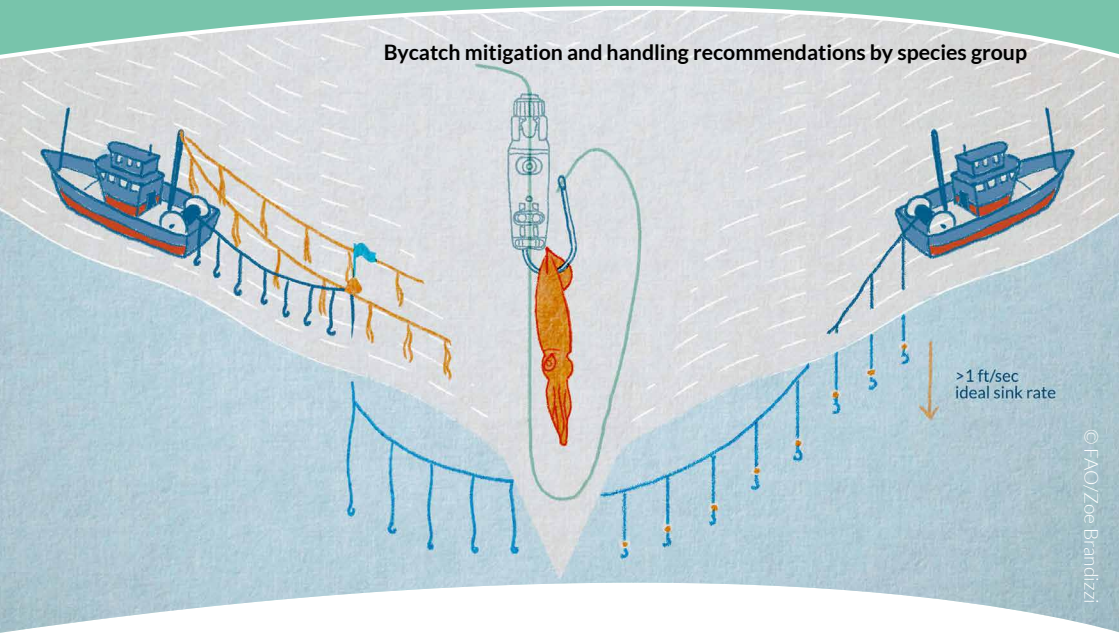


Figure 12
Seabird bycatch reduction techniques: streamers (left), hook pod (middle), and weighted lines (right).

Source: Adapted from Eng, 2019.

Marine mammal bycatch

Figure 13
Dolphin caught on a longline hook

Pilot whales and dolphins are examples of marine mammals that are known to scavenge from Caribbean longlines, and occasionally become hooked as a result (Figure 13). The use of non-offset circle hooks and weak hooks, which break under the high pressure exerted by large marine mammals, can reduce their capture. Otherwise, general avoidance with fishers informing one another of areas where many marine mammals have recently been seen can reduce marine mammal bycatch. Lines should not be set where marine mammal pods are being seen, rather move to another area. Avoidance can also reduce scavenging losses of the target catch by marine mammals. If a marine mammal is captured, the line should be cut as close to the mouth as safely possible, and this should be done quickly before the animal potentially drowns.

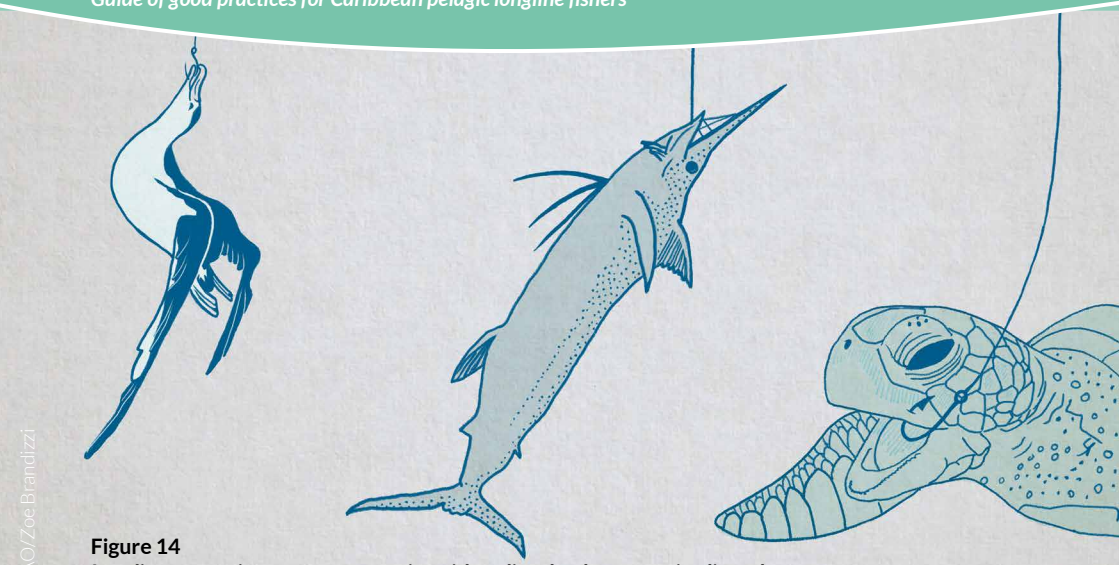


Figure 14
Longlines capturing non-target species with on line deaths preventing live releases that are advised by international regulations

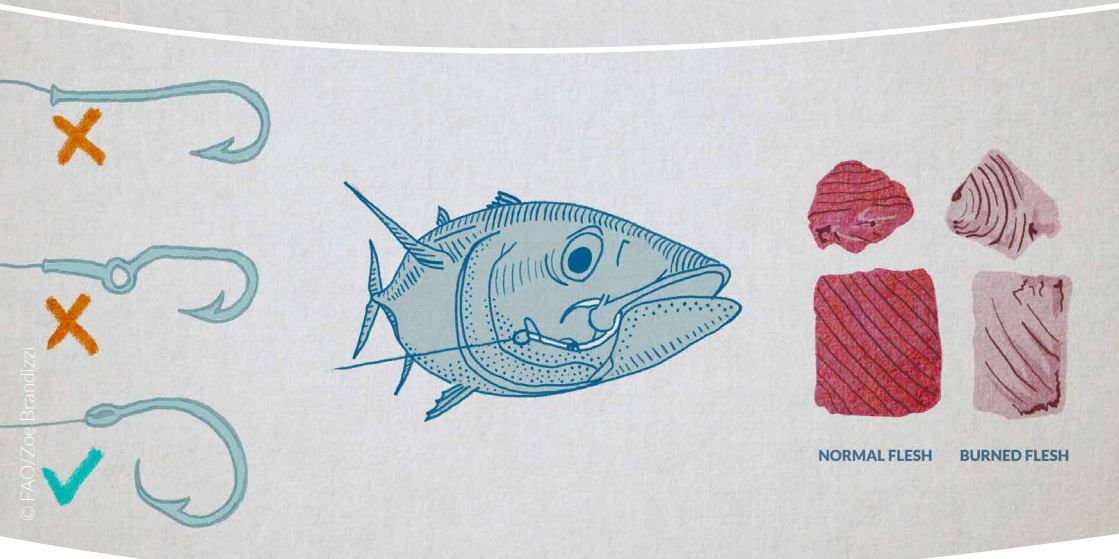


Figure 15
Hook styles (left), non-offset circle hook corner of mouth engagement (middle), and product quality implications (right)

© Hookpod. Source: Adapted from Eng, 2019.

4 SUSTAINABLE FISHING PRACTICES THAT ALSO INCREASE HARVEST VALUE

Changing aspects of the fishing gear can help reduce bycatch and help improve the economic returns from longlining.

Hook selection

Traditional J hooks often damage captured animals' gills, lungs, eyes or stomachs. Animals dead upon gear collection cannot be effectively released (if bycatch), or support all the best handling practices that could maximize their value (if target tunas). Moreover, bycatch species that are released alive but later die from their wounds represent unnecessary and wasteful marine ecosystem impacts. Each hook that catches a bycatch animal (Figure 14) has also been made unavailable to potentially catch a higher-value target species. This represents an unwanted loss in potential profits for fishers. Although some bycatch species are harvested and sold, they are typically sold at lower prices than targeted tunas and swordfish. It is better to specifically target premium-value species and maximize the quality and value of the overall achieved catch.

Non-offset circle hooks typically hook animals in the corner of their mouths and away from their gills, eyes or stomachs. This increases the likelihood of animals being alive when the gear is retrieved. This helps fishers and the marine environment because:

- Tunas kept alive on the line can support the best slaughter, bleeding and processing techniques that maximize their meat quality and value. Tunas that die under stress on the line typically do not achieve export quality standards because their meat is tainted by low oxygen conditions and stress hormones. Fishers then lose money because they can only sell these "burned fish" at low prices.
- Bycatch species can be released alive following best handling practices to minimize how many die after being released. These species are important to maintaining a healthy supporting ecosystem.

- Many scavenging species are scared of live fish and will only consume dead fish on the line. Fishers again lose potential profits when scavenging reduces harvest quantity and quality.

Trials with non-offset circle hooks in Caribbean longlines have shown:

- increased catch rates and average values for harvested tunas;
- reduced capture rates for some bycatch species, leaving more baited hooks available to catch high-value tunas instead;
- increased percentages of overfished or endangered bycatch species being alive and not mortally wounded at gear retrieval, allowing successful release.

The spacing of hooks on a longline also influences its catch rate, and the species that it catches best. This is because fish already hooked on the line can influence the actions of free-swimming fish that might eat a nearby bait. Some species scare others away from neighbouring hooks, while the struggles of some hooked fish attract and excite others in the same school of fish to feed and also become captured as a result. Hooked predators of tunas, such as sharks and large marlins, are therefore expected to reduce tuna catches on nearby hooks. Resultant lower tuna catches can cause fishers to make less money from the overall harvest. However, spacing hooks too far apart can reduce the potential for hooked tunas to encourage other tunas in the same school to competitively eat nearby baits and also become hooked. Therefore, fishers should avoid areas of high bycatch and work out what hook spacing works best in their fishing area.

Monofilament leaders

Using monofilament leaders increases the chance of capturing targeted tunas, while also allowing many shark species to escape by biting through the leader line. Increased profits, resulting from non-offset circle hooks on monofilament leaders improving average tuna catches and values, have already proved to more than compensate for the costs of some hooks being lost to sharks in Caribbean longline fisheries. Wire or cable leaders should not be used in fisheries that do not sustainably target sharks for harvest (Figure 16).

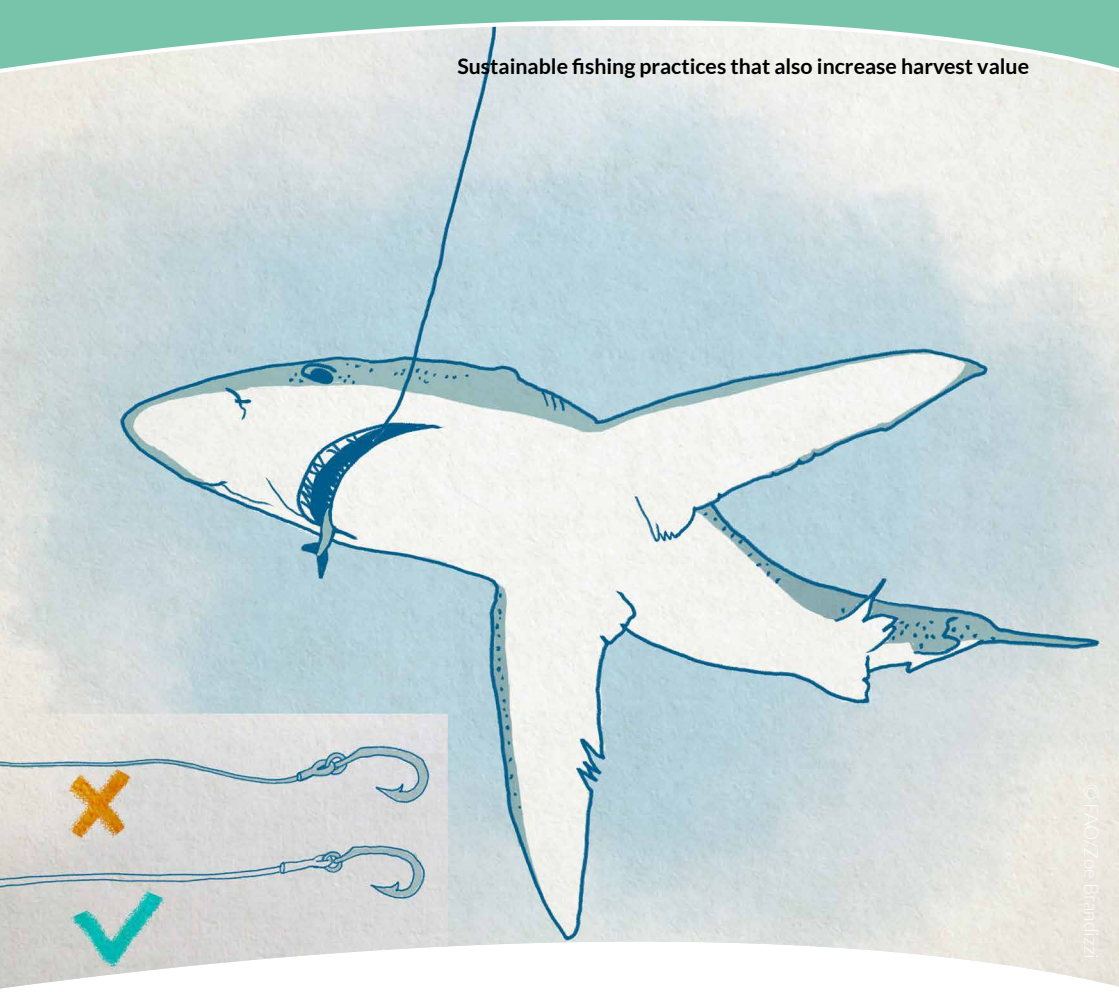


Figure 16
Cable and monofilament leader materials – implications for shark bycatch

Source: Adapted from Ward *et al.*, 2007/ Source: Adapted from Kleitou *et al.*, 2017

Non-offset circle hooks can increase shark catch rates because hooking in the corner of the mouth keeps the monofilament leader line outside the mouth of the shark. However, the number sharks captured on non-offset circle hooks with monofilament leaders is still expected to be lower than when using cable or wire leader lines, and the sharks are still more likely to survive and be safely released. Non-offset circle hooks will also keep leaders outside the mouths of tunas and swordfish, so these lines need to be replaced less often when using non-offset circle hooks.

Bait choice and baiting pattern considerations

Bait choice and configuration can have a large impact upon the success of pelagic fishing. It also influences which species are caught most, according to each species' preferred foods or feeding methods. Frozen baits should be fully thawed before use. This will reduce the damage caused when inserting the hook, and therefore help the baits stay on hooks for longer to have a better chance of catching target species. Large baits sink at slower rates, which increases the likelihood of catching birds and other surface-associated bycatch species during gear setting. However, larger baits can also reduce scavenging losses and the capture rates of smaller bycatch species that cannot bite into or swallow larger baits whole. The best bait size is different in each fishery, so fishers should experiment to determine what works best in their area.

With reference to Figure 17, horizontal baiting patterns (A) have been shown to produce greater strike and hooking rates, but bait loss tends to be faster than for vertical baiting patterns (B), which can also reduce some bycatch by sinking faster. Soak time, fishing depth, currents and water temperatures all affect how quickly baits will fall off hooks. Hooks without baits are less likely to catch fish, so it is worth looking after baits and making the most of them by using the best methods.

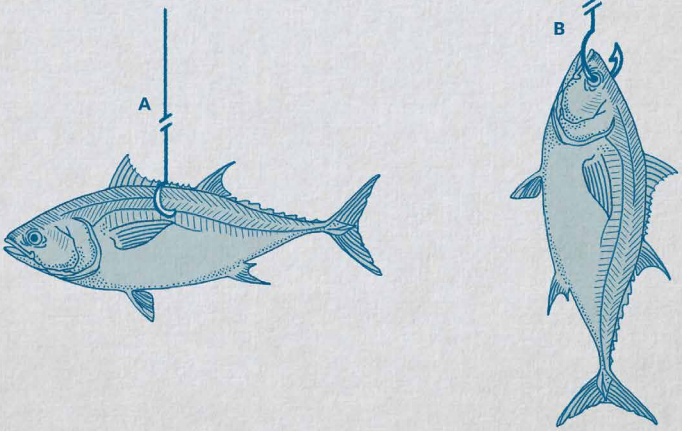


Figure 17
Bait configuration options

Source: Adapted from Kumar *et al.*, 2015

The choice of single or threaded (hooked multiple times) baiting patterns also influences the rate of bait loss and each bait's effective fishing time. Fish baits are usually hooked through the eyes or close behind the head, where firm flesh and bones can reduce unwanted bait losses. Squid baits are typically hooked (often twice) through the tail so they hang naturally in the water column (Figure 18), but hooking them through the head can reduce bait loss rates. Squid baits hooked in the head sink more slowly than those hooked in the tail which can increase unwanted catches of surface-oriented bycatch species (e.g. seabirds) in some fisheries.

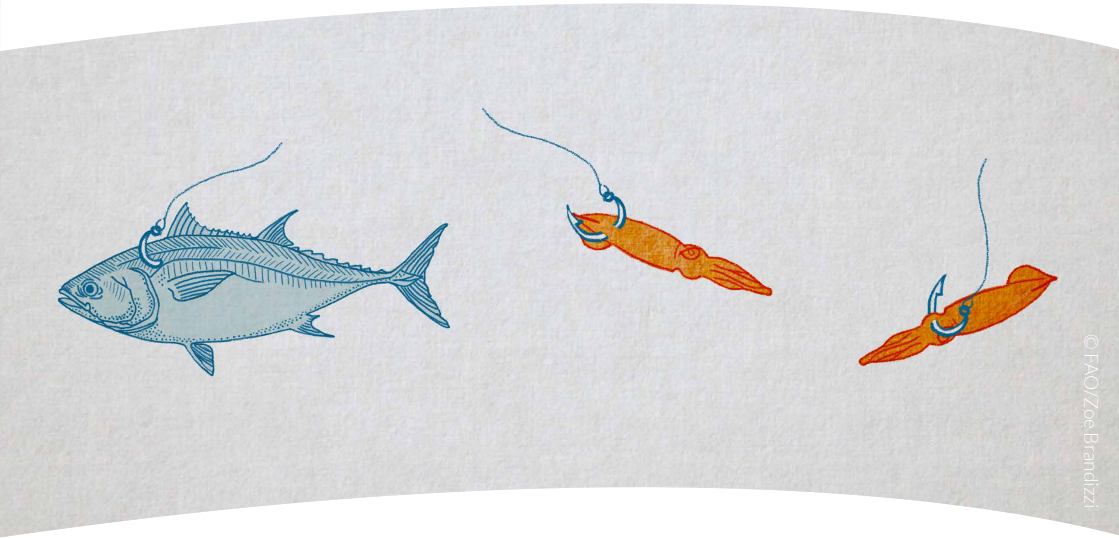


Figure 18
Common configurations for fish and squid baits

Source: Adapted from Beverly, Chapman and Sokimi, 2003

Figure 19
Tuna coring tool, pithing tool, coring line and bleeding knife equipment (left)
Caribbean longline vessels preparing with ice and equipment (right)

Source: Panaquatic, 2019

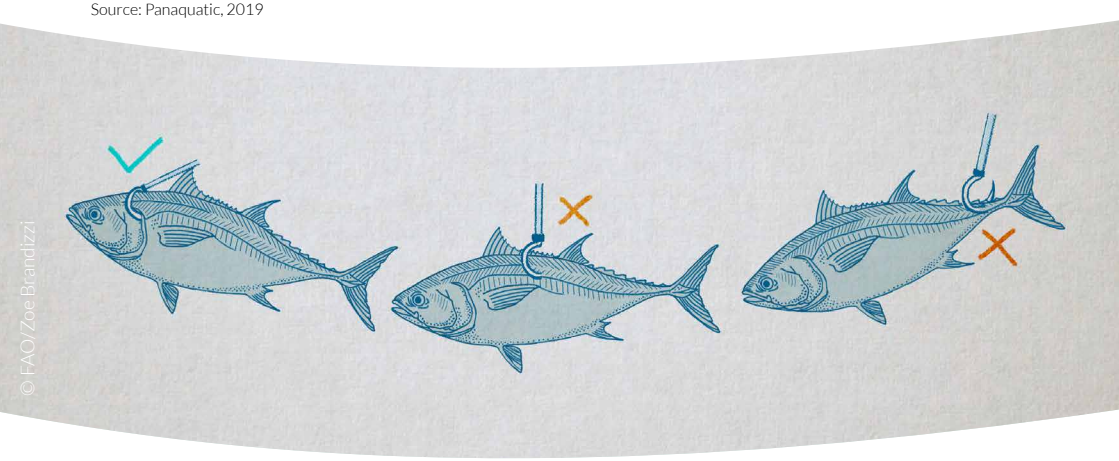


Figure 20
Best locations for gaffing tuna for harvest

Source: Adapted from wikiHow, 2019

5 ONBOARD HANDLING OF THE CATCH

This section has been developed using regionally prioritized suggestions from many documents on harvest handling (see Bibliography), from which further details can be sourced by interested readers.

Preparing to harvest

To ensure no time is wasted during onboard handling and processing, fishers should be fully prepared before they start harvesting any line. Planning begins with ensuring suitable equipment is available, and that suitable types and quantities of ice are in properly insulated cold storage areas on the vessel. The vessel deck, storage hold and all equipment should be thoroughly cleaned before the harvest begins. All fishers should also make sure their hands are clean and that proper personal hygiene standards have been applied, before the harvest commences. Tuna fishers should have, at a minimum, the following equipment prepared and ready for use before gear hauling begins:

- Rubber or foam mats should be placed on the deck to support careful and safe handling of fish.
- Gloves should be worn by all crew.
- Multiple suitably sized gaffs should be ready for pulling fish from the water.
- One or more clubs should be in convenient locations for use in quickly stunning fish when needed.
- One or more brain spikes and/or coring tools should be available for quickly killing fish.
- Ready-cut lengths of monofilament or cable should be available for coring the spinal columns of fish.
- One or more short, sharp knifes should be ready for bleeding the fish.
- One or more larger, sharp knifes should be easily available for gutting and gilling the fish.

- A seawater pump should be already running in a convenient and safe location.
- A stiff scrubbing brush should be available for the interior cleaning and rinsing of harvested fish.

Each fish should be treated individually as it arrives at the boat, rather than pulling the whole line first and only then dealing with the harvested fish. The gear should only be hauled during cooler daylight hours or at night whenever possible, to minimize the temperatures fish are exposed to during the process.

Tuna harvest and slaughter considerations

All fishing and harvest activities must prioritize the quality and ultimate value of all harvested fish. The line should not be soaked for too long, because this will result in more dead, rotting or scavenged fish on the line when it is retrieved. The best soak times to use depend on many factors, but fishers should minimize their soak times to prioritize harvest quality and value as much as possible. Fast harvests with safe and efficient handling of all fish is also key to promoting harvest quality and value.

Fish chosen for harvest should be gaffed in the back of their head (Figure 20). This will help fishers safely and quickly control the fish while also minimizing damage to the fish's valuable flesh.

If the fish is very large, it may be easier to haul it aboard using two gaffs and multiple people. To do this, the second gaff can be carefully hooked through the mouth of the fish to help hauling while causing minimal damage to the fish.

During gaffing and loading, fishers must not damage the throat section of the fish or stab the fish's heart during the gaffing process (Figure 21). An undamaged heart can continue pumping blood for some minutes after death, but damaging the heart will not allow it to pump blood and stress hormones out of the fish during slaughter and onboard processing. Not bleeding the fish properly will result in burnt flesh of lower value, and also reduce the shelf life of any resultant seafood products.

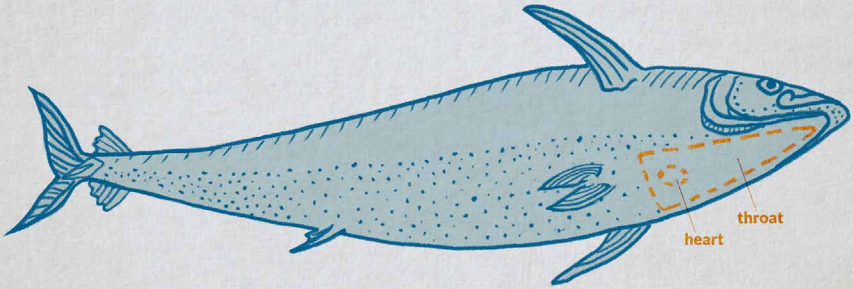


Figure 21
Throat and heart locations of a tuna

Source: Adapted from Blanc, Desurmont and Beverly, 2005.

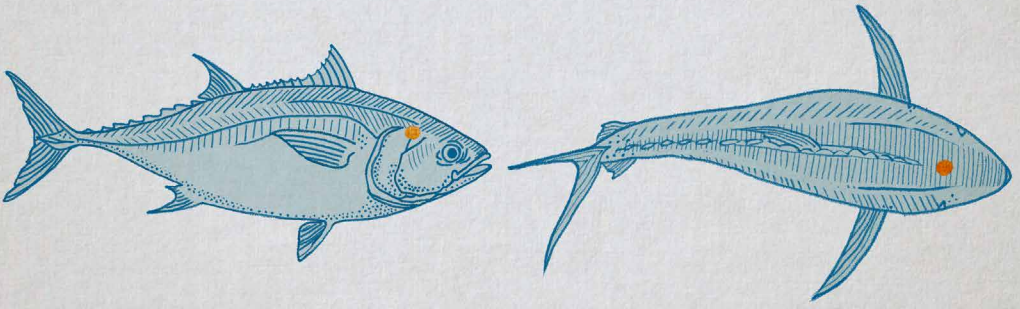


Figure 22
Lateral (left) and dorsal (right) view of a tuna's brain location

Source: Adapted from Iki Jime, 2019

The fish should be quickly killed by inserting a spike into its brain (Figure 22), and only stunned with a club if this is required for safe handling. Quick killing will reduce stress, the potential for the struggling fish to bruise or damage itself, and increase the potential value of the fish at sale. It is better to spike the brain without clubbing the fish if possible, because stunning with a club can cause the body to vibrate uncontrollably. This generates heat within its muscle fibres, which can reduce flesh quality and value. Correct spiking of the brain should make the fish immediately stop moving, except for its mouth typically falling open.Tunas should then be bled as soon as possible in order to preserve the flesh quality and value. Proper bleeding improves the appearance and quality of the flesh, as well as the taste and shelf life of its ultimate products. Fishers must move quickly to bleed the fish as soon as they can do safely and without mishandling the fish.

Various bleeding sites are available on tunas (Figure 23), but it is often best to make small cuts into the pectoral fin recesses on both sides of the fish. The arteries near the pectoral fin grooves run very close to the skin surface, so there is no need to cut more than 2 cm deep and damage the valuable flesh during this process. A running seawater hose must then be quickly inserted through the membrane between the body and gills to help expel the blood. The seawater pipe should have ample pressure and continue flowing until the water leaving the fish runs clear, to indicate enough blood has run out of the body.

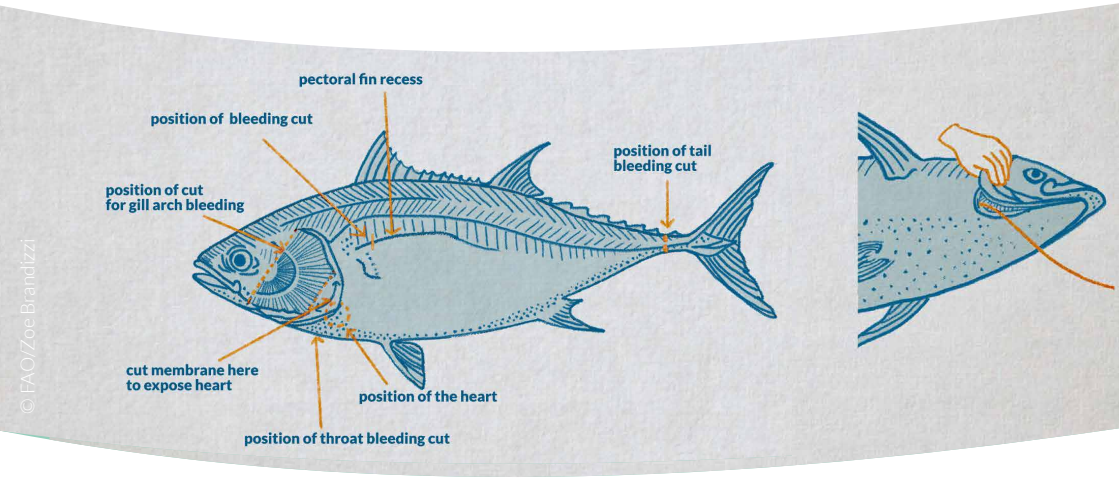


Figure 23
Tuna bleeding locations and procedure for using seawater to flush blood from a tuna's body

Source: Adapted from ASBTIA, 2011

A section of cable or thick monofilament line should then be inserted down, and rubbed in and out of, the fish's spine (Figure 24). This will stop flesh-heating muscle twitches that can still be occurring deep inside the fishes' body after death, even if the fisher cannot see any outside movements. Cleaned, old monofilament lines from when the fishers last replaced their leaders can be used for this, and the process can be repeated after removing the head of the fish. Some buyers ask fishers to then leave the line in the spine as evidence that they have implemented this best practice.

The tuna should then be gutted in a way that does not let fluids from the internal organs spill into the body cavity and taint the meat of the fish. Internal organ fluid spillage is avoided by cutting a shallow incision from the pelvic fins down the belly and stopping 1 cm before the anus. The digestive tract is then pulled through this cut and the tube is cut outside of the fish's body by the anus. The head and tail can then be quickly removed before carefully placing the fish on ice. Larger Caribbean longline fleets typically land headed and gutted tunas that are then exported into seafood markets in the United States of America.

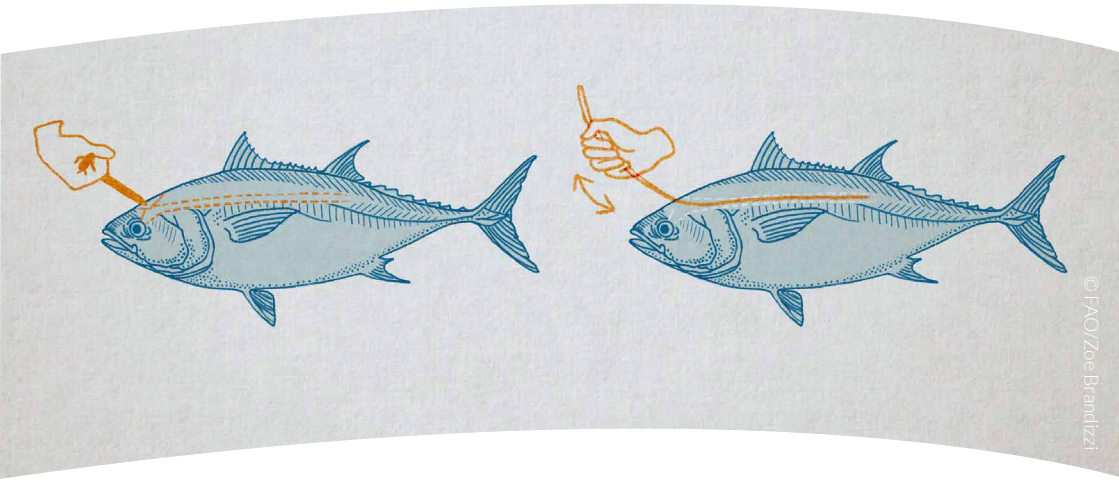


Figure 24
How to kill and core a tuna to maximize product quality

Source: Adapted from Blanc *et al.*, 2005

Harvest chilling and handling considerations

This section focuses purely on using ice to cool the harvest, because typical Caribbean vessels at the time of writing do not have refrigerated seawater, chilled seawater or more advanced quick chill or freezing systems onboard. They generally rely on ice in insulated holds to cool and store their catch. After onboard slaughter and primary processing, fish should be gently placed belly down onto a layer of ice thick enough to avoid exterior warming from the boat's hull. Ice must be gently packed into each fish's body. The fish should be arranged to ensure they are completely surrounded by ice and are not in any direct contact with one another (Figure 25). To avoid damaging fish on the bottom of a pile, do not stack more than three layers of fish and ice on top of one another.

As the fish bodies cool within ice, air pockets will develop around them due to their retained body heat melting the ice closest to them. Resultant air pockets will reduce the cooling effectiveness of the ice. These air pockets should be filled by occasionally rearranging the ice around the fish to maintain ice contact with the fish bodies. Gloves should also always be worn when handling fish, to avoid warming the skin and leaving handprints on their bodies. Suitable gloves can also promote fisher safety by providing some protection of hands during onboard handling and processing, as shown in Figure 26.

Figure 26
Use gloves when handling the harvest

Source: FAO/ Roy Bealey

6 CATCH DATA REPORTING

Suitable harvest-quality tracking is essential to ensure that end-consumers receive products that are safe to eat. Harvest traceability starts on board the vessel; therefore, all fishing vessels should maintain accurate and suitably detailed documentation for every harvested fish. Accurate data and traceability of the catch can also be used to access premium-value sustainable seafood markets. An accurate catch certificate also helps prove that the vessel was not engaged in illegal, unreported and unregulated (IUU) fishing.

The vessel captain should record the time of gear sets, harvest, onboard processing times, temperatures, and the time of icing for each fish captured. These details should be recorded with the gear setting and retrieval GPS locations alongside other data about the gear used, the gear soak time for the recorded set, and the overall harvest composition, including all bycatch, even what may be released alive. This report must be submitted to the buyers as a required vessel log, which is then used to develop local cooling curves for monitoring and reporting product-quality data in compliance with import regulators of the receiving nations. Caribbean fishers seeking to export tunas to the United States of America should ensure their fish are processed and chilled within 6 hours of death to ensure compliance with current regulations of the United States Food and Drug Administration (FDA).

Non-offset circle hooks keeping tunas alive on the line can mitigate risks of exceeding the above time of chilling after death, while hauling at night can avoid high temperature exposures that increase the rate of flesh degradation and the threat of dangerous histamine build-up. This information should be recorded with all the vessel logbook data that are also required by national and international fisheries authorities, as in Figure 27.

Block 4: Fishing activity and catch

SET #	DATE/TIME	START GPS POS. LAT/LONG	# HOOKS	BAIT TYPE	PICK UP TIME	PICK UP GPS POS.
1						
2						
3						
4						
5						
6						

Set #1

SPECIES NAME	EST. WT	DISCARDS
Yellow fin tuna		
Albacore		
Bigeye tuna		
Blackfin tuna		
Skipjack tuna		
Sailfish		
Blue Marlin		
Swordfish		
Dolphin fish		
Wahoo		
King Mackerel		
Shark		

Set #2

SPECIES NAME	EST. WT	DISCARDS
Yellow fin tuna		
Albacore		
Bigeye tuna		
Blackfin tuna		
Skipjack tuna		
Sailfish		
Blue Marlin		
Swordfish		
Dolphin fish		
Wahoo		
King Mackerel		
Shark		

Figure 27
Example of a current Caribbean longline vessel logbook template

Source: FAO

More details are available from the FDA (FDA, 2019a) and from other sources noted in the Bibliography. For fleets aiming to export to European seafood markets, guidance on catch certificate requirements is also available at:

https://ec.europa.eu/fisheries/sites/fisheries/files/docs/body/technical_note_en.pdf

BIBLIOGRAPHY

Australian Southern Bluefin Tuna Industry Association (ASBTIA). 2011. Southern bluefin tuna for the sashimi market [online]. [Cited 17 January 2020]. https://asbtia.com.au/wp-content/uploads/2013/07/Product-Processing.pdf

Bealey, R., Pérez Moreno, M. & van Anrooy, R. 2019. *The Caribbean Billfish Management and Conservation Plan*. FAO Fisheries and Aquaculture Technical Paper No. 643. Rome, FAO. 106 pp. Licence: CC BY-NC-SA 3.0 IGO. (available at www.fao.org/3/CA3366EN/ca3366en.pdf).

Bell, J. 2003. *Handling offshore catch on board* [online]. Florida Sea Grant Fact Sheet. (available at www.seagrantfish.lsu.edu/pdfs/factsheets/handling_offshorecatch.pdf).

Beverly, S. 2006. Deep-setting longline technique for bycatch mitigation tested in Hawaii. Secretariat of the Pacific Community. *SPC Fisheries Newsletter*, 119.

Beverly, S. & Robinson, E. 2004. *New deep setting longline technique for bycatch mitigation*. Secretariat of the Pacific Community. AFMA Report Number R03/1398.

Beverly, S., Chapman, L. & Sokimi, W. 2003. *Horizontal longline fishing methods and techniques: a manual for fishermen*. Secretariat of the Pacific Community.

Blanc, M., Desurmont, A. & Beverly, S. 2005. *Onboard handling of sashimi-grade tuna: a practical guide for crew members*. Secretariat of the Pacific Community.

Bonnell, A.D. 1994. *Quality assurance in seafood processing: a practical guide*. Dordrecht, Netherlands, Springer Science+Business Media.

Bushnell, P.G. & Jones, D.R. 1994. Cardiovascular and respiratory physiology of tuna: adaptations in support of exceptionally high metabolic rates. *Environmental Biology of Fishes*, 40: 303–318.

Caribbean Regional Fisheries Mechanism (CRFM). 2015. *FAD fishery model logbook*. CRFM Special Publication No. 4. 21 pp. (also available at https://issuu.com/crfm/docs/fad_fishery_model_logbook).

Clarke, S., Sato, M., Small, C., Sullivan, B., Inoue, Y. & Ochi, D. 2014. *Bycatch in longline fisheries for tuna and tuna-like species: a global review of status and mitigation measures*. FAO Fisheries and Aquaculture Technical Paper No. 588. Rome, FAO. 199 pp. (also available www.fao.org/3/a-i4017e.pdf).

Davey, K.R. 2012. Calculating quantities of ice for cooling and maintenance of freshly harvested fish at sea. *Journal of Food Science*, 77(11): E335–E341 [online]. [Cited 17 January 2020]. https://doi.org/10.1111/j.1750-3841.2012.02963.x

Department for Environment, Food & Rural Affairs and Marine Management Organisation. 2019. *Catch certificates for non-EU imports and exports of fish: how to prove your fish has been caught legally for imports and exports of fish* [online]. [Cited 17 January 2020]. www.gov.uk/guidance/catch-certificates-for-non-eu-imports-and-exports-of-fish

Diver, G. & Bevilacqua, C. 2003. *Western Tuna and Billfish Fishery: Industry Code of Practice for Responsible Fishing*. Australia, Ocean Watch Australia; SeaNet; WAPLA.

Eng, E.M. 2019. Science illustration portfolio. In: *Emily M. Eng* [online]. [Cited 17 January 2020]. www.emilymeng.com/portfolio.html

Eugène, S., Andrews, C., Dromer, C., Ishida, M. & Mohammed, E. 2015. *Maintaining good quality of FAD-caught fish: from point of capture to point of sale* [online]. CRFM Special Publication No. 6. [Cited 17 January 2020]. www.crfm.int/images/FAD_Manual_-_Volume_II_-_English_29_Feb_Electronic_Copy_4875.pdf

FAO. 1995. *Quality and quality changes in fresh fish*, by H.H. Huss. *FAO Fisheries Technical Paper No. 348*. Rome. (also available at www.fao.org/3/V7180E/V7180E00.htm).

Gangema, A.G.J., Kjayasinghe, J.M.P., Wijeyaratne, M.J.S., Perera, W.M.K., Jayasooriya, S. & Hettiarachchi, K. 2000. Handling practices and post-harvest losses of tuna catches from multi-day boats operating from fish landing sire Negombo, Sri Lanka. *Sri Lankan Journal of Aquatic Science*, 5: 87–95.

General Fisheries Commission for the Mediterranean (GFCM). 2018. *Good practice guide for the handling of sea turtles caught incidentally in Mediterranean Fisheries* [online]. FAO Fisheries and Aquaculture Series. Job no. I8951/F. FAO and ACCOBAMS. [Cited 17 January 2020]. www.fao.org/3/i8951en/I8951EN.pdf

Goodrick, G.B., Thomas, P.T., Paterson, B.D. & Smart, A. 2002. *Southern Bluefin Tuna Aquaculture Sub-program Project 4: Effect of husbandry and handling techniques on the post-harvest quality of farmed southern bluefin tuna* [online]. [Cited 17 January 2020]. http://asbtia.com.au/wp-content/uploads/2013/07/Effect-of-husbandry-and-handling-techniques-on-the-post-harvest-quality-of-farmed-southern-bluefin-tuna-1997364.pdf

Iki Jime. 2019. *Humane killing of fish* [online]. [Cited 17 January 2020]. www.ikijime.com/fish/tuna-yellowfin/

International Commission for the Conservation of Atlantic Tunas (ICCAT). 2018. *Recommendation 18-05 on Improvement of Compliance of Conservation and Management Measures Regarding Billfish Caught in the ICCAT Convention Area* [online]. [Cited 17 January 2020]. www.iccat.int/Documents/Recs/compendiopdf-e/2018-05-e.pdf

Kleitou, P., Antoniou, C., Giovos, I. & Kletou, D. 2017. How accurately are we describing the longline bycatch? The case of the 'rare' shark *Alopias superciliosus* in the eastern Mediterranean. *International Journal of Fisheries and Aquatic Studies*, 5(3): 375–378.

Korsmeyer, K.E., Dewar. H., Lai, N.C. & Graham, J.B. 1996. The aerobic capacity of tunas: adaptation for multiple metabolic demands. *Comparative Biochemistry and Physiology*, 113A: 17–24.

Kumar, A., Pravin, P., Khanolkar, P.S., Remesan, M.P. & Meenakumari, B. 2015. Efficiency of bait species and baiting pattern on hooking rates and bait loss during longline fishing in Lakshadweep Sea, India. *Indian Journal of Geo-Marine Science*, 44: 1844–1851.

McLauchlin, J., Little, C.L., Grant, K.A. & Mithani, V. 2005. Scombrotoxic fish poisoning. *Journal of Public Health*, 28: 61–62.

Morgan, A. & Pickerell, T. 2018. *SFP best practices in tuna longline fisheries report* [online]. [Cited 17 January 2020]. www.sustainablefish.org/Publications?page=2

Nakamura, R.M., Akamine, J.S., Coleman, D.E. & Takashima, S.N. 1987. *The management of yellowfin tuna in the handline fishing industry of Hawaii*. USA, University of Hawaii Sea Grant College Program.

National Oceanic and Atmospheric Administration (NOAA). 2019. Southeast Fisheries Science Centre (SEFSC). In: NOAA Fisheries [online]. [Cited 17 January 2020]. www.sefsc.noaa.gov/

Oliveira, R.B.A., Evangelosta, W.P., Sena, M.J. & Gloria, M.B.A. 2012. Tuna fishing, capture and post-capture practices in the northeast of Brazil and their effects on histamine and other bioactive amines. *Food Control*, 25: 64–68.

Panaquatic. 2019. Tuna tool kit. In: *Panaquatic* [online]. [Cited 17 January 2020]. www.panaquatic.com/shop/tuna-tool-kit/

Poisson, F., Vernet, A.L., Séret, B. & Dagorn, L. 2012. *Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners* [online]. Western and Central Pacific Fisheries Commission. WCPFC-SC8-2012/ EB-IP-12. [Cited 17 January 2020]. www.wcpfc.int/node/3282

Sparre, P.J. 2000. Manual on sample-based data collection for fisheries assessment. Examples from Viet Nam. FAO Fisheries Technical Paper No. 398. Rome, FAO. 171 pp. FAO. (also available at www.fao.org/3/X8923E/X8923E02.htm).

Thomas, P.M., Pankhurst, N.W. & Bremner, H.A. 1999. The effect of stress and exercise on the post-mortem biochemistry of Atlantic salmon and rainbow trout. *Journal of Fish Biology*, 54: 1177–1196.

United States Food and Drug Administration (FDA). 2019a. *Fish and Fishery Products Hazards and Control Guidance*. Fourth edition (August 2019). 501 pp. (also available at www.fda.gov/media/80637/download).

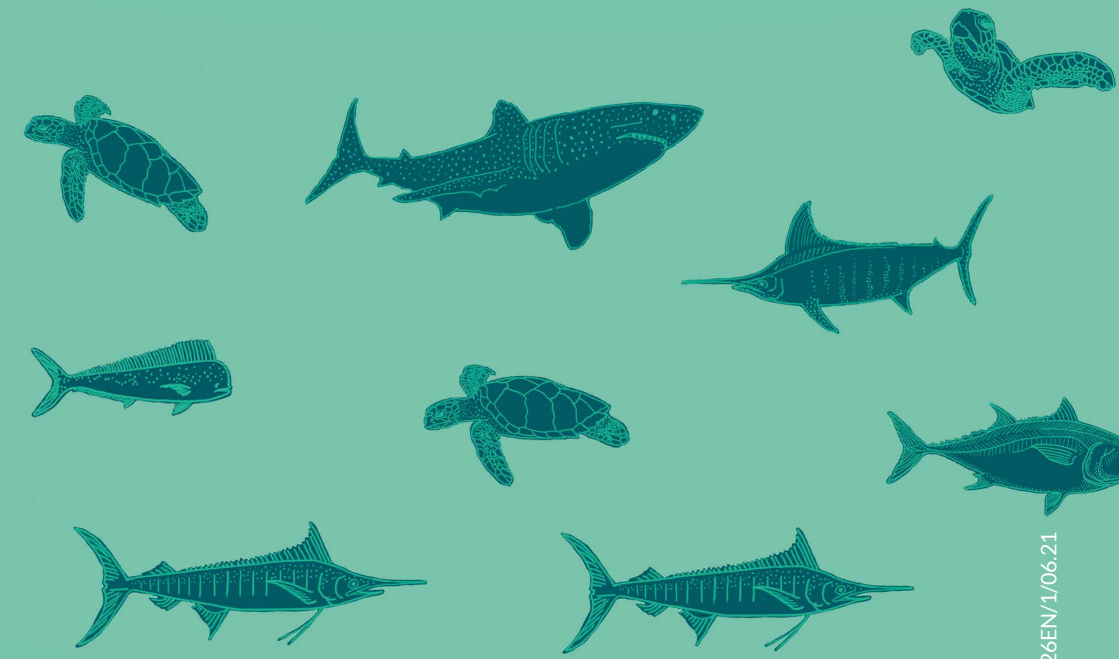
United States Food and Drug Administration (FDA). 2019b. Primary Processor Scombrotoxin Controls – Harvest Vessel Records. Available at - https://www.fda.gov/media/100358/download

Ward, P., Lawrence, E., Darbyshire, R. & Hindmarch, S. 2007. Large scale experiment shows that nylon leaders reduce shark bycatch and benefit pelagic longline fishers. *Fisheries Research*, 90: 100–108.

wikiHow. 2019. *How to gaff a fish* [online]. [Cited 17 January 2020]. www.wikihow.com/Gaff-a-Fish

This guide was developed to support implementation of good practices that will promote Caribbean pelagic fisheries' resilience to climate change impacts, and their international seafood market competitiveness, through sustainably maximizing the socio-economic benefits achieved from each harvest.

At a time of harvest reductions being required in order to help achieve sustainability, the responsible and efficient use of all marine resources is in the critical interest of all fishers, processors, traders and consumers everywhere.



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