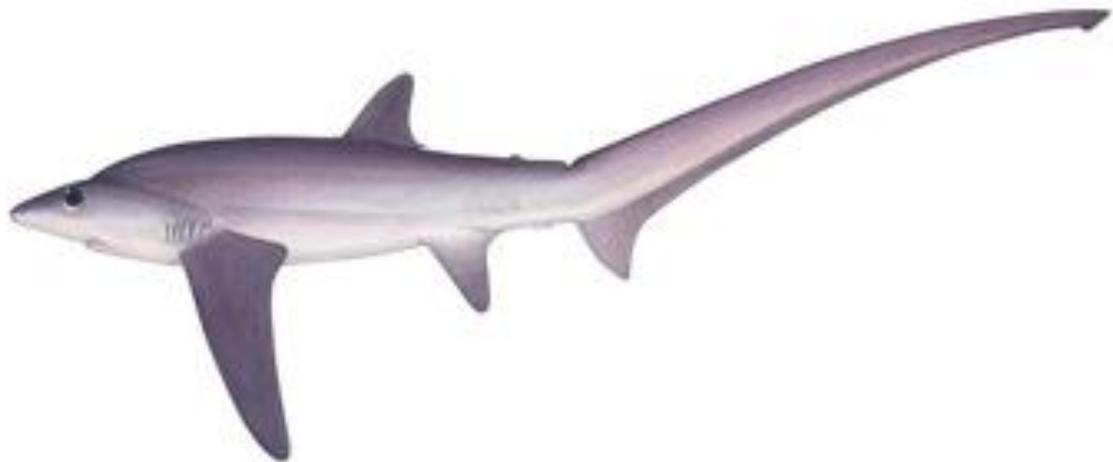


V2019.2

IOTC manual for tagging bigeye thresher shark (BTH) with pop-up satellite archival tags (PSAT) to evaluate post-release mortality (PRM)



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Introduction

Sharks are harvested either by direct targeting or as bycatch in the IOTC area of competence by a variety of fleets and gears, including industrial fleets (purse seine and longline), semi-industrial (drifting gillnets, coastal longline and pole and line), artisanal (gillnets, hand lines) and recreational (sport fishing) (IOTC, 2014; IOTC-IOSHY01, 2014).

“Although diverse, the biological characteristics of these species share some general patterns that make them potentially more susceptible to overfishing than other species, namely because they generally have a low reproductive potential, are slow growing and mature late compared to other species” (IOTC-IOSHY01, 2014). Therefore appropriate conservation measures are necessary to preserve populations of vulnerable, threatened and endangered species in order to preserve biodiversity and ecosystem stability.

Shark caught as unwanted bycatch for many fleets are discarded dead or released alive. Releasing shark alive has been considered as a robust measure of conservation for several non-targeted species. Furthermore, several IOTC resolutions, in particular resolutions 12/09 and 13/06, prohibit retention of any part of thresher and oceanic whitetip sharks, aiming to promote the release of those species and to support conservation efforts. However, the effectiveness of those retention ban policies has not been evaluated in the Indian Ocean and is probably overestimated for many shark species, especially due to the high level of haul-back mortality (Coelho et al., 2011) and unknown level of post release survival.

Tagging with Pop-up Satellite Archival Tags (PSATs) proved to be an expensive but highly efficient tool to estimate post release survival and mortality (both immediate and delayed) for many marine top predators (e.g., Moyes et al., 2006, Skomal, 2007, Musyl, 2015), including sharks (Moyes et al., 2006, Campana et al., 2009b, Musyl et al., 2011; Poisson et al., 2014). In addition to an efficient estimation of post-release survivorship, PSATs also provide important information on species ecology such as horizontal and vertical movements, habitat use and diel behaviour.

Post-release survival of sharks depends on numerous factors, including fishing gear, handling and releasing practices, shark ‘health’ state at the moment of release, etc. In the Indian Ocean information on the post release mortality of sharks is only available for a single species captured by a single gear, notably silky sharks caught in Fish Aggregating Devices (FADs) used in purse seine fisheries (Poisson et al., 2014). Based on this study, a ‘Best practices’ guide was developed for release of sharks from purse seine fisheries (Poisson et al., 2012). Some preliminary information from PSATs was also obtained for whale sharks released from purse seine nets (Escalle et al., 2014).

Survival rates of shark species caught and released from longline fishing gears are still unknown. This study is focused on the bigeye thresher shark (*Alopias superciliosus*) BTH, which is the principal thresher shark species occurring as bycatch in the major fleets. This shark species is prohibited for retention (Resolution 12/09) and is mostly impacted by LL gear; bycatch by other gears is relatively minor.

The primary objective of this study is to assess the post release survival of bigeye thresher sharks caught and released (in accordance with IOTC CMMs¹) by the major commercial longline fleets fishing in the in the IOTC Area of Competence, using common handling practices.

Below we present a detailed step by step guide to the various stages of a tagging operation.

¹ Indian Ocean Tuna Commission Conservation and Management Measure: Resolution 12/09 *On the conservation of thresher sharks (Family Alopiidae) caught in association with fisheries in the IOTC Area of Competence*. <http://www.iotc.org/cmm/resolution-1209-conservation-thresher-sharks-family-alopiidae-caught-association-fisheries-iotc>

Security in tagging operations

Please follow the standard safety regulations in place for each country/vessel. Do not make exceptions for this tagging program.

Tagger

Anyone can be a tagger: scientist, observer, vessel crew member. If national (flag state) safety rules prohibit observers from handling or manipulating fish and/or fishing gear, please select a tagger (together with the vessel captain) from the vessel crew and explain the basics of tagging basics to him/her.

Tagging equipment

Tagging applicators and tag anchors are sharp objects. Be extremely careful when you manipulate them, in particular when the tagging pole is carrying an installed applicator with the mounted tag. Be careful in your manipulations; avoid non-controlled movements of the tagging pole in order to keep yourself safe and to ensure the safety of others around you. Never point the tagging pole at another person. Keep it pointed upwards or facing outwards from the vessel, towards the object of tagging.

Rough seas

Do not try to tag a shark in bad weather. It may be dangerous for both the tagger and deck crew and may also result in a bad tag attachment. If you think that sea conditions are dangerous for manipulating a shark and/or tagging equipment abandon the tagging operation and inform deck crew about your decision.

Shark

The Bigeye thresher shark is not considered to be a dangerous species due to its relatively inactive behaviour on the hook and/or on deck. Despite its impression, the long tail of the thresher shark is a potentially dangerous weapon that should not be neglected. In the wild the thresher shark often uses its tail to stun or kill its prey (mainly small pelagic fish). Thresher sharks are capable of rapid tail movements in the air that, in combination with large range of extension of the tail, may cause serious injuries to humans. If you tag a thresher shark on the deck never approach the animal within range of the tail and remain at least a full tail's length away from the shark, even when approaching from the side. Approach the shark towards the head only and do not handle it, except to insert the tag.

Tagging a shark in the water is not a dangerous activity for the tagger, however usual precautions should be taken to avoid collision with terminal gear (hook, lead) in case of eventual de-hooking of the shark.

Fishing gears

Follow the usual safety precautions during longline hauling operations and tagging. Do not manipulate fishing gears by yourself: leave the manipulation fishing gears to vessel crew. Stay out of the direct line between the terminal gear and fish. The swivels and/or hooks may fly-back at the vessel after a bite-off, break off from the line or de-hooking. Leaded swivels and hooks may

cause serious injuries or even death. Stay away from the loops of branchlines or the mainline when retrieving on the deck.

Fish identification

Bigeye thresher shark

Consult the IOTC identification guide provided to ensure that the animal is the right species before tagging it. The Bigeye thresher shark is a big species and may attain 585 cm in total length (TL) (size at birth 130-150 cm TL) with an extremely long tail that may reach about 50% of the TL. There are at least two species of thresher sharks in tropical Indian Ocean waters (bigeye thresher and pelagic thresher) while another one (common thresher) is apparently present in temperate waters. The following external characteristics can be used to distinguish **bigeye thresher** shark from **other threshers** (Compagno, 2001; IOTC, 2012; Ebert, 2014) (Fig. 1, 2):

1. Deep grooves on head
2. Dorsal fin much closer to pelvic fins than to pectoral fins
3. Huge eyes visible from dorsal surface of the head.
4. Tail tip is broad.
5. Colour of the body from dark violet-brown on the back to silvery on the sides. Pure white colour (do not confuse with silvery) present on the belly only. White patches **NEVER** extend on the sides (that always silvery) above pectoral fins. Tips of the pectoral, dorsal and ventral fins **NEVER** white-tipped.

Other species of threshers have smaller eyes which never extend to the dorsal surface and have no groove on the head.

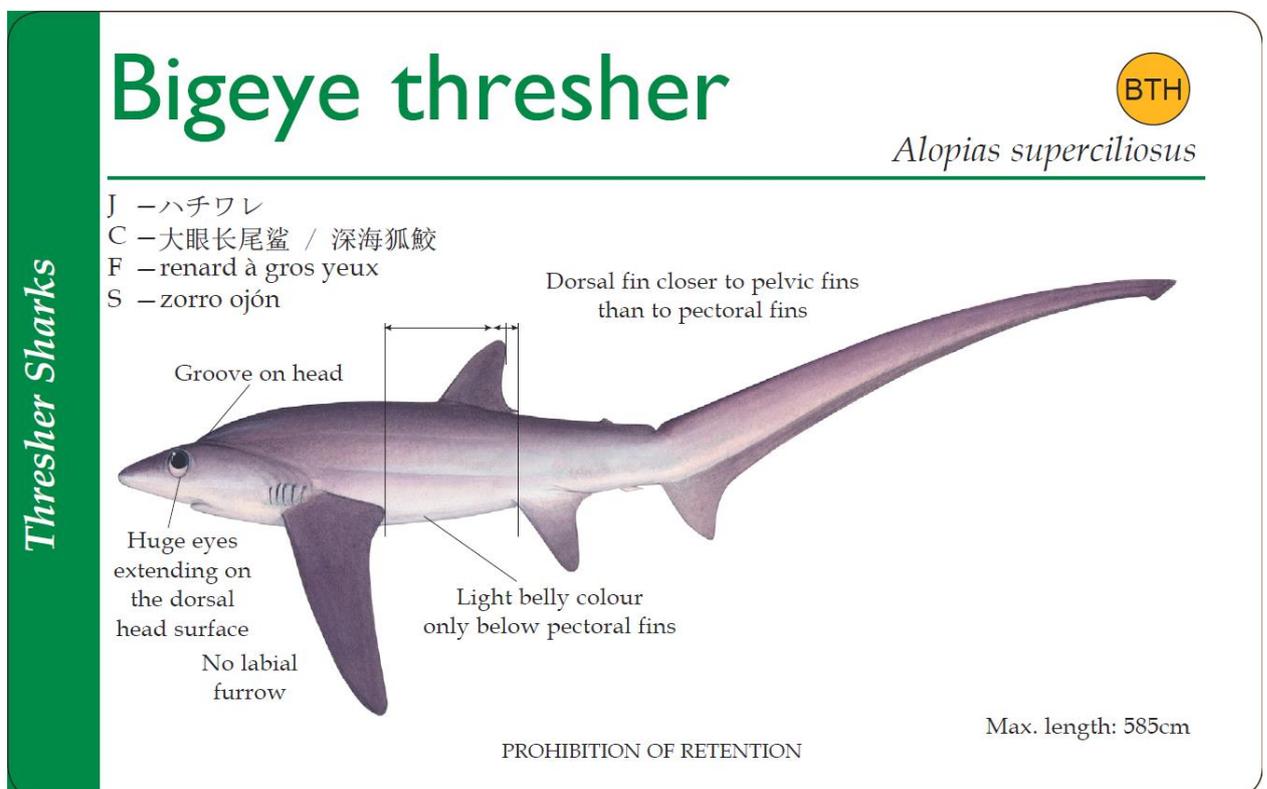


Figure 1. Extract from IOTC Shark and ray identification in Indian Ocean pelagic fisheries. Identification cards (IOTC, 2012).



Figure 2. View of the head of the bigeye thresher shark from above. Note huge eyes extended to dorsal surface of head. Photo courtesy NOAA

<https://www.floridamuseum.ufl.edu/fish/discover/species-profiles/alopias-superciliosus>

Tag handling

Pop-up satellite archival tag (PSAT): miniPATs and survivorship pop-up archival tag (sPAT)

The Pop-up satellite archival tag (PSAT) is a microcomputer designed to collect data on the environment crossed by tagged animal. During the IOTC BTH PRM study two types of PSATs developed by Wildlife Computers (Redmond, USA) will be used: (i) the miniPAT – a full functioning electronic tag programmed to collect data on habitat and migratory behaviour and (ii) the survivorship pop-up archival tag (sPAT), that is an electronic tag with reduced capabilities focused on post-release mortality detection. Data collected by both types of tags could be used for further reconstruction of the animal fate, horizontal and vertical movements, and study of animal habitat and behaviour. The tags represent a fusiform cylinder of a variable diameter with antenna and anchor suite (Fig. 3). Details of the tag are given in Figure 4.



Figure 3. Pop-up satellite archival tag (PSAT) (here MiniPAT by Wildlife Computers) and survivorship pop-up archival tag (sPAT). MiniPAT tag rigged with a stainless steel heat shrink-covered tether and a Wilton anchor; sPAT (see insertion) is clearly marked by letter 'S' (Source: Wildlife Computers, 2016, 2017).

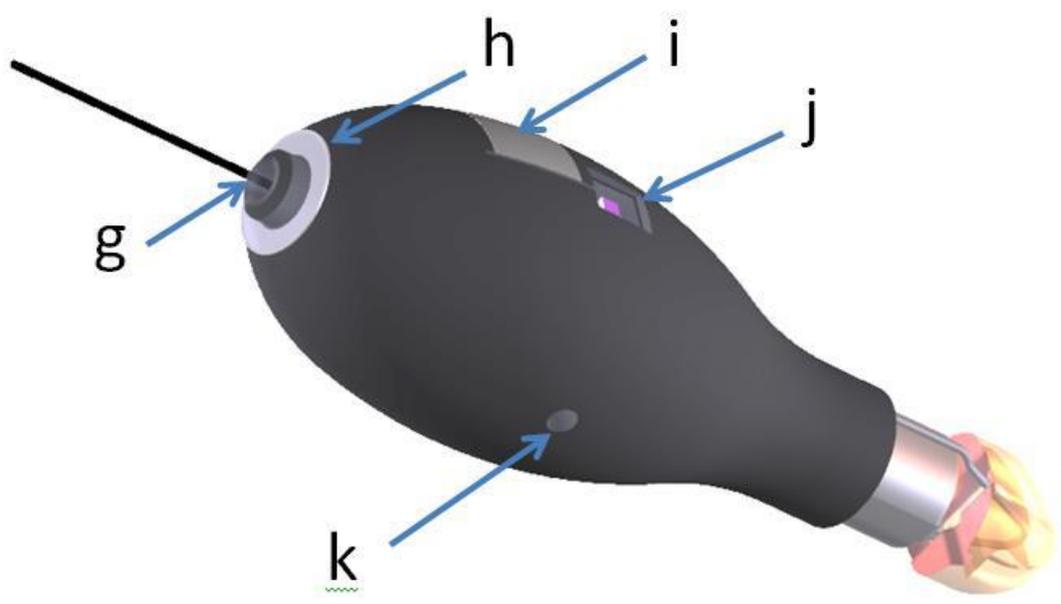
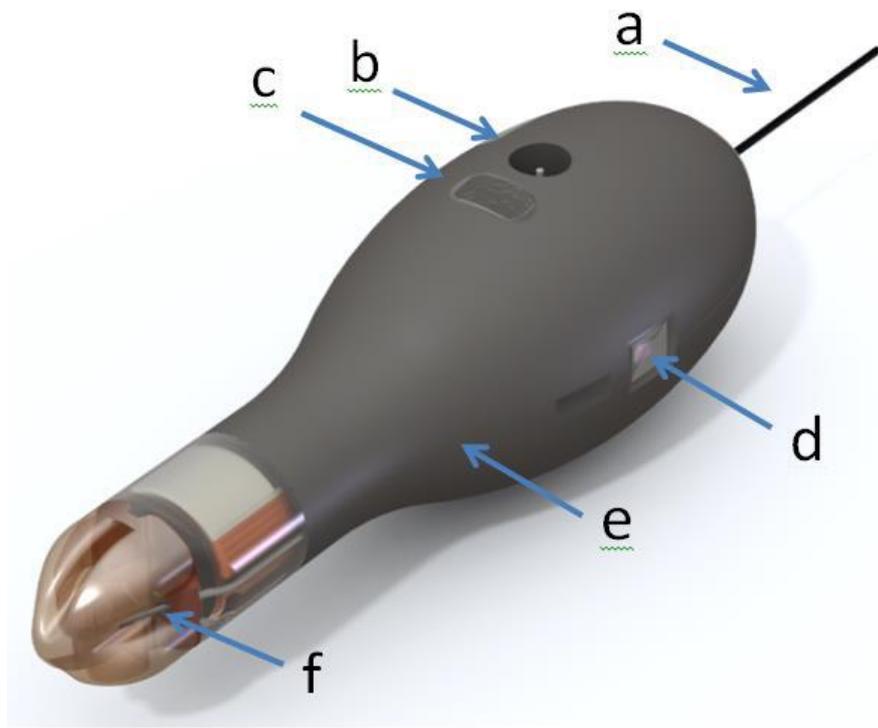


Figure 4. MiniPAT tag showing: (a) Argos antenna, (b) temperature sensor, (c) communications port with plug, (d) light sensor (1 of 2), (e) float, (f) release pin, (g) LED light, (h) wet/dry sensor, (i) ground plate, (j) light sensor (2 of 2), (k) pressure sensor (Source: Wildlife Computers, 2016, 2017).

Storage and Transport

Store tags inside a plastic 'zip-lock' bag in a cool environment (ideally around +5°C) to minimize battery passivation and keep the batteries charged. If you have no cold storage space onboard the vessel please keep the tag in the air-conditioned area. Elevated temperatures during storage will decrease battery capacity and tag life. Magnets and communication cables (if any) should be stored separately from tags.

!!! Tag should be mounted at the tagging pole just before tagging. Do not store tag mounted on tagging pole. !!!

Tags should be transported inside a hard case packed in plastic 'zip-lock' bags to protect against damage and humidity.

Tag state

Tags have been programmed using a uniform template for all tags used in the project. They are **ready for immediate attachment to fish**, so no additional programming is necessary. However it is advisable to check the state of the tag before departure and after exposure of the tag to salt water, e.g. if your attempt to attach the tag to a fish failed...

MiniPAT tags have 3 states: Start, Auto Start, and Stop. When in **Start** mode, a tag is running and begins its deployment. **Auto Start** allows the tag to Start by submersion in seawater. In **Stop** state, the tag will remain unresponsive unless connected to a computer and tag management software 'Tag Agent'. **Stop** mode is used for storage of tags for periods longer than a month (Wildlife Computers, 2016). However, onboard the vessel, tags should be stored in **Auto Start** mode irrespective of cruise duration. Tags are shipped to partners ready to dispatch among observers in **Auto Start** state: tag will switch to **Start** state as soon as it is submerged in salt water. **We do not recommend** any re-programming of tags or switching their mode onboard the vessel except for rare occasions in which the tag was started while not attached to a shark. State of the tag should be checked using the magnet provided together with the tag (see below).

sPATs (survivorship pop-up archival tag) also have three states: Auto Start, Start, and Stop. sPATs ships in **Auto Start**. A tag in **Auto Start** mode can be activated by sea water submersion. Activated tag pass into **Start** mode: data collection is running and the tag begins monitoring for its set release condition. **Stop** puts the tag into deep shutdown for storage (Wildlife Computers, 2017).

Checking and switching tag state

Attention! Do not check tag state under bright sunlight – LED indicator light will be difficult to detect. Use shelter or check tag status in the interior of the vessel.

PSAT (miniPAT)¹

A single pass of a magnet near the communications port (Fig. 4, C) will cause the tag to blink the indicator light (Fig. 4 G), revealing its current state.



Two blinks and a pause repeated 3 times means the tag is in **Auto Start**. At the end of the sequence the indicator light will remain 'On' for several seconds



Ten rapid blinks indicate the tag is **Started**.

At the end of the blinking pattern the indicator light will remain 'On' for several seconds

No blinks indicate the tag is **Stopped**.

If your tag is in **Auto Start** mode, no any further manipulations are necessary, it is ready for deployment.

If your tag appeared to be in another mode, e.g. started, please take the following actions:

1. If your tag **Started** (ten rapid blinks), it should be attached to shark immediately (we recommend do not wait more than **one** hour). If you are unable to attach tag to fish within **one** hour the tag should be returned into **Auto Start** state. Please remember you have no more than **5 days** to switch tag from **Start** state into **Auto Start** state.
Hint: within 2 hours after **Start** the LED indicator light will briefly blink at the sampling interval (5 seconds) without any manipulations with magnet. If you occasionally discover that your tag is blinking – it is started! Please attach tag to fish or to switch it into **Auto Start** state with a magnet.
2. If you cannot attach tag to shark within recommended one hour please use magnet to return your started tag into **Auto Start** state. A magnet should be used to toggle the MiniPAT out of **Start** mode. This requires two specifically timed passes of the magnet. First, swipe the magnet near the communications port (Fig. 4, C) and wait for the tag to indicate its current state. At the end of the blinking pattern (10 rapid blinks in a row if **Started**) the indicator light will remain 'On' for several seconds. Please swipe the magnet a second time during the extended light-on stretch, the state will toggle. The second swipe needs to happen in the period when the light is 'On' (Wildlife Computers, 2016). Please wait 30 seconds and to check tag state again. It should be in **Auto Start** state now: two blinks and a pause repeated 3 times.

Tag (miniPAT) was submerged in seawater but not attached to a fish

If the tag was submerged in seawater but not attached to a shark (e.g. an attempt to tag a shark or exposure tag to salt water during rough weather) please take the following actions:

1. Rinse tag in fresh water and wipe it dry with paper or regular towel.
2. Carefully check if LED indicator light is blinking at sensors sampling rate (5 seconds).
3. Please check tag state with a magnet. If tag is **Started** (ten rapid blinks) please return tag into **Auto Start** state (see instructions above).
4. Please pack the tag in the zip-lock bag for further storage or next deployment. Please use tag exposed to salt water for your next fish to be tagged.

¹ Please note that sPAT requires different types of manipulations with a magnet.

sPAT (survivorship pop-up archival tag PAT) marked by letter 'S'

sPAT is shipped in **Auto Start** mode, no further manipulations are necessary, it is ready for deployment.

However if you want to check status a single pass of a magnet near the communications port (Fig. 4, C) will cause the tag to blink the indicator light (Fig. 4 G), revealing its current state.



Gradual transition from bright to dim indicates that the tag is in **Auto Start**.

This tag has **no other blink sequences** produced by sPAT in response to **magnet** pass. However LED produces other blink sequences after immersion of tag in seawater.

Tag (sPAT) was immersed in seawater but not attached to a fish

If tag was submerged in the seawater but not attached to a shark (e.g. an attempt to tag a shark or salt water exposure during rough weather): you have only **one hour** to switch the tag back into **Auto Start** mode! Please take the following actions:

1. Please note that tag will show the single sequence of 10 blinks after immersing for 10 s in seawater. No more blinks will be visible!



Ten rapid blinks after 10 s indicate the tag is **Starting**. Once upon immersion in the seawater.

2. Rinse tag in fresh water as soon as possible and wipe it dry with paper or regular towel.
3. Please swipe magnet along communication port to return tag into **Auto Start** state. Tag LED should demonstrate a gradual transition from bright to dim.



Gradual transition from bright to dim indicates that the tag is in **Auto Start**.

4. Please pack the tag in the zip-lock bag for further storage or next deployment. Please use tag exposed to salt water for your next fish to be tagged.

The 'S' tags have 'security' feature against premature deployment. If the tag gets wet while in Auto-Start mode, but not long enough to enter "deploy" mode as above, the LED gradually goes from bright to dim and remains in Auto-Start mode. However to secure yourself please swipe magnet to check tag status and to return it back into **Auto Start** mode.

Please wait 30 seconds and to check tag state again. It should be in **Auto Start** state now: LED will show gradual transition from bright to dim.

Data recording and reporting

IOTC bigeye thresher shark tagging card

The data recording cards provided with the tags are tag-specific. Each card has unique numbers corresponding to the tag serial number, PTT (Platform Terminal Transmitter) number and tether number. Using tether number recaptured shark could be traced to initial tagging place, date and time. The card is printed on waterproof paper and can resist short-time water exposure. Please use a pencil to fill the form. Please fill the form **immediately** after release of tagged shark. Exact and complete information is essential for correct processing and interpretation of data. **Never** wait until the end of longline operation.

Data recording

Please clearly write down Tagger name, Observer name (please repeat this information if tagger an observer is the same person), vessel name, international radio call-sign (four to five symbols: characters or in combination with numbers, e.g. '9UKTY') and captain name (optional).

Release date and time. Please note exact time (vessel time) when shark was tagged and released.

Release Position. Please write down **exact** vessel GPS position at time of shark release. Precise release data are important for further data processing.

Hooks between floats and leader (branchline) length. Please note how many hooks between floats were in the basket where tagged shark were caught. Leader (branchline) length is commonly not changed during the cruise so this information could be collected at the start of the cruise.

Soaking time. Is calculated from the beginning of set to the end of haul in hours and minutes. Please fill this information at the end of the longline hauling.

Shark condition

The description of **shark condition** was adapted from NOAA-JIMAR codes (Common Oceans, 2017). Please identify shark condition before making the decision whether or not to tag the animal and to ensure the correct type (model) of tag is selected. Please also note shark condition after release. Cross the box below corresponding to the shark condition. The following terms should be use to describe the state of the shark.

Dead – Animal showed no signs of life. **Do not tag this fish.** This individual represents at-vessel mortality and should be noted in the regular observer log.

Alive Injured – Animal was alive but there was clear evidence of a serious injury. **Please use 'S' tag (sPAT) to tag this fish.**

The serious injury category is met when **ONE OR MORE** of the following injury criteria exists:

- 1) the hook has been swallowed (e.g. the bend of the hook is not in the tissue surrounding the jaw but has been ingested posterior to the oesophageal sphincter or deeper),
- 2) bleeding is seen from the vent and/or gills,
- 3) stomach is everted (please specify in comments), or
- 4) other damage (e.g. depredation, entangled in gear) occurred prior to hook/gear removal.

Alive, in Good condition - Animal appears lively and healthy with no obvious signs of injury or lethargy (animal should appear active). **Please use PSAT to tag this fish.**

This condition code is used when ALL of the following criteria are observed and met:

- 1) no bleeding,
- 2) shark is actively swimming,
- 3) not upside down and/or sinking,
- 4) no external injury,
- 5) not hooked in the esophagus, stomach or the gills.

Alive - Animal was observed to exhibit signs of life, but its level of activity or injury could not be established or the criteria for the **Alive Injured** or **Alive, in Good condition** are not met. **Do not tag this fish.**

Please cross the box corresponding to the correct field reporting shark condition at haulback (i.e. before tagging) and after release (after attachment of tag).

A summary table for evaluation of shark conditions and corresponding type of tag to be used is presented on the reverse of the tagging form.

Tagging conditions

Please follow the usual vessel crew handling practices for thresher shark. If vessel crew release sharks in the water –tag the shark in the water. Similarly, if vessel crew usually haul the shark onboard before release, tag the shark on deck. If handling practices vary depending on shark size, please follow whatever the standard practice is for the particular individual that has been caught. Cross the corresponding box in the tagging form.

Hook type, hooking location and related information

Identify all hook types used by the boat before fishing operations commence. Ask the captain or fishing master about hook types rigged and available onboard. Check rigged branchlines for the types of hook ready for deployment. That will facilitate further hook identification during tagging.

Circle hook is a hook with the point turned perpendicularly back to the shank (Cooke and Suski, 2004; Watson, Kerstetter, 2006). Do not confuse it with **tuna hook** or **teracima** hook that also has circular shape but its point never turned perpendicularly to the shank (Fig. 5).

Please cross black box below correct hook type. If vessel' crew use several types of hooks and you cannot identify hook correctly, select '**unknown**'.

Please write down **hooking location**: mouth, gills, throat, stomach, tail, other fin. Bigeye thresher shark is commonly **tail hooked**. If you don't see hook and cannot identify exact hooking location, write '**unknown**'.

Please note **if the hook was removed** from the shark or not. If not, please write down the estimated length of the '**trailing gear**': part of branchline still attached to hook after shark release.

The amount of leader left on the shark is determined by subtracting the length of leader (branchline) left attached after cutting off the shark from the original leader length.

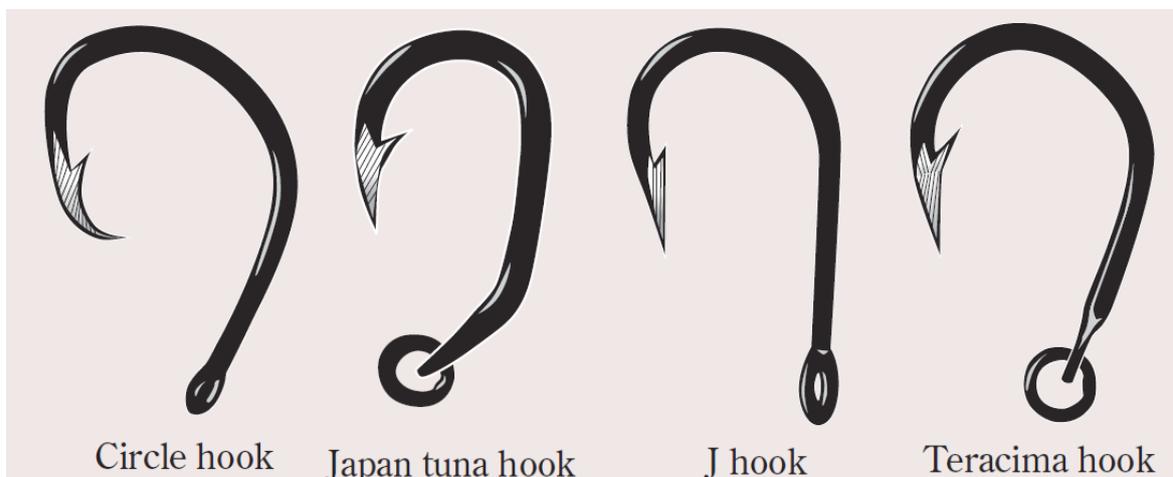


Figure 5. Most commonly used types of hooks in pelagic longline fisheries. Source: Secretariat of Pacific Community

http://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Beverly_09_LLTerminalGear.pdf

Biological data

Please note the **sex** of shark (cross correct box). If you cannot identify the sex, select '**unknown**'.

Whenever possible, the observer or a vessel crew member should take a photograph of the tagged shark. Please note if the shark was photographed or not.

Please estimate the **tagging time**: time spent to tag and to release the shark: on deck or in water before release (min).

Sea state. Roughly estimate sea state and put cross in the correct field: 'Calm', 'Moderate', or 'Rough'.

Please note the **sea surface temperature** (SST).



Example. Each tag will be supplied with tagging card

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien

iotc ctoi



IOTC bigeye thresher shark tagging card

Tag serial N°

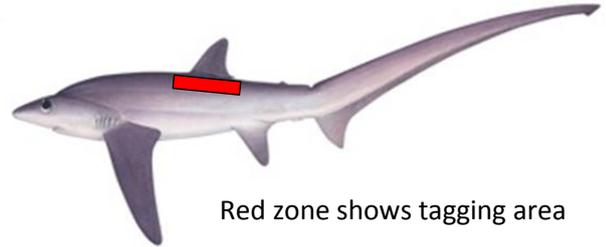
Tag PTT N°

17P9999

99999

Tether N°

BTH99



Tagger name				
Observer name				
Vessel name				
Radio call sign				
Captain name (optional)				
Release Date		Release time		
Day	Month	Year	HH	mm

Release Position (exact GPS)						
Latitude	dd°mm.mmm'		N/S	Longitude	ddd°mm.mmm'	
	°				°	E
Soaking time (from beginning of set to end of haul), hours : minutes			HH	mm	Hooks between floats	Leader length

Shark conditions	Dead	Alive injured	Alive good	Alive	
At haulback	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
At release	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Tagging conditions	In water		On the deck		
	<input type="checkbox"/>		<input type="checkbox"/>		
Hook type	Tuna	J-hook	Circle	Teracima	Unknown
	<input type="checkbox"/>				
Hooking location (mouth, gills, throat, stomach, tail, other fin)					
Hook removed	Yes	No			
	<input type="checkbox"/>	<input type="checkbox"/>			
If hook was not removed, estimate length of trailing gear (cm), and type				Mono	Wire
				<input type="checkbox"/>	<input type="checkbox"/>
Sex	Male ♂	Female ♀	Unknown		
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Fork length (cm)				Measured	Estimated
				<input type="checkbox"/>	<input type="checkbox"/>
Photograph of tagged shark	Yes	No			
	<input type="checkbox"/>	<input type="checkbox"/>			
Time on deck / tagging time in water before release (min)					
Sea state	Calm	Moderate	Rough		
	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		
Sea surface temperature					

Please use space on reverse side of the page for additional comments



Example. Each tag will be supplied with tagging card printed on waterproof paper

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien

iotc ctoi



Inverse side of the IOTC bigeye thresher shark tagging card

Filling instructions:

Please write down required information in the empty fields immediately after shark release.

Cross 'check-boxes' below correct values.

Comments

		
Do not tag	Tag with miniPAT	Tag with sPAT
<u>Dead</u> Animal showed no signs of life	<u>Alive, in Good condition</u> Animal is lively and healthy with no obvious signs of injury or lethargy (animal should be active)	<u>Alive Injured</u> Animal is alive but there was clear evidence of serious injury
<u>Alive</u> Animal exhibit signs of life, but its level of activity or injury could not be established	no bleeding, shark is actively swimming, not upside down and/or sinking, no external injury, not hooked in the esophagus, stomach or the gills	the hook has been swallowed bleeding is seen from the vent and/or gills, stomach is everted (please specify in comments), or other damage (e.g. depredation, entangled in gear) occurred prior to hook/gear removal
Do not tag	Tag with miniPAT	Tag with sPAT

How to complete 'IOTC bigeye thresher shark tagging card'

The form provided should be filled out completely (preferably in English) for each bigeye thresher shark tagged and released

Please write clearly with a pencil.

Tagging card have two types of fields: 'Empty' – should be filled with written information and 'check-box' (small black square): please put cross against correct value.

If you make a mistake just cross wrong information and write correct information nearby.

Tagging

Prepare your equipment

Discuss with vessel skipper or head of deck crew (boatswain) where you can safely keep your tagging equipment: on route to fishing grounds and later during fishing operations – ready for tagging.

Keep your tags in a safe place – away from direct sun and waves but easy to reach if you are going to tag the shark. Keep a stock of rubber bands together with tags.

Tagging pole

Tagging poles supplied by IOTC have maximum length 1.8 m. If tagging from your vessel requires longer tagging pole please fabricate tagging pole in the port or at sea from tagging poles provided by IOTC and equipment available onboard. E.g. you can use lower part of IOTC tagging pole and attach it to bamboo pole or gaff used by vessel crew to mount catch onboard. Several layers of duct tape ('Scotch') are sufficient to keep two pieces together safely.

Mounting tag to a tagging pole

Do not attach tag to a tagging pole before you estimate state of shark.

Tag should be mounted on tagging pole just prior to tagging. Select the appropriate type of tag: '**S**' for **Alive Injured** shark or '**miniPAT**' for fish **Alive, in Good condition**.

Put or adjust rubber stopper on the applicator (Fig. 6 a) in order to protect shark from deep penetrations of applicator and potential injury. Free applicator end should be adjusted to shark size but not exceed in all cases 8-9 cm for large bigeye thresher shark reducing free applicator length to 6-7 cm for smaller fish. Rubber stoppers are not supplied anymore with tagging applicators by Wildlife Computers. However vine bottle cork either natural or plastic can be used as replacement (Fig. 6 b).

Prior to mounting tag on tagging pole remove label with tag serial number, PTT and deployment period information (Fig. 7) and keep label in safe place. It should be returned together with tagging form. Please use rubber bands to attach tag to a tagging pole. Carefully insert anchor eye into tagging applicator slot (Fig. 8 a, b) and install body of the tag on the tagging pole using rubber bands (Fig. 8 c). You can use alcohol or 'Betadine®' to disinfect tag anchor, tether and tagging applicator (needle). Avoid spreading disinfectant over the tag.

Always clean your equipment, in particular applicator (needle) after tagging.

Be ready to tag a fish and collect data.

Be ready for the tagging operation; never try to tag a shark unprepared as it may be dangerous.



A



B

Figure 6. **A.** Position of rubber stopper on the applicator adjusted to limit applicator penetration inside fish body to 9 cm and **B.** natural cork stopper used for same purposes.

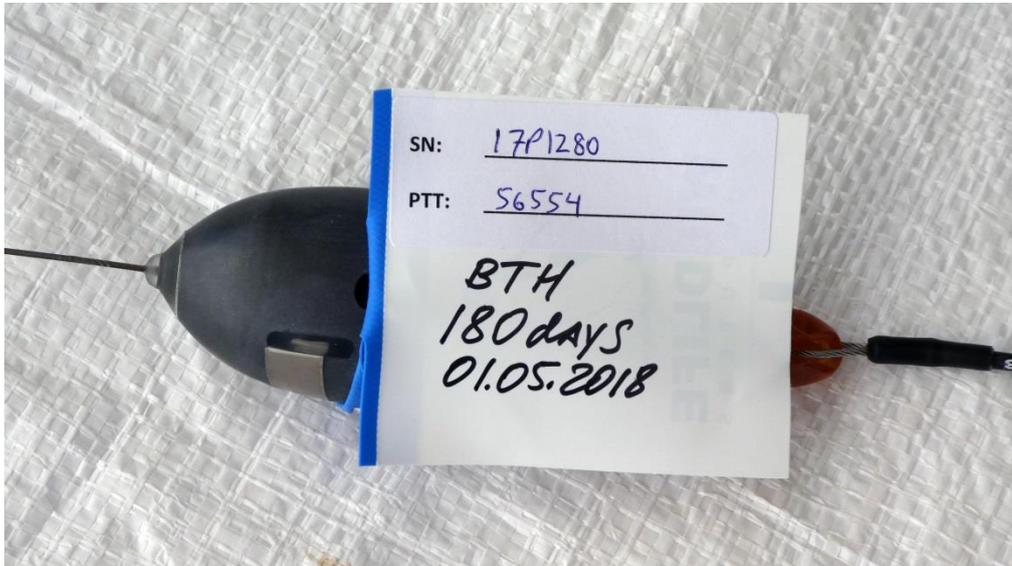


Figure 7. Tag label showing serial number, PTT and programming details. Should be removed before tagging and returned together with tagging form.



A



B



C

Figure 8. Mounting of tag on a tagging pole. Upper panel (A, B): attachment of anchor to applicator; Lower panel (C): attachment of tag to tagging pole with rubber bands.

Shark length estimations

Size estimation: estimate **fork length** not total length.

Estimate shark length before tagging in water or take the fork length measurement of sharks tagged on deck.

Vessel: try to locate reference marks on the boat hull and try to measure distance between them for further shark size estimations. Write down these measurements for further reference.

A measuring tape or calipers could be used for sharks tagged on the desk.

Directly measuring fish in the water is complicated and not advisable for a person who has never previously tagged a fish. To measure fish length while it remains in the water, you can rig up a simple rope measure. It should be flexible, and at least 3 meters long with clearly distinct marks separating meters. Electric tape of various colours could be used to create marks. A good method is to attach a tennis ball (or similar) to the end and to attach the other end to a line cutter (if any) or pole. When the fish is alongside the boat, float the tennis ball to the tail fork.

Fish handling and tagging

Fish selection and evaluation of state

Where a thresher shark was caught, please carefully look at fish to verify species and fish state: check hooking position, shark activity, bleeding, and presence of injuries.

Fish handling

Please follow the usual vessel crew handling practices for thresher shark. Fish should be manipulated in the same way as in ordinary fishing operations: if common practice of the particular boat is to release from water, the tagging should be undertaken on shark in the water; if vessel crew pull shark onboard before release, the tagging should take place on the deck.

Tagging in water

The vessel should, when feasible, remain in gear slowly moving forward during tagging in the water so that the shark continues to swim. Otherwise the shark's position will be erratic and it will be difficult to tag (Common Oceans, 2017).

At least two persons should be involved in tagging: one to manipulate the branchline, retrieving shark close to bulwark door and another to handle the tagging pole with attached tag.

Again, do not forget remove label (Fig. 7) prior to tagging and put label in your pocket, then keep label in safe place. It should be returned together with tagging form.

To tag, aim for the base of the dorsal fin (Lyon et al., 2017). However placing the anchor into the dorsal musculature anterior to first dorsal fin is acceptable (Fig. 9).

Try to tag the shark from above or from the tail end, so the tag pulls evenly on its anchor (Lyon et al., 2017).

Do not let the tag anchor enter the gut cavity, it must stop within the muscles on the back of the animal, which is why rubber stoppers are used on the tagging needles (Lyon et al., 2017).

Use a single sharp movement of tagging pole to penetrate the shark's skin and to set the anchor inside the dorsal musculature below the first dorsal fin. Apply sufficient force to your movement.

Tail-hooked sharks, if alive, are usually more active than mouth-hooked sharks. It would therefore be more difficult and dangerous to tag a tail-hooked shark, so proceed with the tagging of a tail-hooked shark only if you feel confident.

Cut the leader following usual boat practice and release the shark.

Keep branchline to estimate length of trailing gear. Estimate length of trailing gear based on known length of branchline and length of branchline parts left onboard. Write down estimated branchline length in the tagging form.

Fill tagging form immediately after shark release with particular attention to release position, date and time.

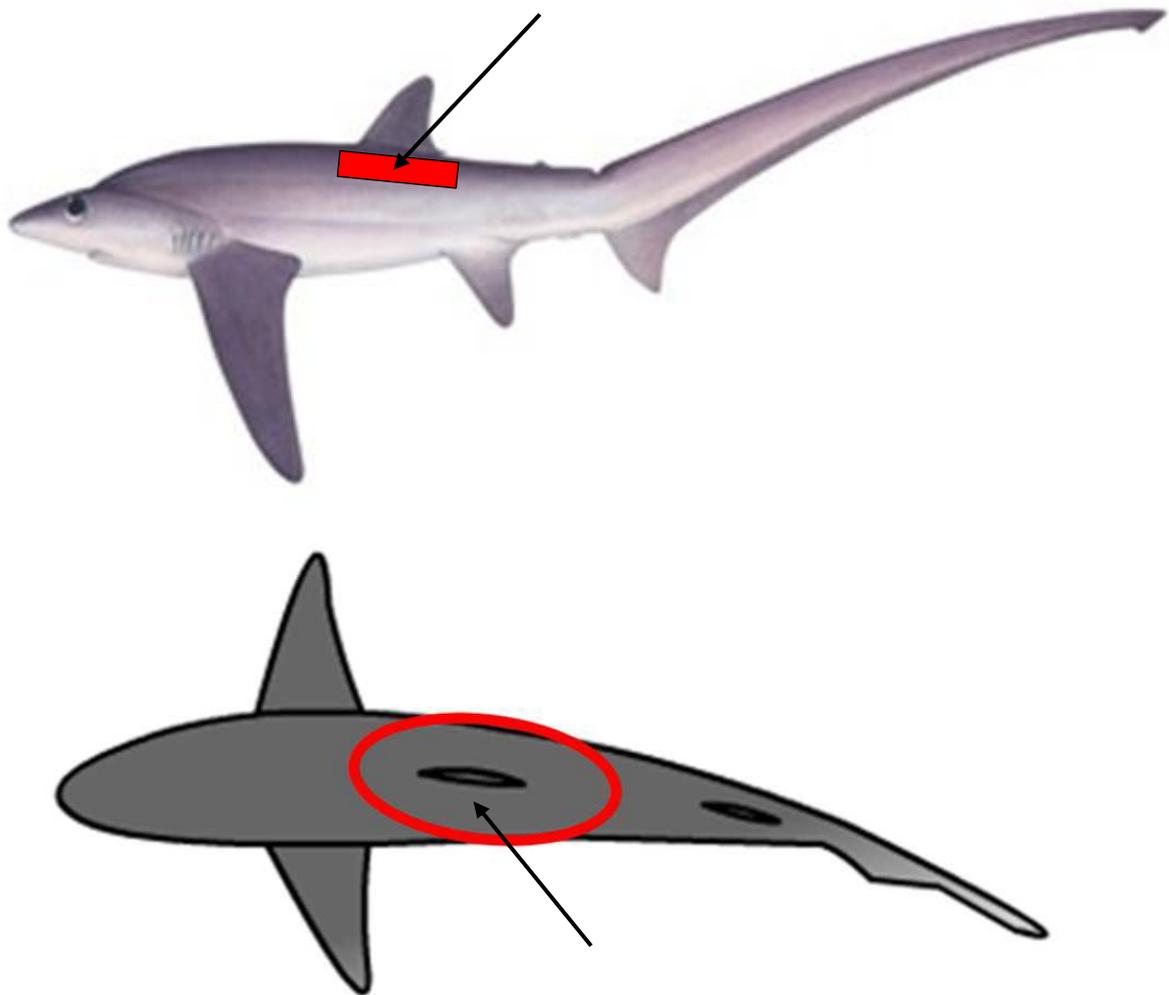


Figure 9. Tagging area and direction of tag anchor penetration. Upper panel lateral view. Lower panel (adapted from Lyon et al., 2017) – dorsal view.

Tagging on deck (only where hauling the shark on-deck is common handling practice for the vessel)

It is critical to find the right place on the vessel to work and to be prepared for the contingency of dealing with more than one shark on deck at a time (Common Oceans, 2017). However do not tag more than 2 BTH sharks in a single set.

When tagging on deck remember security advice regarding shark handling: avoid shark tail and teeth as these could be dangerous.

To help keep a shark calm while on deck, the eyes of the fish can be covered with a wet chamois synthetic cloth. In most cases a hose with running seawater placed in the mouth to ensure oxygenation of the gills is also calming.

Try to remove the hook while tagging on deck.

Again, do not forget remove label (Fig. 7) prior to tagging and put label in your pocket, then keep label in safe place. It should be returned together with tagging form.

Insert the tag anchor below the base of first dorsal fin through the pterygiophores using a short tagging pole.

Adjust the stopper. Keep the stopper ~5-7 cm from the tip of the needle for small sharks that are brought on deck. You can select appropriate length of applicator tip yourself depend on shark size. Anchor should penetrate skin and muscles and pass between pterygophores. Aim forwards and slightly sideways so the tag trails more naturally. See Figure 9 for a guide. Do not insert the tag vertically, as the tag anchor may go into the stomach cavity of the shark. Use a shallow enough angle to avoid the stomach cavity (Lyon et al., 2017).

Take the fork length using calipers or a measuring tape.

If the hook was not removed, please measure or estimate the length of the trailing gear and write it down in the tagging form.

Release the shark as soon as possible respecting safety protocols but attempting minimise damage to the shark. Pay attention to tag!

Fill tagging form immediately after shark release.

Reporting of tagging data

Tagging event

As soon as tagged shark was released information should be transferred within **48** hours to the observer institution, to the IOTC (Sarah.Martin@fao.org, james.geehan@fao.org) and to the Program co-ordinator (island.www@gmail.com). The following information should be sent: Vessel name, observer name, tag number, release date, release time, exact geographic position, fish condition.

Tagging data

On return from the cruise all IOTC bigeye thresher shark tagging cards should be presented to the local partner (national institution that is running observer program). Scanned copies of cards should be send to the IOTC (Sarah.Martin@fao.org, james.geehan@fao.org) and to the Program co-ordinator (island.www@gmail.com).

Non-used tags

Tags that have not been used should be returned to the local partner (national institution) for tag checking and further distribution for the project purposes.

Tagging kit.

1. IOTC Guide: Shark and ray identification in Indian Ocean pelagic fisheries.
2. Tagging poles: long, short.
3. PSAT (minPAT) and sPAT tags.
4. Tagging forms (unique for each tag)
5. Magnets
6. Rubber bands

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