IOTC Working Party on Ecosystems and Bycatch (WPEB)
Cape Town, South Africa

10-14 September 2018

A progress report on the implementation of the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project)

IOTC BTH PRM Project Team*

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ABSTRACT

We present a progress report on the IOTC bigeye thresher shark post-release mortality study project (IOTC BTH PRM Project). The goal of the study is to evaluate efficiency of the IOTC CMM focused on conservation of thresher sharks of the genus *Alopias* (Resolution 12/09). Summary of the collective efforts since IOTC WPEB 13, including development of formal documents, operation manuals, PSATs acquisition and preparation, field operations is presented.

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 (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-IOShYP01, 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-IOShYP01, 2014). Therefore appropriate conservation measures are necessary to preserve populations of vulnerable, threatened and endangered species in order to preserve biodiversity and ecosystem stability.

Sharks caught as unwanted bycatch for many fleets are discarded dead or released alive. Live release of sharks has been considered a robust measure of conservation for non-targeted species. IOTC Resolutions 12/09 and 13/06 prohibit the 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 these retention ban policies has not been evaluated in the Indian Ocean and is probably overestimated for many shark species due to the high level of haul-back mortality (Coelho et al., 2011) and unknown levels of post-release survival.

Tagging with Pop-up Satellite Archival Tags (PSATs) has 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., 2009; 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 release practices, shark condition or 'health' 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 the 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 mostly impacted by LL gear with relatively minor interactions with other gears, and retention is prohibited (Resolution 12/09).

The primary objective of this study is to assess the post-release survival of bigeye thresher sharks caught and released (in accordance with IOTC CMMs[1]) by the major commercial longline fleets fishing in the in the IOTC Area of Competence, using common handling practices.

Experimental design

Experimental design of the study was discussed during an *ad hoc* meeting of IOTC scientists organized within the framework of the 13th WPEB in San Sebastián, Spain, and further developed intersessionally.

Key points of the experimental design are: utilisation of two types of tags: (i) survivorship PATs (SPATs) that are designed to evaluate short-term post release mortality (up to 60 days) and (ii) miniPATs for evaluating potential delayed mortality beyond 60 days, and obtaining additional high-priority information for WPEB (IOTC-WPEB13, 2017, IOTC-IOShYP01 2014) such as data on horizontal movements and habitat utilization. The total sample size is 54 (34 sPATs and 20 miniPATs) across all fleets included in the project. Assuming an average non-reporting rate of 10%, it is expected that information will be obtained from at least 48 BTH tagged (minimum recommended sample size is 40 individuals) (Common Oceans, 2017).

Five major fleet were initially expected to take part in the project: Japan (tropical tuna fleet), Taiwan (tropical tuna fleet), EU: France, Portugal, and Spain. However, during the project development phase Spain withdrew itself from the project (communication with Instituto Español de Oceanografía (IEO) in January 2018) and South Africa agreed to join the team.

In order to obtain data that are representative of the actual level of post-release survival of bigeye thresher sharks in commercial fishing operations, tags should be deployed from commercial longline vessels fishing according to their usual practices. Tags should be deployed by trained scientific observers or trained crew members who are allowed sufficient time to focus on tagging with minimal disruption to the standard release methods used by the crew.

The complete experimental design document is attached here as **Annex I**.

Equipment acquisition

A tender for PSATs and tagging equipment acquisition was posted by IOTC in accordance with FAO rules, including a call for Expressions of Interest from suppliers to fully explore the market. Strict FAO requirements caused some delay in the purchase of equipment; this concluded in April 2018, i.e. five months after the intended purchase date of November 2017.

Pop-up Archival Satellite Tags (PSATs) were purchased from a single manufacturer, Wildlife Computers, to ensure comparable reliability and performance. The supplier was selected based on known tag performance and reliability based on IOTC and international experts' opinion and the independent literature available to verify this (Common Oceans, 2017).

[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*

Complementary equipment: including tagging poles, applicators and equipment for tag programming and manipulations (magnets, USB cables) were also purchased and polo shirts were designed as incentives for project participation and as advertising materials.

Tag preparation

The project coordinator, E.V. Romanov, undertook a mission to the IOTC Headquarters in Seychelles between 29 April and 6 May 2018. The pincipal goal of this trip was tag programming and the preparation of tagging kits for each partner organisation. The mission was successfully completed: all 54 tags were programmed according to the tagging template agreed by the project team (see. Experimental Design, **Annex I**) together with 54 tagging cards printed on waterproof paper with a unique tag ID number already printed on the card. The equipment was combined into **five** tagging kits; one for each partner. Each tagging kits included: tagging poles (1.8 m long), short tagging handles, tagging applicators, USB interface cable for satellite tags and magnets for tag activation and manipulation.

Training material

A draft tagging manual was developed (IOTC manual for tagging bigeye thresher shark (BTH) with pop-up satellite archival tags (PSAT) to evaluate post-release mortality (PRM)). This is presented as a document for review by the current WPEB (IOTC-2018-WPEB14-INF02).

LoU

A Letter of Understanding was developed to formalise the engagement among project partners by outlining the project objectives, methods and outputs as well as defining roles and responsibilities of each partner organisation. The LoU was finalised by 21.06.2018 and was signed by all partners by 15.08.2018.

Tagging efforts to date

In April 2018 an observer embarked on a Portugal-flagged LL vessel that planned to operate in the south-western Indian Ocean. Although IOTC tags were not yet available at the moment of vessel departure, thanks to co-operation with the similar PRM study (Project POREMO, IRD) for oceanic whitetip shark (*Carcharhinus longimanus*), the Portuguese partners were supplied with four tags ahead of scheduel: 2 mini-PATs and 2 sPATs.

To date 3 BTH have been tagged (2 with mini-PATs, and 1 with sPAT). Preliminary results will be presented and discussed during the WPEB14 Meeting.

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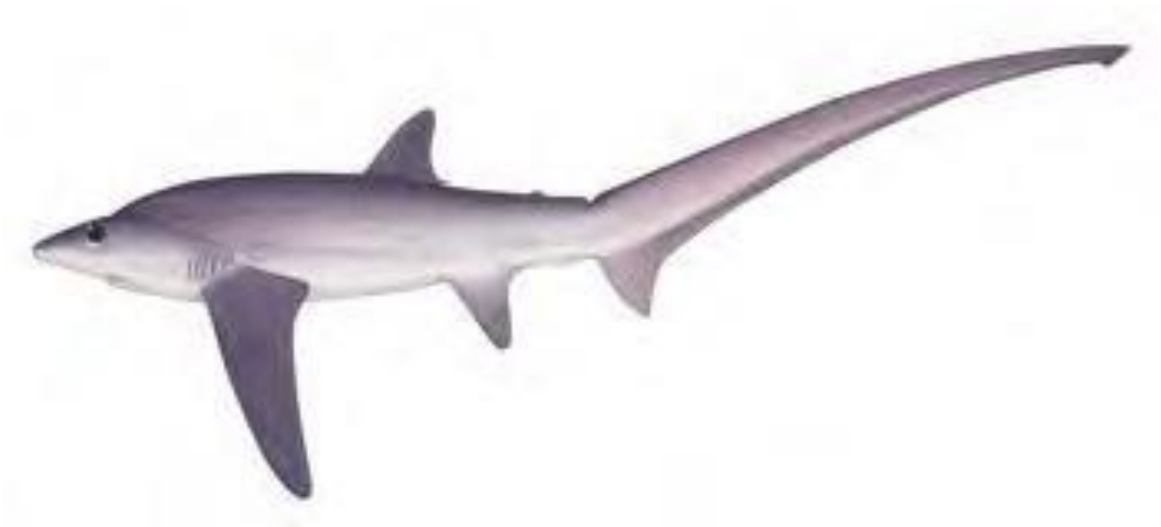
IOTC bigeye thresher shark (BTH) post-release mortality (PRM) study with pop-up satellite archival tags (PSAT) experimental design



Evgeny V. Romanov (CAP RUN, Île de la Réunion) in collaboration with IOTC BTH PRM Project Team

Background/introduction

Following the request of the IOTC Scientific Committee (SC) to the WPEB '…to assess the efficiency of management resolutions on no retention species…' (IOTC-2014-SC17-R) post release mortality (PRM) studies for shark species with an IOTC retention ban were ranked as high-priority both in the WPEB program of work and in the Indian Ocean Shark Year Program (IO-ShYP) (IOTC-2014-IOShYP01-R[E]). Responding to these requests a concept note IOTC-2015-WPEB11-INF11 Rev_1 was developed which focused on the major shark species interacting with IOTC fisheries, including species with a retention ban. The total cost of the program was estimated at US$ 770 000. In 2017 the IOTC Secretariat received funding from the EC of which EUR 153 000 was made available for shark PRM studies. Recognizing that such funding is not adequate for the entire proposed study, an *ad hoc* meeting of IOTC scientists was organized within the framework of the 13th WPEB in San Sebastián, Spain, to discuss and develop a shark PRM study in light of the specific research priorities of the Commission.

There are currently two IOTC Resolutions outlining retention bans on sharks within the IOTC Area of Competence; Resolution 13/06 on oceanic whitetip sharks *Carcharhinus longimanus*, OCS and Resolution 12/09 on thresher sharks, Family Alopiidae (Resolution 12/09). A separate project, led by IRD, France, is currently underway focusing on EU fleets in the Indian Ocean and will be investigating the PRM mortality of a single species; the oceanic whitetip shark. That study will cover the purse seine fleets of EU,France and EU,Spain and the longline fleets of EU,France, EU,Portugal.

In order to use resources most efficiently and maximise outputs, it was agreed that this would be framed as a complementary partner study focussing on the other species group with a retention ban; the thresher sharks. Undertaking a single species approach to the experiment was agreed to be the best option in terms of obtaining adequate fleet coverage and an achieving an appropriate sample size. Priority was given to the bigeye thresher shark, *Alopias superciliosus*, the main thresher shark species occurring as bycatch in Indian Ocean fisheries. The species is primarily impacted by longline, while catches by other gear types are relatively minor.

The primary objective of this study is to asses the post release survival of bigeye thresher sharks caught and released (in accordance with IOTC CMMs[1]) by commercial longline vessels during fishing operations in the Indian Ocean for the major fleets and common handling practices in the IOTC Area of Competence.

Fleets/areas

The study is designed to cover five major fleets operating in the tropical region of the Indian Ocean: Japan, Taiwan,China, EU,France, EU,Portugal.

Project duration

Estimated project duration is two and half years: January 2018-June 2020.

[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*

Experimental approach (experimental equipment, means)

Tagging with Pop-up Satellite Archival Tags (PSATs) has proved to be an expensive but highly efficient tool for the estimation of 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., 2009, Hammerschlag et al., 2011; Musyl et al., 2011; Poisson et al., 2014). In addition to providing an efficient estimate of post-release survivorship, PSATs also provide important information on species ecology such as horizontal and vertical movements, habitat use and dial behaviour (Common Oceans, 2017).

Considering the costs and benefits associated with the range of tags available, two types of tags were selected for use in the study: (i) survivorship PATs (SPATs) that are designed to evaluate short-term post release mortality (up to 60 days) and (ii) miniPATs for evaluating potential delayed mortality beyond 30 days, and obtaining additional high-priority information for WPEB (IOTC-WPEB, 2017, IOTC-IOShYP01 2014) such as horizontal movements and habitat utilization. Such information is essential to evaluate the interactions between protected species and fisheries and can also answer questions about population connectivity within the Indian Ocean basin.

Both types of tags will be provided by single manufacturer: Wildlife Computers to ensure comparable tags reliability and performance (Common Oceans, 2017).

Scientific observers placed onboard commercial fishing vessels will be the end-point persons responsible for implementation of the BTH PRM tagging project in the field.

Sample size

The number of tags to be deployed was decided based on a compromise between the level of funding available, number of fleets across which to stratify the sample and the overall sample size needed to ensure robust results. It was decided that 34 sPATs and 20 miniPATs would be used, totalling 54 tags dedicated to BTH tagging across all fleets included in the project. Assuming an average non-reporting rate of 10%, it is expected that information will be obtained from at least **48** BTH tagged (minimum recommended sample size is **40** individuals) (Common Oceans, 2017).

Tag repartition by fleets is presented in the table:

Fleet	Number of tags
miniPATs	
Japan tropical	5
Taiwan tropical	5
EU (France, Portugal)	10
Sub-total	**20**
Survivorship PAT	
Japan tropical	8
Taiwan tropical	8
EU (France, Portugal)	18
Sub-total	**34**
Total	**54**

Deployment logistics

In order to obtain data that are representative of the actual level of post release survival of bigeye thresher sharks in commercial fishing operations, tags should be deployed from commercial longline vessels, fishing according to their usual practices. Tags should be deployed by trained scientific observers allowed sufficient time to focus on tagging with minimal disruption to the standard release methods used by the crew.

Within each fleet up to 6 fishing trips longer than 30 days (or more trips if the duration is less than 30 days) should be covered by scientific observers with a goal to deploy 1-2 miniPATs and 2-3 sPAT per trip.

The bigeye thresher shark is not a commonly caught species and so it may not be possible to achieve the project objectives based on a random approach to the selection of individuals for tagging. Therefore sharks should be selected non-randomly: all bigeye thresher sharks in conditions defined by experimental design (**see below**) should be tagged as soon as they occur in the catch. Nevertheless, the deployment of all available tags in single set/place should be avoided; no more than **2** BTH sharks should be tagged in a single set of longline.

Shark handling

The aim of the PRM experiment is to replicate commercial fishing conditions and evaluate the probability of shark survival after release by commercial fishing vessel crew. Therefore for fleets that release BTH in the water without taking the individual onboard the tagging should take place in the water whereas if the vessel crew routinely haul sharks onboard, the sharks should be tagged on deck. Consequently, the approach to tagging should be vessel-specific. National partners should undertake efforts to evaluate the extent of each type of handling practice in their fleets which may also depend on shark size and crew preferences.

Individuals selected for tagging (shark condition)

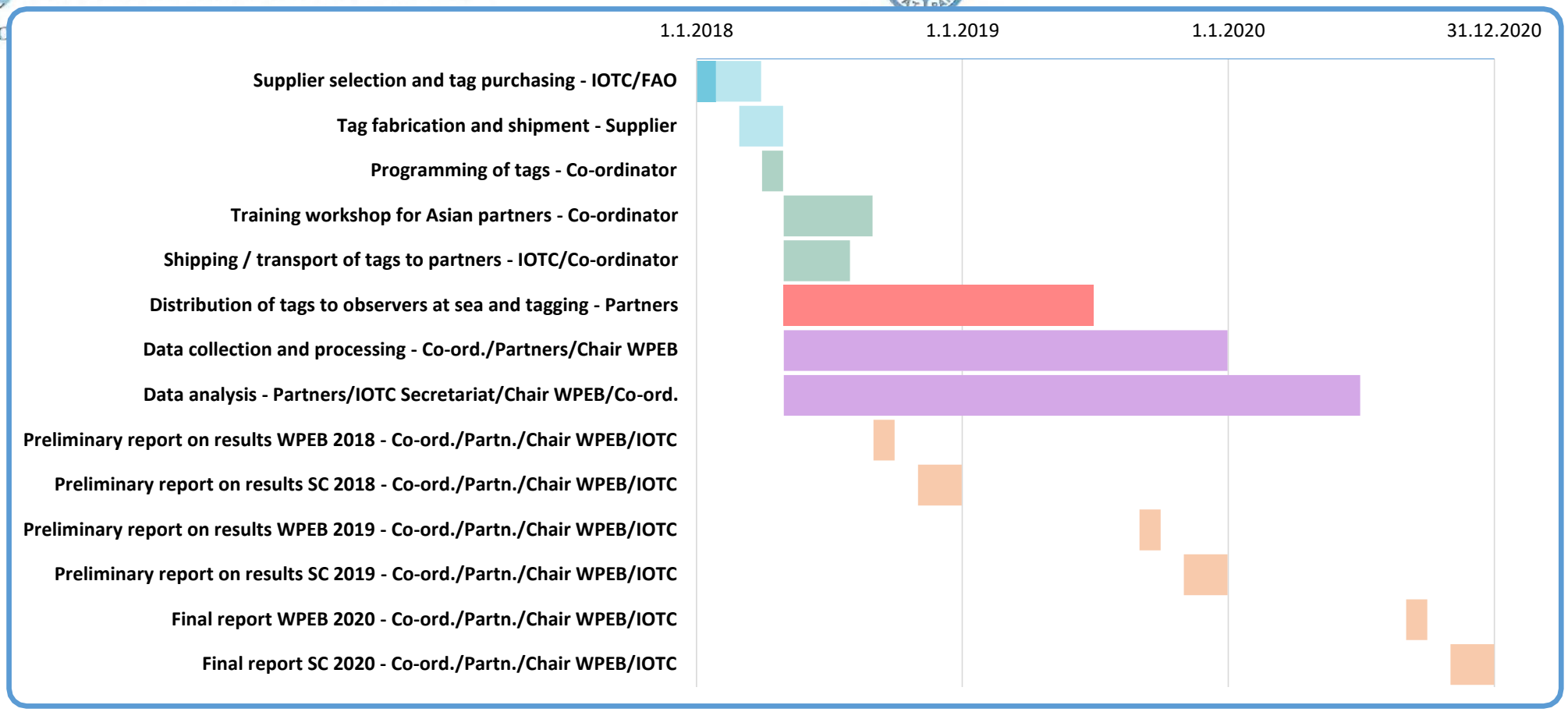
The experiment is focused on the evaluation of a probability of shark survival after release. Therefore sharks that are already **dead** at haulback should **not be tagged**. All thresher sharks caught during the observed trip (dead or alive) should be recorded by an observer in order to develop robust estimates of fishing mortality. Such information should be provided by Implementing Partners as complementary data for each tagging cruise.

Only **live** sharks should be tagged. Observers should provide details on the injury and status of the shark. **Injured** shark should be tagged with a sPAT but **healthy** sharks should be tagged with a miniPATs (more details on the definition of shark condition are given in Appendix I and in the Observer Tagging Manual).

Shark size. The bigeye thresher shark is a large species which ranges from approximately 130 to 150cm TL at birth. Therefore only bigeye thresher sharks greater than 80 cm FL should be selected for tagging.

Schedule of the project

The tentative project schedule is presented in Figure 1.



Legend:

- Acquisition of tags
- Tag preparation / distribution
- At-sea operations – tagging
- Data collection and processing
- Reporting

Figure 1. Tentative schedule of BTH PRM study project

Tags

Rigging

Tags will be shipped pre-tethered, with a stainless steel wire tether of 12-14 cm in length, with small titanium dart anchors attached. Wildlife Computers will be responsible for tag rigging.

Programming

The sPAT should be programmed to stay on the shark for 60 days in order to estimate both immediate mortality and short-term delayed mortality. Wildlife Computers will be responsible for sPAT programming.

The miniPATs should be programed to stay on the shark for 180 days in order to estimate delayed mortality and also to collect data on horizontal movements and habitat utilization using the following programming template. The Program Coordinator will be responsible for programming the miniPATs.

Therefore, all project partners will receive pre-programmed tags.

Bigeye thresher programming template

Deployment period: 180 days, sampling interval 600 s, summary periods for profiles of depth and temperature (PDT) data: 4 hours.

Transmission of binned data for time at depth and time at temperature is not requested in order to increase probability of transmission of depth data series, geolocation data and PDT.

The tag programming template is presented at Figure 2.

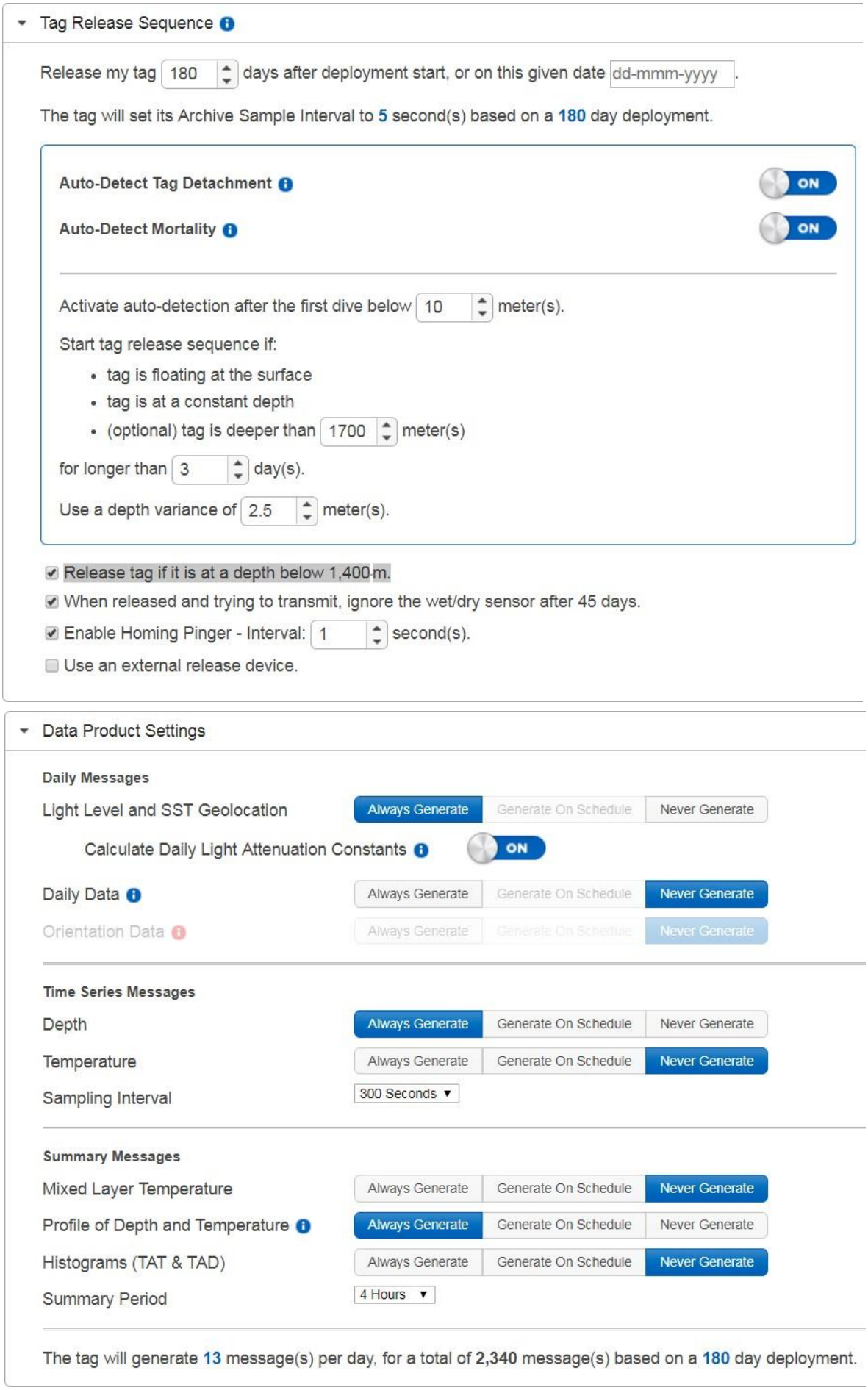


Figure 2. Principal tag programming template for miniPATs PRM study for bigeye thresher shark (BTH).

Sampling protocol

The detailed sampling protocol, reporting form and reporting requirements are presented in the Observer Tagging Manual. The 'IOTC PTH PSAT PRM study tagging manual' describes: Security in tagging operations, Fish identification, Tag handling, Fish handling and tagging, Data recording and reporting (including detailed description of the IOTC bigeye thresher shark tagging card and the following variables: Shark conditions, Tagging conditions, Hook type, hooking location and related information, Biological data).

Observer should **observe, measure or estimate** and record the following variables: tagger name, observer name, vessel name, vessel radio call sign, vessel captain name (optional), tagged shark release date, shark release time, exact release position, soaking time of the longline gear, number of hooks between floats, branchline length, shark condition at haulback, shark condition at release, tagging conditions (in water or on the deck), hook type, hooking location, if hook has been removed or remains in the shark, length and type of trailing gear (if any), sex, fork length, time spent on tagging operation, sea state, and sea surface temperature (Appendix I).

Whenever possible, the observer or a vessel crew member should take a photograph of the tagged shark.

Each tagging event should be reported to the national partner, IOTC and program co-ordinator by e-mail within **48** hours. The following information (minimum) should be sent: Vessel name, observer name, tag number, release date, release time, exact geographic position, fish size, sex and condition.

Expected results and project outcomes

1. Estimates of survival rates for BTH caught and released (in accordance with IOTC CMMs[1]) by commercial longline vessels during fishing operations in the Indian Ocean.
2. Improved estimates of total fishing mortality for BTH (including at-vessel mortality, handling mortality and post-release mortality)
3. Evaluation of BTH mortality rates by fleet and by handling practice and effect of environmental variables on BTH mortality.
4. Evaluation of efficiency of current IOTC CMMs directed to the conservation of BTH in the IOTC Area of Competence.
5. Evaluation of current handling practice for BTH released from longline gears and development of best practice advice.
6. Evaluation of needs in mitigation measures to reduce bycatch of BTH.
7. Analysis of vertical behaviour and habitat for BTH in the Indian Ocean and limits of spatial and temporal interactions of BTH with pelagic longline gears.
8. Horizontal movements of BTH, population connectivity and horizontal interactions with major fleets.

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Appendix I

Shark condition

The descriptions of shark condition were adapted from the codes developed by NOAA-JIMAR (Common Oceans, 2017). Shark condition should be evaluated before the decision about whether to tag the animal and to determine appropriate tag selection. Condition of the shark at release should also be recorded. The following terms should be used to describe 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 - 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.**

Alive Injured – Animal was alive but there was clear evidence of serious injury. **'S' tag (sPAT) should be used 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). **miniPATs should be used 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.

Appendix II

IOTC bigeye thresher shark tagging card

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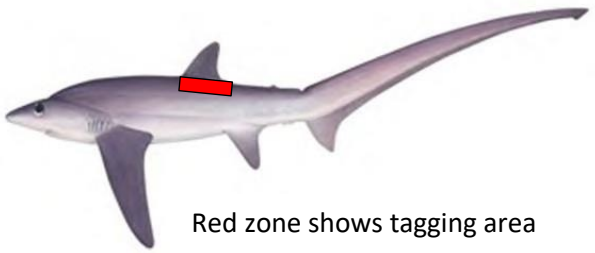
IOTC bigeye thresher shark tagging card

Tag serial N° 18P9999

Tag PTT N° 99999

Tagger name	
Observer name	
Vessel name	
Radio call sign	
Captain name (optional)	

Release Date				Release time	
Day	Month	Year		HH	mm



Red zone shows tagging area

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	☐	☐	☐	☐
At release	☐	☐	☐	☐

Tagging conditions	In water	On the deck
	☐	☐

Hook type	Tuna	J-hook	Circle	Teracima	Unknown
	☐	☐	☐	☐	☐

Hooking location (mouth, gills, throat, stomach, tail, other fin)	

Hook removed	Yes	No
	☐	☐

If hook was not removed, estimate length of trailing gear (cm), and type	Mono	Wire
	☐	☐

Sex	Male ♂	Female ♀	Unknown
	☐	☐	☐

Fork length (cm)	Measured	Estimated
	☐	☐

Photograph of tagged shark	Yes	No
	☐	☐

Time on deck / tagging time in water before release (min)	

Sea state	Calm	Moderate	Rough
	☐	☐	☐

Sea surface temperature	

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

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**
Dead Animal showed no signs of life	**Alive, in Good condition** Animal is lively and healthy with no obvious signs of injury or lethargy (animal should be active)	**Alive Injured** Animal is alive but there was clear evidence of serious injury
Alive 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**