

Shark Tagging

Equipment and training for the estimation of post-release mortality of sharks

Prepared for Western and Central Pacific Fisheries Commission

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Image: Pacific shark tagging. [Designed by Shelley Clarke, WCPFC]

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1 Introduction

The purpose of fisheries management is to ensure that populations can be exploited in a sustainable manner. This requires accurate information on mortality due to fishing. Mortality due to fishing activities has long been synonymous with catch but there is a growing recognition that catch statistics, particularly those representing landed catch, may greatly under-represent the actual number of fish removed from the current and future stock. This is especially true for fishes such as sharks which may be discarded (whole or in part) or released in large numbers either because of regulations or lack of market demand. In many cases, discarded or released sharks are often not enumerated at all; if they are enumerated there is often no record of their condition; and even if there is a record of their condition that condition may not be a reliable predictor of their survival. As a result, there is considerable uncertainty about the number of sharks killed through fishing activities and this uncertainty leads to a lack of clarity in defining and refining shark conservation and management.

The Western and Central Pacific Fisheries Commission (WCPFC), along with the four other tuna Regional Fisheries Management Organizations (t-RFMOs), is a partner in the Areas Beyond National Jurisdiction (ABNJ) – often referred to as Common Oceans – Tuna Project. The objective of this project is to achieve efficient and sustainable management of fisheries resources and biodiversity conservation in marine areas that do not fall under the responsibility of any one country. One set of activities of the GEF-funded ABNJ Tuna Project aims to reduce the impact of tuna fisheries on biodiversity by improving data and assessment methods for sharks, thereby promoting their effective management. Within this set of activities WCPFC has been tasked with conducting a major study of shark post-release mortality (PRM) in its longline fisheries. The first stage in this process culminated in a workshop on methods for estimating shark PRM. The workshop produced a survey design that called for the deployment of 200 ‘survival’ popup electronic tags on 100 shortfin mako and 100 silky sharks in selected areas of the Pacific Ocean.

For stage two of the project, the New Zealand surface longline tuna fishery was chosen for the deployment of 33 tags by Ministry for Primary Industries (MPI) fisheries observers on shortfin mako sharks caught as bycatch within the fishery. For stage three of the project, the Fiji surface longline tuna fishery was chosen for the deployment of 83 survival tags by Fiji Fishing Industry Association (FFIA) vessels and Ministry of Fisheries observers on 33 shortfin mako sharks and 50 silky sharks.

This report was prepared as a resource for training Fiji Fishing Industry Association officers and crew, and Fiji Ministry of Fisheries Observers.

2 Tagging protocols

2.1 Goal and approach

The goal of this study is to determine the proportion of sharks that die after being released alive from commercial fishing operations. Two requirements arising from this goal are that (a) only sharks that are alive at release should be tagged; and (b) tagged sharks should be handled and treated in exactly the same way that fishing crews normally do. Examples of the second requirement include:

- If the branch-lines/snoods are usually cut off at 20 m while the sharks are in the water, then after tagging a shark, 20 m of snood should be let out before the crew cut the line

- If sharks are usually hauled aboard for hook removal before being released, then tagged sharks should also be hauled aboard and have their hooks removed.

2.2 Shark tagging kit contents

- Tags (Wildlife Computer sPAT)
- Telescoping tagging poles (x 2) (up to 3 m), short tagging pole (x 1) (20 cm), with stoppers x 3, bushes x 3, applicator needles x 3
- PVC piping for pole and tag protection on board and during transport
- Data sheets
- Tagging instructions folder
- Camera and power/download cable, instructions
- Camera head harness
- Magnets (x 2)
- Gloves
- Electrical tape
- Self-amalgamating tape
- Rubber bands
- Allen key (imperial) for tightening bushes
- One-pager about research project
- Alcohol wipes for anchor and needle
- Spare butterfly nut & bolt for long tagging pole
- Pencils
- Pencil sharpener

2.3 Turning tags on and off

2.3.1 Turning tags ON

There is no need to turn the tags on, they start automatically when submerged in seawater for a few seconds. They may be accidentally turned on by:

- Hosing the tag with a deck hose.
- A failed tagging attempt where the tag got wet.

If you do accidentally turn a tag on, switch your tag off. There is no ON switch, you can only switch the tag off, and you can turn your tag off as many times as you want.

2.3.2 Turning tags OFF

- If you think the tag has turned on, you have 60 minutes to turn it off or it will stay on.
- You can turn the tag off as often as you want, and you can do it even if the tag hasn't started.
- Read the instructions on the back of the tag label (Figure 1). Touch a magnet to hole near "S" on the tag. An LED light above the thin circular metal strip on the top of the tag will glow orange from bright to dim to confirm the tag has turned off and is ready to be deployed.



Figure 1: Instructions to turn the tag off.

2.4 What size sharks to tag

All short-finned mako or silky sharks longer than 100 cm total length or 90 cm fork length and 'life-status' **X** or **Y** but **NOT Z** (see Appendix A)

2.5 On-deck tagging with the short tagging pole

- Use the short hand-held tagging pole (with the stopper ~6 cm from the tip of the needle) for small sharks that are brought on deck.
- Insert the tag underneath the first dorsal fin, far enough to go through the centre-line of the animal so the tag anchor will be anchored through the cartilaginous fin supports.
- Aim forwards and slightly sideways so the tag trails more naturally. See Figure 2 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.

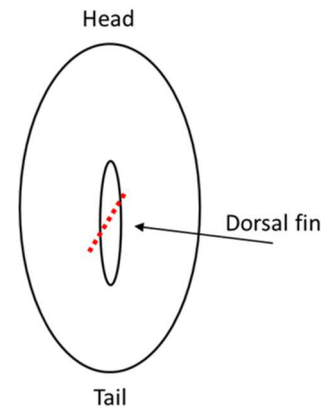


Figure 2: Location and direction of tag insertion.

2.6 In-water tagging with the long tagging pole

- Use the bolt and butterfly nut at the end of the tagging pole to adjust the length of the pole for your boat's height above the sea.
- Use the photos in this guide to see how to attach a tag anchor to a tag needle. Use the rubber band to restrain the tag, and avoid loss in case of a failed tagging event (Appendix C).
- Aim for the base of the dorsal fin, but anywhere on the back of the shark is ok.
- Try to tag the shark from above or from the tail end, so the tag pulls evenly on its anchor.
- We 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.
- The stopper for the long tagging pole needle is placed ~6 cm from the tip of the needle (that holds the tag anchor).
- There is a figure on the data sheet to record where the shark was tagged (Appendix A).

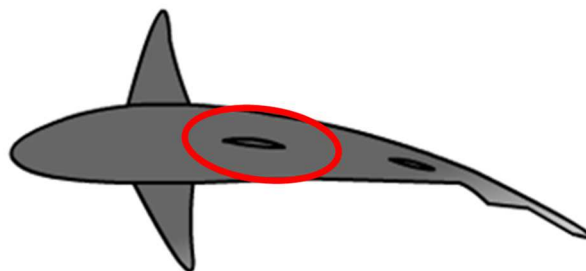
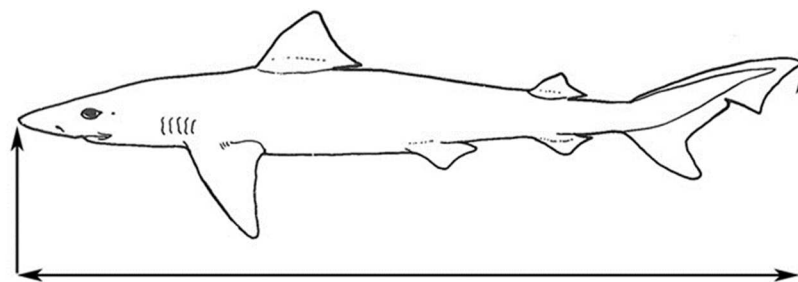


Figure 3: Site to aim for when using the long tagging pole from the boat: aim for the main dorsal fin. Modified from Chris Huh via Wikimedia Commons.

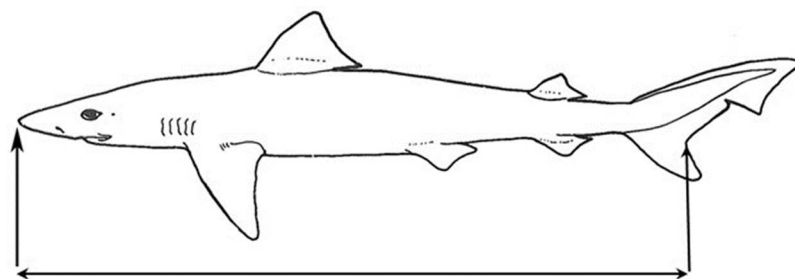
2.7 In-water measuring of sharks

- Wear the GoPro camera, which can later help to improve the accuracy of length measurements.
- Before sailing, use the vessel sea-door as a start point and place tape on the hull at 50 cm intervals behind the door on the side of boat to measure the shark.
- Attach a rope of a known length to the end of a tagging pole and run that alongside the shark.
- Before leaving the wharf, measure from the back of the side door to a scupper or other feature to help measure your shark
- Estimate the shark's weight, as this can later be converted into a length using a weight-length regression.



Total length (TL)

From tip of nose to tip of tail



Fork length (FL)

From tip of nose to fork in tail

Figure 4: Shark length measurement options. Modified after Paulin et al. 2001.

2.8 Sexing sharks

2.8.1 Sexing male sharks

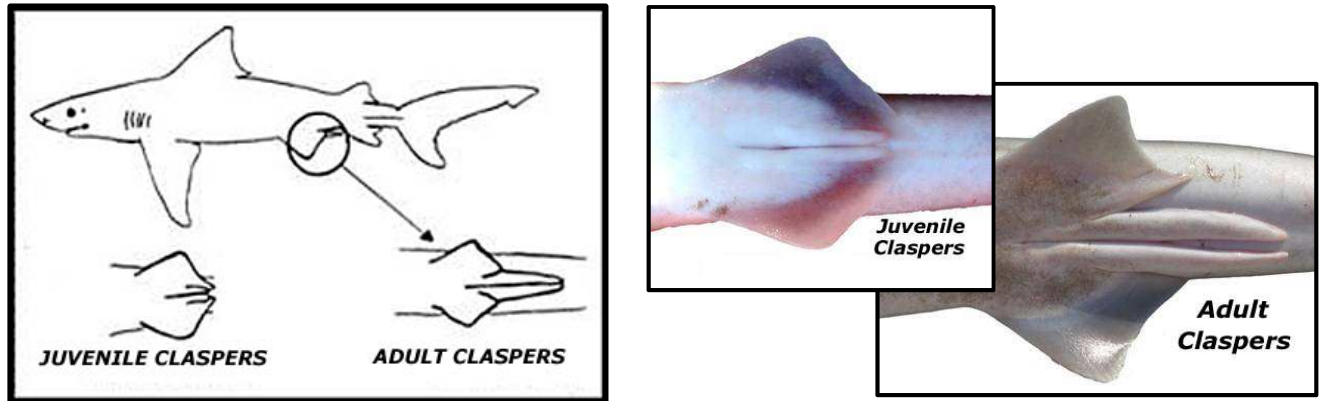


Figure 5: Male shark external reproductive organs (from NOAA 2017).

2.8.2 Sexing female sharks

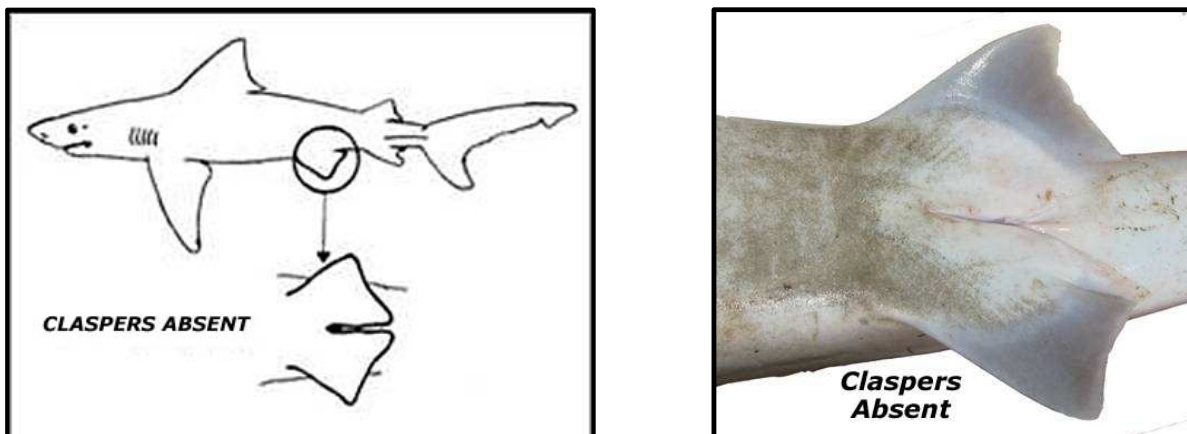


Figure 6: Female shark external reproductive organs from (NOAA 2017).

2.9 Retrieving lost tags

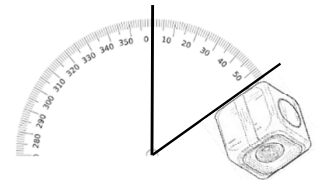
- Tape or cable tie a net to the end of the second long tag pole and use the net to retrieve the tag.
- If the boat has a catch net, use that.

2.10 Clean equipment between and after use

- Use alcohol wipes before tagging sharks. Wipe the needle, tag anchor and the start of the tag tether.
- Rinse the tagging poles with fresh water so they don't corrode together. On long trips wash regularly.
- **When sending the tagging poles back to your shore contact, please separate them into two parts (after rinsing with freshwater) and place into the transport and safety tube, so they don't corrode together.**

2.11 GoPro Session camera instructions

- The GoPro Session camera will be set to record video. Press the button once and it will start recording video, press it again and it will stop recording and turn off.
- If you have the GoPro App on your smart phone you can use it to view footage.
- Battery life with the video settings 1080 and 30fps is about 2 hours.
- Turn the camera on and attach it to your head as soon as you hear that the boat has a mako or silky shark hooked.
- The video footage will help us confirm the shark length, sex and any additional injuries that may be missed while you deal with the shark in real time.
- Film the shark tagging logsheet to record the essential tag numbers, trip, and set. This will be used to name the video file later. Talk to the camera, say the date and time, boat name, your name, shark species, tag number, shark size, and any other relevant details.
- You can record the longline equipment with the video if you wish.
- If you have a laptop onboard and want to make some videos, please only show your immediate family and friends, and do not post anything online. You will need to download the GoPro App first.
- When attached to your head harness, the GoPro needs to be on a 55 degree angle to film activities you are doing, like working on a shark on deck or tagging a shark from the side of the boat. You may have to lift your head un-naturally higher than normal to film anything at a distance.
- Instructions on how to pair the camera with the GoPro App for the HERO4 Session can be found at <https://gopro.com/help/articles/Block/How-to-Pair-the-Camera-with-the-GoPro-App#HERO4Session>



2.12 What to do if your boat catches another sPAT tagged mako or silky

- If the shark is ALIVE: Don't put another tag into it, please record (somewhere on the data form) where it was tagged (front of dorsal, back of dorsal, left right etc) and whether any hooks or snood length were added to the shark from your boat, then release the shark.
- If the shark is DEAD: Bring the shark on board, remove the tag, and record the tag and tether number and details of the catch on a data sheet. Include the tag with the data sheets that you give to your shore contact person, and let Warrick know what you've caught warrick.lyon@niwa.co.nz

2.13 Shore-contact

- If you are running out of tags, or break or lose any equipment, let your shore-contact know and they will provide more tags, or replacement equipment.
- As you complete your tagging logsheets, please hand them to your shore contact, who will copy them and will send a copy to Warrick Lyon in New Zealand.
- **If you have your own camera or phone-camera, please take a photo of the data-logsheet every time you tag a shark, just in case the original data sheet blows away, gets thrown away or lost, then you can copy out another sheet without losing any of the valuable information that you have worked so hard to compile.**
- Let your shore-contact know how the tagging is going, so they can keep Warrick Lyon informed.

2.14 Returning gear

- Keep your tagging gear with you until you finish work in the tuna longline fishery, or you have put all of your tags out, then return your gear to your shore-contact who will let Warrick Lyon know.
- **Photograph your completed data sheets and then text or email them to Warrick Lyon at NIWA (details below). Give the original logsheets to your shore-contact when you have finished your tagging or finish a logsheet.**
- When you have no more use for the tagging equipment please return it to your shore contact.

2.15 Shore contact details

Fiji Fishing Industry Association: Anare Raiwalui, raiwalui.anare@gmail.com

Fiji Ministry of Fisheries: Apenisa Sauturaga, sauturaga.apenisa@gmail.com

New Zealand: Warrick Lyon, NIWA, Private Bag 14901, Wellington. Phone +64-4-386-0873, mobile 021 029 20221, email warrick.lyon@niwa.co.nz or SharkTags@niwa.co.nz

3 Acknowledgements

Thank you to Reyn Naylor, NIWA, for reviewing this report.

4 References

Last, P. R., Stevens, J. D. (1994). Sharks and rays of Australia. Australia: CSIRO Division of Fisheries; ISBN: 0-643-05143-0.

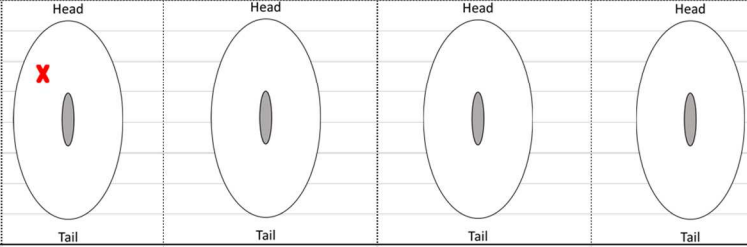
NOAA (2017). Northeast Fisheries Science Centre Apex Predators Program: how to determine the sex of a shark
<https://www.nefsc.noaa.gov/nefsc/Narragansett/sharks/sexdet.html>

Paulin, C., Stewart, A., Roberts, C., McMillan, P. (2001). New Zealand fish. A complete guide. Te Papa Press Wellington.

Appendix A Post release mortality shark tagging logsheet & guide

An Excel spreadsheet is available, please email the principal author or find the link at <https://www.niwa.co.nz/gallery/shark-tagging>

Please photograph completed sheets and email to warrick.lyon@niwa.co.nz

Vessel name	Solander_21			
Trip	2096			
Set	5			
Date (DD/MM/YY)	15/09/17			
Time (HHMM)	1510			
Location	Astrolabe Trough			
Latitude	19° 31.4'			
Longitude	178° 13.5'			
Sea surface temp (°C)	22.2			
Seafloor depth (m)	~1600 (from chart)			
Tag serial no.	17P 1610	17P	17P	17P
Tag tether no.	17Z 0210	17Z	17Z	17Z
Tagger's name	Warrick Lyon			
Species	Mako shark			
Length (cm) & measurement codes on back	110 TL (3)			
Estimated weight (kg)	10			
Sex	m			
Hook location (M,G,I,U,F)	F (around tail)			
Handling (codes on back)	H, D,			
Life status (X) alive-uninjured	✓			
Life status (Y) alive-injured (codes on back Y3, Y6, Y8)	-			
Life status (Z) alive-moribund	Do not tag shark if Life Status is near death (Z) check descriptions on back			
Additional injuries	bite mark on right flank, looks new			
Release (codes on back)	F, D,			
Additional notes on release				
Material left on shark & snood description				
hook	1 x 6-barO			
swivels	1 x ss d-swivel			
length of snood (m)	8.5 m			
snood weight and material	nylon 200 lb			
lead sinkers	no			
shark clips	no			
Does this reflect the boats usual handling practices (yes/no/comment)	No, snood cut ~2m shorter, usually 10+m			
tagging position				
Extra comments				
Crew / Observer contact (email, phone, mail)	Bob Smith(1st mate) b.smith@gmail.com			

Hook location		Life status
M Mouth	OK to tag these sharks	Use this code if the shark is lively when observed
G Gullet		X Alive – uninjured
I Gills		Use if ALL of the following apply:
U Gut		1. quick movements and/or response to being hauled;
F Foul hooked (describe)		2. frequent gill movement;
		3. shark is not bleeding or is slowly bleeding and not from the gills (blood may be seen around mouth and/or jaw);
		4. hook is visible (eg mouth hooked) and has not been swallowed or hooked in the gills;
		5. jaw is intact and appears functional with injury limited to hook puncture and/or small hook extraction wound, with some bleeding possible from the wound;
		6. if gear is wrapped around the shark, it is not inhibiting or it is removed with minimal damage;
		7. appendages remain functional after removal of gear.
Handling codes		Use this code when the shark appears lively but has obvious injuries.
A Hook removed by hand		Y Alive – injured
C Cut free		Use if at least one of the following characteristics applies:
H hauled on deck		Y1 minimal shark movements and/or minimum reaction to being hauled;
G Body gaffed		Y2 minimal gill movement;
E left on deck		Y3 shark is gill hooked or hook is not visible and has obviously been swallowed;
Y Hook yanked out		Y4 blood is flowing freely, continuously, and shows no sign of slowing down or stopping;
O Hook cut off		Y5 jaw is damaged but still useable;
D De-hooker used		Y6 injuries (greater than hook puncture or minimal gear extraction wound) are present, but not immediately life threatening, eg fins may be frayed, damaged or torn, but are still useable;
U Struck with club		Y7 if wounds are present on the body (muscle may be visible but not deep enough to expose internal organs).
S Trod on		
T Tagged and released		
F Cheek gaffed		
Z Other (specify)		
Life status		Use this code if the shark is expected to die (DO NOT TAG)
X Alive - uninjured		Z Alive – moribund
Y Alive - injured		Shark is alive, but <i>presumed</i> to have at least one of the following lethal injuries:
Z Alive – moribund		- Bleeding from a torn or severed gill arch (unlikely to survive if gills are bleeding)
		- Multiple fins missing;
		- Serious damage to eyes or head;
		- Jaw broken, unusable or missing to the point where the shark will be unable to hunt or feed;
		- Deep wounds with internal organs visible;
		- Amount of bleeding may be used to quantify whether a shark is moribund
Response on release codes		
F swam away quickly		
S swam away slowly		
D swam away disoriented		
K shark sank no strong tail beats		
U Not swimming upright		
E Stomach everted		
Length measurement methods		
1 accurate, length measured		
2 measured against known length		
3 eyeball estimate		

Appendix B Shark life status at or on the boat

X Alive – uninjured

Use this code if the shark is lively when observed

Use if ALL of the following apply:

1. quick movements and/or quick response to being hauled;
2. frequent gill movement;
3. shark is not bleeding or is slowly bleeding and not from the gills (blood may be seen around mouth and/or jaw);
4. hook is visible (eg mouth hooked) and has not been swallowed or hooked in the gills;
5. jaw is intact and appears functional with injury limited to hook puncture and/or small hook extraction wound, with some bleeding possible from the wound;
6. if gear is wrapped around the shark, it is not inhibiting or it is removed with minimal damage; appendages remain functional after removal of gear.

Y Alive – injured

Use this code when the shark appears lively but has obvious injuries.

Use if at least one of the following characteristics applies:

- minimal shark movements and/or minimum reaction to being hauled;
- minimal gill movement;
- shark is gill hooked or hook is not visible and has obviously been swallowed;
- blood is flowing freely and continuously (ie gushing) from any wound on the shark and shows no sign of slowing down or stopping;
- jaw is damaged but still useable;
- injuries (greater than hook puncture or minimal gear extraction wound) are present, but not immediately life threatening, eg fins may be frayed, damaged or torn, but are still useable;
- if wounds are present on the body (muscle may be visible but not deep enough to expose internal organs).

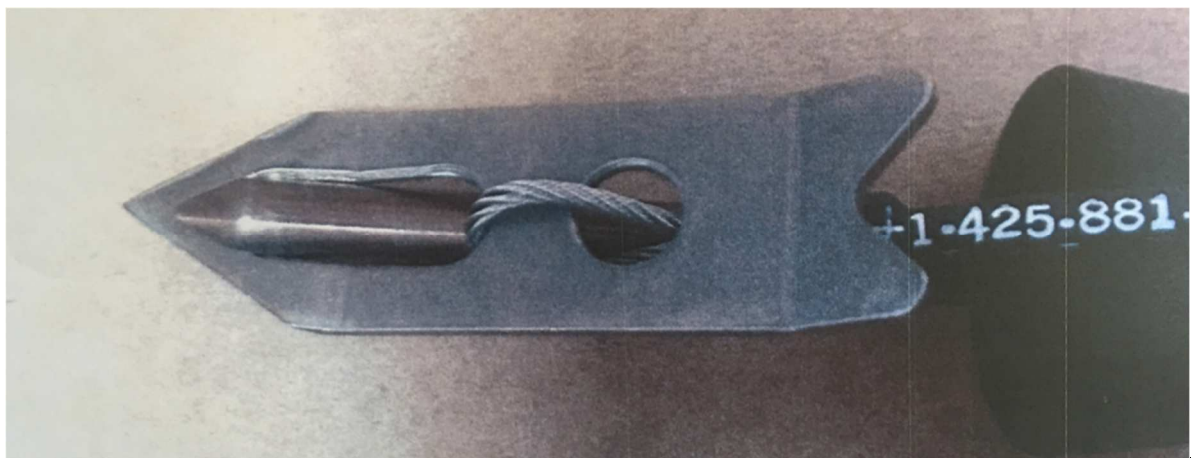
Z Alive – moribund

Use this code if the shark is expected to die

Shark is alive, but *presumed* to have at least one of the following lethal injuries:

- Bleeding from a torn or severed gill arch (unlikely to survive if gills are bleeding, even though it may look alive at the moment of release);
- Multiple fins missing;
- Serious damage to eyes or head;
- Jaw broken, unusable or missing to the point where the shark will be unable to hunt or feed;
- Deep wounds with internal organs visible;
- Amount of bleeding may be used to quantify whether a shark is moribund

Appendix C Attaching tag to short tagging pole



Appendix D Species identification guide for silky shark

Silky shark ID sheet with similar species from Last and Stevens (1994)

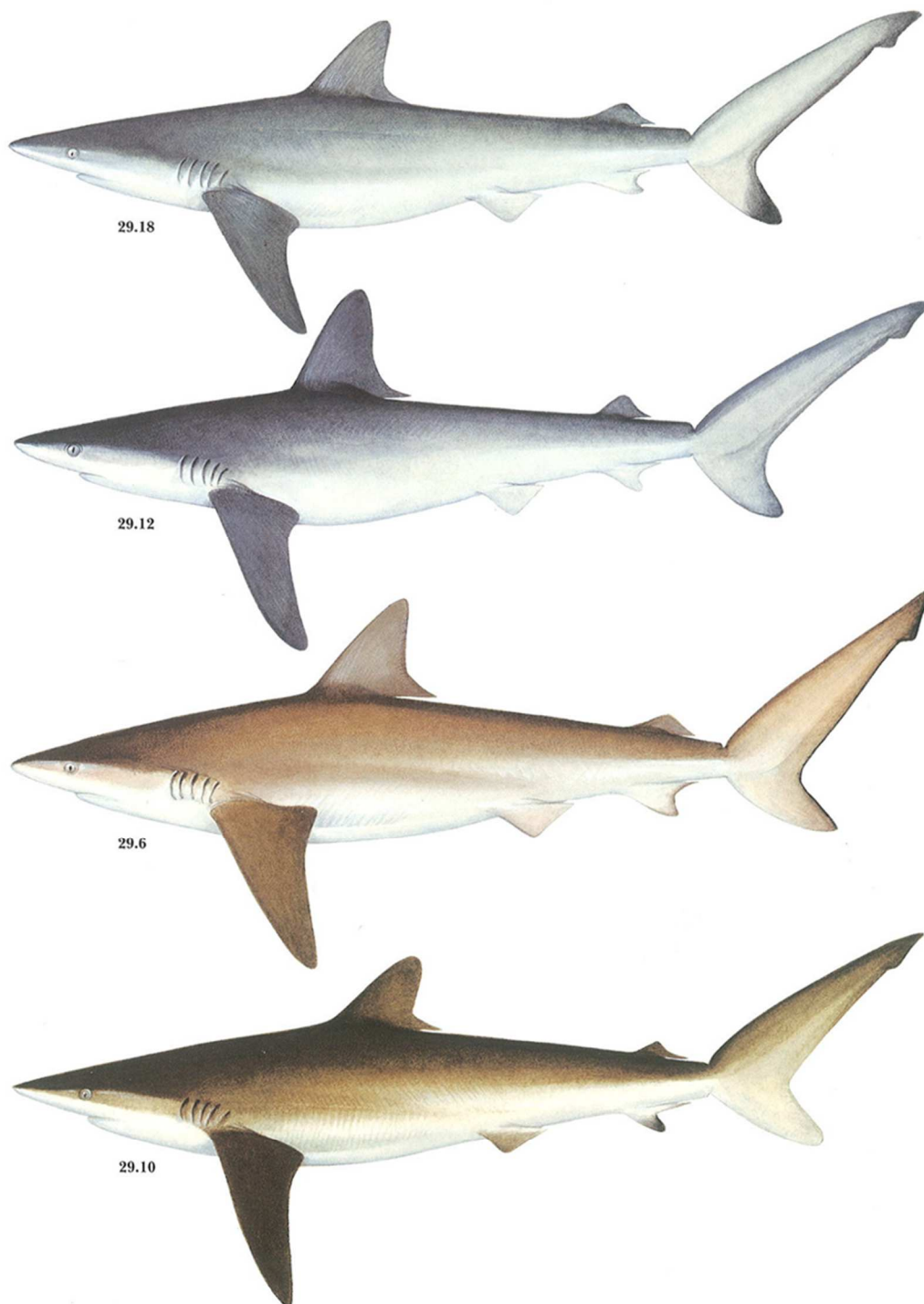


Plate 35 — Whaler Sharks

29.18 *Carcharhinus obscurus* (dusky shark) juvenile; 29.12 *Carcharhinus galapagensis* (Galapagos shark) immature; 29.6 *Carcharhinus brachyurus* (bronze whaler) immature; 29.10 *Carcharhinus falciiformis* (silky shark) immature.

Appendix E Species identification guide for short-finned mako shark

Short-finned mako shark and similar species ID sheet from Last and Stevens (1994)

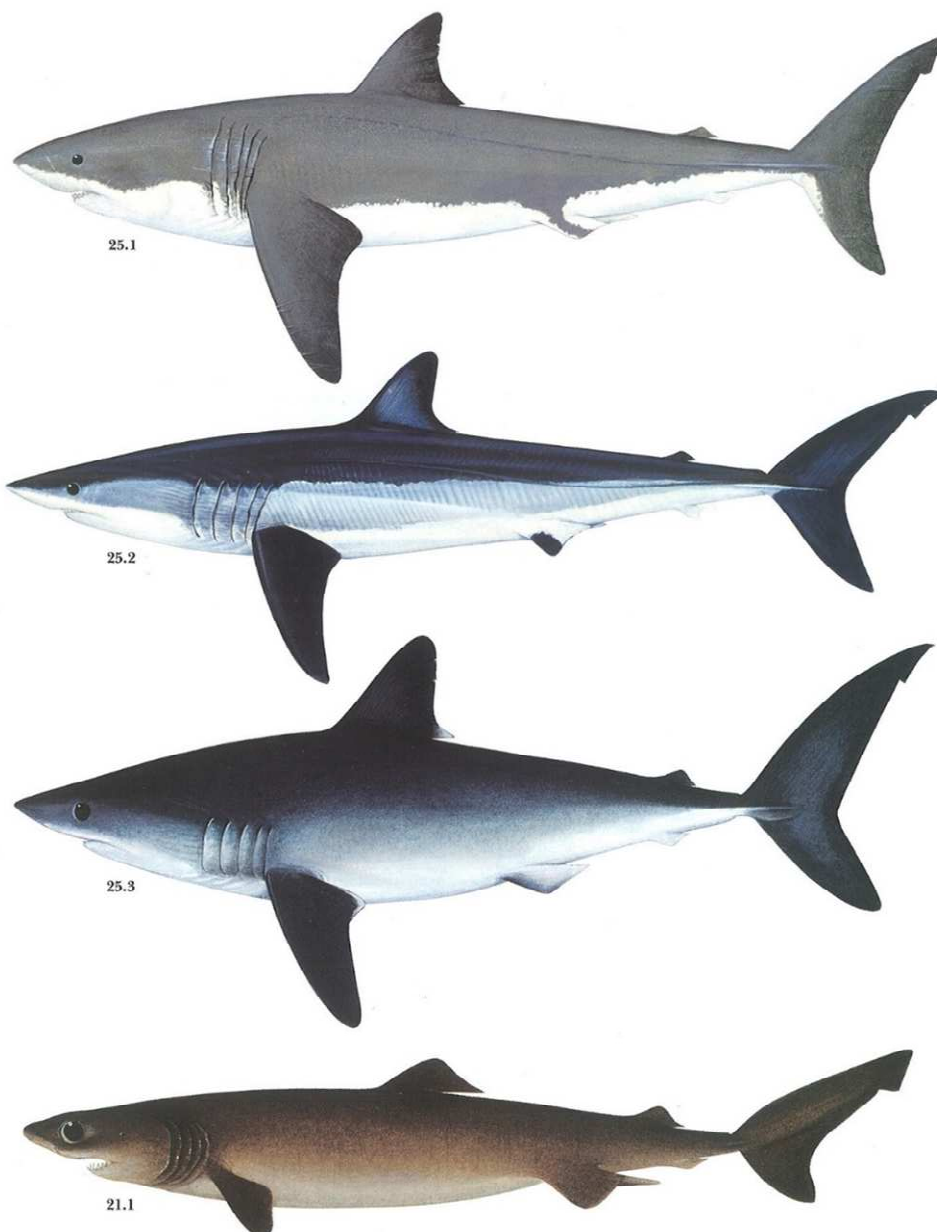


Plate 14 — Mackerel and Crocodile Sharks

25.1 *Carcharodon carcharias* (white shark) male; 25.2 *Isurus oxyrinchus* (shortfin mako) immature; 25.3 *Lamna nasus* (porbeagle) immature; 21.1 *Pseudocarcharias kamoharui* (crocodile shark) male.

Mako & silky shark tagging summary

1. Start recording video.
2. Point to the tag numbers on the data sheet, for the video, we will then know which tagging event we are watching. Or talk loudly to yourself about the tag number a few times, shark length estimates, any injuries, hook position, sex, the GoPro microphone should pick up your voice.
3. Remember SAFETY, don't fall overboard, remain calm, there are plenty of sharks in the ocean, take your time with in-water tagging.
4. Only tag mako or silky sharks greater than 100 cm (TL) or 90 cm (FL) with 'life-status' X or Y, but NOT Z (definitely dying).
5. Is the weather ok for tagging? Any rain or swell? Be careful.
6. Make sure you stop the video recording, a fully charged battery will last 2 hours.
7. Check you have completed everything on the data sheet, it's easier to do now, than try to remember later.

Appendix G One-page introduction to captain and crew

Tagging mako and silky sharks in Fiji to estimate post-release mortality

NIWA has been contracted by the Western and Central Pacific Fisheries Commission to coordinate and manage a large-scale Pacific Ocean shark tagging study. The aim is to determine whether mako and silky sharks released alive from tuna longlines live or die. The same research is almost finished in New Zealand, and has now moved to Fiji.

- This research is part of the Common Oceans (ABNJ) Tuna Project funded by the Global Environment Facility (GEF) through the Food and Agriculture Organisation of the United Nations (UN-FAO).
- The European Union (EU) recently granted WCPFC additional funding for shark post-release mortality (PRM) tagging studies on silky sharks.
- Managed by the Western and Central Pacific Fisheries Commission (WCPFC)
- Being coordinated by the National Institute of Water and Atmosphere (NIWA)
- Tagging will be done by trained Fiji Fishing Industry Association (FFIA) officers and crew. And potentially also by Fiji's national observer programme observers pending official approval under an MOU between the Fiji Ministry of Fisheries and the WCPFC.
- A total of 50 silky shark and 33 mako sharks will be tagged over the next year, from September 2017 – 2018.
- Tagging will be undertaken on or beside longline boats.
- Tagging protocol is to tag all silky and mako sharks (unless the shark is likely to die) with a sPAT satellite tag which records (for 60 days) the temperature, depth and light levels to determine if the shark is alive or has died. After those 2 months, the data are transmitted to a satellite, then back to NIWA for analysis.
- NIWA and WCPFC seek the support of longline vessel skippers and crew to assist with the tagging of mako and silky sharks.
- **Please keep vessel fishing procedures the same, we do not want you to change anything, except to tag some silky and mako sharks.**

The shark survival data will be used by the WCPFC to inform their assessment of the status of Pacific shark stocks.

Tagging Lottery

Every 6 months there will be a lottery for all tags that have been deployed in each 6 month period. Each tag deployed will gain 1 ticket in the lottery (unless both a trained observer and trained crew are aboard, then both will get a ticket for each tag deployed).

The total prize pool will be FJD50 x number of sharks tagged in that 6 month period (E.g. 50 tags out is a prize pool of FJD2500, prizes could be valued at 1 x FJD600, 2 x FJD400, 3 x FJD200, 5 x FJD100)

Good luck

The most important thing to do is to keep your vessel fishing procedures the same, we do not want you to change anything, except for the tagging of silky and mako sharks.

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