# 2020 YEAR IN REVIEW



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Authorship of other photographs is mentioned throughout the document.



# Overview

# **Mission Statement**

The charity's objectives are to promote for the benefit of the public the conservation, protection and improvement of the physical and natural environment of whale shark and marine biological diversity by: (a) promoting and carrying out for the public benefit research and publishing or otherwise disseminating the useful results of such research: (b) raising awareness and understanding of marine conservation.

# Background

The whale shark *Rhincodon typus* is the largest species of fish on Earth, attaining lengths in excess of 12m. Nonetheless, very little is known about its distribution, habitat requirements, movements or reproduction – all of key importance for conserving and managing this marine mega-vertebrate. The Maldives appears to be unusual, perhaps unique in the Indian Ocean, in supporting a year round aggregation of whale sharks, making the archipelago a superb place to study their behaviour and biology.

Despite these opportunities for research, there were virtually no scientific studies of whale sharks in the Maldives before the MWSRP engaged in a three-month research expedition in 2006. That pilot study documented several dozen sharks and also highlighted the need for further research, conservation and education and provided the seed for the creation of the MWSRP.

The MWSRP has accumulated over 7000 sightings of whale sharks dating back to 1996. The scope for future work in the Maldives is extensive, with questions about spatial distribution, long distance movement and diving behaviour still unanswered. Furthermore, of the 509 individuals identified up to February 2021 only 90 are females, with 240 males and 179 where gender is unidentified. Of those where gender is identified therefore, an 72.7% male bias is recorded, extending the long-held belief that the sub-population in this region principally consists of sub-adult, immature males. The male bias in the Maldives aggregation, as in many other whale shark aggregations in the Indian Ocean (e.g., W. Australia, Mozambique, Seychelles) is an intriguing and pertinent phenomenon and further research is required to account for an apparent lack of female whale sharks.

The MWSRP's research into the characteristics and movements of the whale shark population in the Maldives provides the scientific basis behind the Programme's role as a grassroots conservation charity that acts as a resource for government, industry and community stakeholders. Since 2006 the MWSRP has made numerous school visits, conducted education field trips and facilitated international cultural exchange programmes for local children. Industry stakeholders, fisherman and local-island governing agencies have also been continuously consulted and the Programme has been successful in fostering cooperation between resort and island communities and re-establishing an important bond between the local community and the whale sharks.

The MWSRP has continued to provide key information to the various ministries of the Maldivian government (Ministry of Fisheries, Marine Resources and Agriculture and Ministry of Environment, Climate Change and Technology). Two notable achievements to date include the government's adoption of whale shark encounter guidelines for tour operators developed by the MWSRP in stakeholder consultations and in 2009 the gazetting of the Maldives largest collaboratively managed Marine Protected Area (MPA).

The South Ari Atoll Marine Protected Area (SAMPA) encompasses the Maldives primary whale shark aggregation site and by forging partnerships with resorts and local communities, the MWSRP is continuing to assist the government by building the management capacity of the local stakeholder and island communities within the MPA.

MWSRP in 2014 introduced 'The Big Fish Network' (BFN), an online citizen-science platform developed by the founders of MWSRP to establish a regional monitoring network of wildlife tour guides and interested individuals to increase awareness and stewardship of whale sharks in the Maldives.

MWSRP team members hold training workshops all over the Maldives, training guides (referred to as contributors throughout the rest of the report) to photo-identify whale sharks and record basic encounter information. The information and photographs collected at each whale shark encounter are submitted by the guide through a web-based portal or via a mobile app to the MWSRP's central database.

# A year in summary

Like many grassroots conservation organisations, this pandemic has hit our charity hard. We had no choice but to suspend our infield operations in March 2020. Therefore, the information presented in this report (February 2020 - February 2021) comes from data collected during the month and a half MWSRP was in-field and the rest is all data which came from contributors to the Big Fish Network. Closing our operations temporarily was absolutely the right thing to do, for the safety of our staff, volunteers and community on Dhigurah.

As a team, we decided we are going to weather this storm. We're a passionate group who believe in what we're doing and we're committed to ride out this period and come back stronger than ever in 2021. Bear in mind that we all worked voluntarily on the project and looked for other work to bridge the gap. Hope you will enjoy the reading!



# **Key Stats**

- Total number of encounters 286 Encounters. 154 after COVID struck oficially in the Maldives and we had to cease operations.
- MWSRP submitted 70 encounters. 216 encounters were uploaded by Big Fish Network contributors.
- 33 different contributors provided data to us this year. This includes resorts, guesthouses, liveaboards, dive centres, guesthouses and marine conservation organizations.
- 80 different individual whale sharks were observed from February 2020 until the start of February 2021. 39 of these individual sharks were spotted on 2 or more occasions.
- WS337 'Shaiban' was the most seen shark of the database. He was observed 26 times followed by WS220 'Kuda Kudey' who was seen 16 times.
- WS442 'Avi' was third in the ranking, encountered 13 times! Last year Shaiban was in first position. Out of these three sharks on the 2020 top list, Kuda Kudey has been the only one reported visiting another atoll.
- During the report period we have added 43 new sharks to the register. An increase on 2018 when fewer than 40 new individuals were registered! 8 of this year's sharks were female and 7 were male. For the rest sex identification was not possible.
- Average estimated length from all the submitted estimations (BFN & MWSRP) was 5.86 m.
- South Ari was the atoll with the greatest number of new whale sharks submitted, 20.
- Average length of new sharks on the database for 2020 was 5.64 m.
- Sharks reported as being 'evasive', had the shortest encounter durations, 5.9 minutes on average.
- Whale sharks exhibiting passive 'cruising' behaviour resulted in encounter durations of 17.9 minutes on average. On the other hand, encounters with inquisitive sharks averaged 26.1 minutes.
- Top 3 atolls for encounters by submitted number:

South Ari with 238 encounters Baa with 22 encounters Thaa with 9 encounters

- Two whale sharks have been sighted in three different atolls.
- No whale shark of the Maldives has ever been recorded anywhere else in the world to date.

# Achievements and Performance

# **Research Summary**

Whale Shark Encounter Log Information



As a reminder, the information provided in this section and for the rest of the report offers a snapshot into the past 12 months only (*February 2020 - February 2021*), unless otherwise mentioned. If anyone would like further information on previous seasons or on the holistic understanding of this species in the Maldives or in specific areas, please do reach out to the MWSRP!

Between the study period there was a total of 286 whale shark encounters recorded to the Big Fish Network in the Maldives. This comprised of 70 encounters recorded by the MWSRP researchers which also included environmental parameters. The remaining encounters were contributed by citizen science stakeholders of the BFN, predominantly from active members of the tourism sector as well as conservation NGOs.

Since 2014 MWSRP has a near year-round presence and BFN is operational for all 12 months, although due to COVID-19 the situation has been different since then. BFN contributions have accounted for more than 50% of the Big Fish Network data since 2018 due to an increase in the number of contributors.

From 2014-2017 encounter numbers had remained constant, throughout those years over 590 encounters were being reported yearly. Unfortunately, the number of sightings is diminishing year after year. There could be various factors behind this decline: fewer sharks visiting the area due to increase in human pressure; global or local environmental factors as well as contributors observing the sharks but not uploading their encounters. The number of contributors this year totalled 34 including MWSRP. These came from resorts in Thaa, Alif Dhaal, Alif Alif, Dhaalu and Baa atoll (15). Guesthouses and dive centres from Fuvahmulah, Alif Dhaal, Alif Alif, Lhaviyani and Baa (7), research organizations & and liveaboards (10) made up the remaining contributors.

A larger number of new individuals (previously unregistered individuals added to the ID database) have been sighted in the last few years. The increase in numbers of new individuals coincides with the wider reach of the BFN into other regions of the country and more specifically the southern atolls which are areas of great interest to MWSRP scientifically speaking. Initial findings suggest that it's possible to encounter whale sharks in the southern atolls that have different characteristics and levels of residency to the animals sighted in other atolls in the Maldives.





Encounters by contibutor

# At the time of writing, the total number of different individual whale sharks recorded from across the Maldives now stands at 530.

530

As expected, South Ari accounts for the highest number of encounters. It is the primary site for whale shark tourism due to its year-round aggregation. The MWSRP team used to be based in the South Ari island of Dhigurah and most of the contributors belong to South Ari Atoll or visit the area frequently. Additionally, here whale sharks are sighted all year round. Most of the encounters that came from South Ari, Baa and Thaa were re-sighted individuals. Almost the same number of encounters as in 2019 where provided to us from Baa this year, 22. 14 different individual sharks were observed there.

However, there has been a decrease in the number of encounters submitted from Thaa as well as Fuvahmulah. This reduction in number of encounters could be due to a decrease in sightings in that region due to the pandemic and the fewer chances to go out to sea due to restrictions. Only one encounter was submitted from the other atolls represented in the graph below: North Ari, Rasdhoo, Meemu, Lhaviyani and Shaviyani.



No individual has ever been re-sighted in Fuvahmulah after a two day period. As mentioned in our previous report sharks appear to be more transient than those in other sites, as there is a possibility that the same individuals return on an annual/seasonal basis. However, it does appear that the chance of one whale shark appearing again in the same area within the same season appears to be very low compared with South Ari. In other words, the whale sharks sighted in Fuvahmulah appear to be passing through rather than staying in the area. We still have to wait and see until we receive more encounters from this area as we have just only very recently started receiving encounters from Fuvahmulah. The team is visiting Fuvahmulah in 2021 and meeting the current and future interested contributors from there, so we are hoping to bring some good news. It will be the first time MWSRP visits the area!

Up until now a striking difference is found with the sex ratio of sharks encountered in Fuvahmulah. Females generally make up the vast proportion of encounters. Male ratio is the opposite of that in South Ari and elsewhere in the Maldives. The sharks sighted in Fuvahmulah also appear to be significantly larger than those in South Ari and elsewhere in the Maldives.

MWSRP would like to thank Conrad Maldives, Lti Maafushivaru, LUX\* Maldives, MV Emperor Explorer and Manta Trust for their continuous support during these last years. All of you have independently submitted over 10 encounters during 2020. We would like to express our gratitue to all the other contributors who we have never met in person but have engaged in the process of submitting encounters and have contributed to the citizen science platform "Big Fish Network".





## New individuals

In 2018, 37 new sharks were submitted, in 2019, 79 and this year 43. South Ari Atoll has been the main location for newly identified sharks, 17 individuals.

Submissions of whale shark encounters from areas outside of SAMPA were considerably more likely to be of a new individuals. 42% of the encounters from outside South Ari Atoll were of new individuals.



Out of the 22 encounters registered from Baa, 8 of them were with new sharks. The 8 encounters provided to us from Fuvahmulah, were all from new sharks. One of the encounters from Fuvahmulah was an old encounter from 2018. Due to worldwide lockdowns many contributors managed to go through their old footage stored in dusty hard drives!

During the last four years, the established whale shark sites in the southern and northern atolls were the other major contributors to new sharks on the database.

As of the 1st of February 2021, the database has 509 whale sharks. The sex breakdown is 90 females, 240 males and 179 unsexed individuals. Taking only the data where the sex has been identified this means removing the 'unknown sex' sharks, the sex bias is 72.7%. The trend has decreased since 2017. In 2017 it was 85.5%, 2018, 81.3% and in 2019 and 2020 below 80%. A key region driving this increase in female whale sharks is the Fuvahmulah site. As the BFN spreads and the search effort and data contributions from different regions begin to become more equal, then it will be fascinating to see how this bias changes (or not!) over time.

This year's number of unidentified individuals in relation to sex, is high. Unfortunately, many of our submissions come without a photograph of the pelvic area which enable us to identify the sex of the shark. It is one of the most challenging images to obtain once you are in the water as you have to dive deeper if you are snorkeling or diving and sometimes the individual is too deep or too close to the seafloor. As a matter of fact, most of the contributors are snorkel/dive guides and are at the same time ensuring the safety of their guests apart from getting whale shark footage. 33 of the new individuals couldn't be sexed similar to last year. MWSRP policy states that sex is only assigned where it is affirmed by photographic evidence or has been assuredly noted by a trained guide.

# Which were the most seen sharks of 2020?

# Shark profile - WS337 "Shaiban" seen 135 times

Male

#### WS 337 Shaiban

"Shaiban" is a male immature whale shark and was first seen in October 2017 (South Ari Atoll Marine Protected Area). He is a firm favourite amongst many. Since then, we have 135 logged encounters both by MWSRP and contributors. In 2020 Shaiban was sighted in 30 occasions. This shark was named after our captain's grandson.







Sex First seen Length at first sighting Last seen

26th October 2017 by MWSRP at SA: Holiday Island 5m (est)

18th May 2021 by LUX\* Maldives at SA: Lux

### Shark profile - WS220 "Kuda Kudey" seen 101 times







Male 29th December 2014 by Iti Maafushivaru at SA: WEST Length at first sighting 3m (est) 26th April 2021 by Conrad Maldives at 3.459788, 72.827658 Length at last sighting 6m (est) 2021: 8, 2020: 16, 2019: 15, 2018: 14, 2017: 11, 2016: 11, 2015: 25, 2014: 1

#### WS 220 Kuda Kudey

"Kuda Kudey" was first sighted in 2014 in South Ari Atoll Marine Protected Area. He has been sighted every year ever since it was first encountered in 2014. This individual happens to visit other atolls on a yearly basis!

#### Shark profile - WS442 "Avi" seen 28 times

Sex	Male
First seen	14th May 2019 by Emperor_Divers at SA: Sun Island
Length at first sighting	4m (est)
Last seen	28th April 2021 by Iti Maafushivaru at SA: Mamigilli
Length at last sighting	бт (est)
Sightings per year	2021: 13, 2020: 11, 2019: 4

INTERESTINGLY TWO SHARKS, WS151 "NUFAIL" AND WS100 "SKYE", HADN'T BEEN SEEN SINCE 2017 AND WERE RE-SIGHTED IN 2020!

#### WS 442 Avi

Sex

First seen

Last seen

Sightings per year

"Avi" is a another immature whale shark and was first encountered in May 2019 (South Ari Atoll Marine Protected Area). This specific shark has been sighted on almost 30 occasions! Just like the other three sharks, he has been spotted in SAMPA this year too. This shark visited Baa atoll in 2019!

# Size

Average whale shark size per year has remained between 5 and 6 meters for the last 7 years. From the 193 (BFN& MWSRP) submitted size estimations for the period taken into account for this report, average whale shark length is 5.86 m. 84% of the submitted estimations came from South Ari which is a known aggregation for immature whale sharks and from where there is a higher number of contributors due to the proximity to SAMPA.

Taking into account the whole database, the maximum estimated length of a whale shark was 13 m (estimated by a contributor), minimum 0.70 m and average length for the Maldives 5.67 m.

The MWSRP provided 61 estimations on length in SAMPA and the average was 5.70 m, last year being 5.77 m. The smallest shark was 0.7 m and the largest was 7 m. Size estimations of individuals sighted in Fuvahmulah are generally larger in size over 7 m in length but unfortunately sightings from Fuvahmulah still represent a low percentage of the overall encounters per year.







## Shark behaviours in encounters - South Ari Atoll

Whale sharks of the Maldives have been observed displaying a few different behaviours. The MWSRP categorise the behaviour of a whale shark during an encounter. Each shark is assigned one or more of up to five behavioural categories; "Cruising", "Evasive", "Inquisitive" "Interaction" and "Feeding". By recording these details, the MWSRP are able to compare against other factors – either environmental or human influenced – to see what affect they have on a shark's behaviour. For this specific section we will only take into account data from South Ari Atoll which is where we are present most of the year. Here we expand upon behaviours in more detail:

#### Cruising

A natural behaviour where the whale shark swims at a slow pace near the surface as part of their thermoregulation process. Cruising is likely to take place either on the reef or just off the reef, and typically the dorsal fin does not break the surface of the water. During this time the whale shark is often more sluggish at the beginning, having returned from the depths where it is cooler in water temperature and also lower in oxygen. As the shark continues to cruise uninterrupted it may seem to become slightly more alert comparative to the beginning stages of thermoregulation.

Cruising is the most frequently seen behaviour in South Ari and is absolutely vital recuperation time. If cruising behaviour is disturbed the shark will leave the encounter before it has had sufficient time to warm up. If you consider it from the human perspective; when we get no rest or respite from stimulating scenarios this can lead to stress which can accumulatively impact our health. The same can be applied to the whale shark. This is something to bear in mind especially when you encounter injured individuals; depending on what kind of injury the shark may have sustained, it can be harder for the shark to stay deeper for longer periods of time, so they may need more time at the surface to recuperate.

#### Evasive

Evasiveness is considered an unnatural behaviour, and typically occurs as a result of cruising behaviour being interrupted by human presence. This can be characterised by a few things and often happens simply because snorkelers or vessels are not following the code of conduct. 'Evasive' is considered the most stressed as sharks exhibiting an evasive response are likely to be being negatively influenced by a stimuli in their environment and are taking evasive action to remove themselves from the negative stimuli. The typical response is to change direction abruptly and dive into deeper water, this means that for human snorkelers visual contact is lost. Normally "evasive" behaviour takes place when vessels get too close to the shark or when the in-water code of conduct is broken for instance, when a shark is touched, obstructed, flash photography is used or when a person gets closer than three meters to the shark. If snorkelers/divers jump into the water instead of sliding in gently from the boat the sharks tend to exhibit avoidance behaviour.

Fast swimming: The shark may swim faster than it's comfortable cruising pace if it wants to evade negative stimuli.

Abrupt turns: The shark may change direction abruptly to avoid negative stimuli.

*Parabola diving:* This behaviour is when the shark moves up and down the water column to avoid negative stimuli. For example, a shark may move from 2 metres depth to 7 metres depth to avoid snorkelers who are getting too close, and then later it may rise again closer to the surface.

*Banking:* The whale shark has no defence mechanism other than it's back which is formed of very dense, tough tissue and covered in abrasion resistant dermal denticles. Banking is characterised by the shark turning its whole body abruptly, or slightly, to present it's back as a defense. This action is a cue that the shark feels threatened and the snorkeler needs to back off and give the shark more space.

*Eyeball retraction:* This is another cue that the whale shark feels threatened. The eyeball will recede into the socket when the negative stimuli is too close to the shark. The shark may simply leave the encounter prematurely by diving off the reef in either a steep or gradual way.

#### Feeding

There are two kinds of feeding behaviour which are observed:

*RAM filter feeding:* This is a passive form of feeding, requiring minimum expenditure of energy, and is the feeding method most observed in SAMPA. The whale shark simply opens its mouth wide and lets the plankton flow in. The shark will often RAM feed against the current. Occasionally the gills may 'flush' or the shark may make a 'coughing' action which we believe could aid in the clearing of the gill rakers (the hairy structures which catch the plankton).

*Suction feeding:* This feeding method is rarely seen occurring naturally in South Ari and typically happens when there is a very dense concentrated patch of plankton. If a whale shark should find this concentrated patch, they maximise feeding efficiency by sucking in volumes of water containing the plankton.

#### Inquisitive

Inquisitive behaviour is always very exciting to see and is often displayed by individuals who are new to the area. Inquisitive behaviour is when the whale shark takes an active interest in something, typically a snorkeler or the hull of a boat. This behaviour can be characterised by the shark following snorkelers and actively swimming towards them or circling as if to inspect this point of interest. If this should happen remember to follow the code of conduct and give the shark space. If a shark should approach a boat hull or propeller during an encounter, have your engine turned off as to avoid any injury to the shark.

#### Interaction

This is a behaviour rarely observed in SAMPA specifically. Whale sharks are almost entirely solitary animals who are typically not social unless aggregating in response to a driven food source. Interaction can occur when individual's cross paths and, one or both of them, take an interest in the other. The whale sharks may circle one another as if to check each other. At this point whale shark science has not deduced what they are communicating specifically.



During February 2020 - February 2021, 209 records of behaviour have been annotated. During the same period 206 records of encounter duration time were logged. The most observed behaviour reported in 2020 was "cruising". 35.9% of the encounters submitted, lasted 5 or less minutes. "Cruising" behaviour as a sole reaction was registered on 92 of the encounters, 44%, for an encounter duration of 15.8 minutes. In comparison "evasive" behaviour as the sole reaction, accounted for 23.3% of the encounters and resulted in shorter encounters, 4.1minutes. Encounters were shorter when the shark was observed displaying "evasive" behaviours. On 26.8% of the encounters some evasive behaviour (evasive shown) behavior were exhibited. "Feeding" was seen during 27.8% of the encounters. Encounter duration was on average 25.3 min during the period comprised between 8-17:30. 65.3% of the encounters showed feeding behaviour of more than an hour or so but some of these encounters were linked to "lightpool" activities which take place at night. High powered lights are mounted at the stern of safari vessels in close proximity to the surface of the water. The lights attract plankton and bait fish which, in turn draw in whale sharks which then feed on the relatively high densities of prey.

#### Inter-atoll movements

Some individuals appear to follow a learned or habitual pattern of movements. Most individuals which have visited different atolls repetitively seem to be in those specific atolls at roughly the same time each year. This is likely tied to seasonal feeding opportunities. Baa atoll sightings coincides with the peak season which takes place during the southwest monsoon bringing an abundance in plankton into the Hanifaru bay area and areas close to it. This year we have recorded the first inter-atoll movement for WS485. It was first seen in March 2020.

	Feb	March	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan
WS111	S.Ari							Baa				
WS206	S.Ari	S.Ari						Meemu		S.Ari		
WS209								Baa				S.Ari/Thaa
WS220		S.Ari									S.Ari	Rasdhoo/S.Ari
WS341		S.Ari	S.Ari								Baa/S.Ari	S.Ari
WS357									Baa		S.Ari	S.Ari
WS485		S.Ari							Baa			
	No	rth East Monso	on	South West Monsoon						North East Monsoon		

During the 2020 season, seven individual whale sharks were encountered in more than one atoll. WS206 "Pischke" and WS220 "Kuda Kudey" were sighted in three diferent atolls. In 2019, WS111 (Baa and South Ari), WS209 (Baa-Thaa-South Ari) and WS341(Baa-South Ari) made the same inter-atoll movements as this year.

# Anthropogenic impacts

Throughout 2020, several individual whale sharks have been affected by anthropogenic impacts. Most of the footage of entangled whale sharks came from the Deep South, southernmost atolls.

The image in the center is from Jono Allen on a trip with Pelagic Fuvahmulah. Nasheed Ahmed succeeded in cutting the main securing rope. This individual happened to be new to the database and was named "Farikede". The image on the right was provided by Eric de Vicente from Submaldives. This whale shark was also registered as a new individual "Hazana". It's translation is "treasure". Luckily the last whale shark was "freed" but an injury had been caused due to the rope.

On the other hand "Hannah Dhattha a whale shark first seen in 2020 by Manta Trust had a hook in the eye region (photograph to the left) provided too by Eric de Vicente. Due to the location of the hook it hasn't been removed yet due to the possible further damage it could cause.



Unfortunately whale sharks in the Maldives are no stranger to anthropogenic injuries, largely due to the fact that they dwell near the surface to thermoregulate their bodies specifically in SAMPA and, to a lesser extent, to feed.

Sadly this year many of the registered encounters from SAMPA included injured whales sharks. Some of these whale sharks presented several injuries throughout the year such as "Shabain" and "Kuda Kudey" the most sighted sharks of the year. Below on the left we can see a photograph of "Kuda Kudey" and on the right "Shaiban", taken by a contributor from Centara, Ahmed Hayyan. Three scientific articles have been released recently specifically discussing the ocurrence as well as healing rates. The studies were carried out independently, yet came to similar conclusions as to the status of South Ari's whale sharks, the importance of South Ari as a developmental site for whale sharks and the effect of injuries on whale shark population dynamics and behaviour.





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## Megafauna surveys

2020 represented the tenth year that MWSRP has collected data on incidental megafauna sightings during the daily whale shark search transects. This year MWSRP added an additional 277 encounters of marine megafauna and a total of 963 individuals.

Of course, recording data is what MWSRP does, but it's not to say that megafauna is simply noted and ignored. A chance to swim with a manta ray or watch dolphins socialise is an incredible opportunity in itself, so MWSRP are now focusing on getting more detailed and quality data on each megafauna encounter by investing a bit more time in these frequent sightings.

This may mean stopping our search for whale sharks to get in with a manta ray and obtain a ventral ID photo, or spending time getting dorsal or scale pattern photos from cetaceans or turtles. This information is then shared with other NGO's operating in the Maldives who monitor and research these species.

With Maldives NGO's invariably having limited time or space resources, mutual assistance by other organisations operating in an area where the dedicated charity does not have a presence is a valuable assistance – just look at the BFN for how MWSRP benefits!

If you are a marine researcher with an interest in one of the megafauna species listed in the table below, hit us up! The MWSRP would be happy to share the data with a good project!

Species	Number of Encounters	Number of Individuals
Hawksbill turtle	112	114
Green turtle	22	22
Undefined turtle	54	55
Undefined billfish	3	3
Indo-Pacific bottlenose dolphin	38	498
Undefined dolphin	13	91
Spinner dolphin	14	224
Eagle ray	5	6
Reef Manta Ray	9	10
Mobula rays sp's	1	3
Undefined ray	2	2
Undefined shark	4	4

The hawksbill turtle (*Eretmochelys imbricata*) was once again the most frequently encountered species, by number of separate instances (NB; not necessarily individual turtles, hawksbill turtles are highly resident, so we probably saw the same individuals multiple times!).

The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) sightings were higher that spinner dolphin (*Stenella longirostris*) sightings just like in previous years. Average pod size for bottlenose dolphin was 13 and for spinner dolphins 17. Due to the limited time we have been able to be out at sea during 2020, we were not lucky enough to have encounters with any other cetacean species but in the past years we sighted: false killer whales, short-finned pilot whales, blue whales, Risso's dolphins and even humpack whales!

Some of the dolphin species we observe during our surveys, are most likely coming to rest during the day in the shallow reefs and travel to the outer reefs during the sunset to forage, hence the added importance to slow down within SAMPA and follow the dolphin watching regulations. As a possible consequence of vessels travelling at high speed (dolphins are more than capable of avoiding slow moving vessels), several individuals of the dolphin database have major dorsal amputations and lacerations which are consistent with propeller strikes.



# **Other Research**

#### Scientific articles and thesis outputs in 2020

The MWSRP this year has collaborated with the University of York, University of Plymouth, University of Edinburgh and Scripps Institution of Oceanography, UC San Diego.

All of the below will be available in full on the MWSRP website once permission periods are finished. Should you wish for the full document, please contact MWSRP at

info@maldiveswhalesharkresearch.org



Anthropogenic injury and site fidelity in Maldivian whale sharks (*Rhincodon typus*)

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#### Abstract

1. Whale sharks collect in predictable seasonal aggregations across the tropics.

South Ari Atoll in the Maldives is one of a few aggregation sites where whale sharks can be encountered year-round. Here, areas with high levels of tourism-related boating traffic overlap with the whale shark hotspot, increasing the probability of anthropogenic injury. Whale sharks have been reported to remain faithful to this aggregation site following injury, despite the costs of injury and the risk of re-injury. However, the impacts of injury on site fidelity and residency behaviour are not fully understood.

2. Encounter data on individual sharks from the Maldives Whale Shark Research Programme database (2006–2018) were analysed to assess the relationship between injury and site fidelity in whale sharks. There was no difference in geographic site use, with injured and non-injured individuals being encountered in the same areas.

However, there were differences in residency timings: injured resident whale sharks (individuals repeatedly encountered over 6 months or longer) spent significantly more time at the atoll and less time absent, and were seen more consistently than noninjured residents. Increased residency duration, return rate and number of residency periods correlated with increasing injury number. 3. These differences in behaviour imply a cost to injury, with whale sharks potentially remaining at this site to recover. With boat traffic being concentrated at the aggregation site, injured sharks may be more vulnerable to further injury. Alternatively, these individuals may remain at the atoll despite injury because the benefits gained from this area outweigh the potential costs, with more resident individuals facing greater exposure to anthropogenic threats. These findings highlight the importance of this location and emphasize the need for improved management of anthropogenic activities, particularly boating traffic, at aggregation hotspots to reduce injury rates and any subsequent impacts on behaviour and fitness.



The impact of injury on apparent survival of whale sharks (*Rhincodon typus*) in South Ari Atoll Marine Protected Area, Maldives

Jessica Harvey-Carroll, Joshua D. Stewart, Daire Carroll, Basith Mohamed,

Ibrahim Shameel, Irthisham H. Zareer, Gonzalo Araujo & Richard Rees.

#### Abstract

The whale shark (Rhincodon typus) is an endangered species with a declining global population. The South Ari Atoll Marine Protected Area (SAMPA), Maldives, is one of few locations globally where yearlong residency of individuals occurs. This SAMPA aggregation appears to consist almost exclusively of immature males. Due to its year-round residency, this local aggregation is subjected to a high degree of tourism pressure. This ecotourism contributes to the high level of interest and protection offered to whale sharks by the local community. Unfortunately, if regulations are not followed or enforced, tourism can bring with it major stressors, such as accidental injuries.

We used POPAN capture-markrecapture models and lagged identification rate analysis to assess the effect of major injuries on whale shark residency within SAMPA. Injuries may be obtained outside SAMPA. We found individuals with major injuries had a higher apparent survival in the area than those without. Lagged identification rates also demonstrated that sharks with major injuries are more likely to return to the area. We suggest that major injuries result in sharks prolonging their time in the developmental habitat. These findings have implications for individual fitness and the population viability of this endangered species. We propose targeted conservation strategies be considered to protect sharks from further injury. Based on the presented spatio-temporal distributions of sharks, and current local knowledge of sighting patterns, speed limit zones and propeller-exclusion zones should be implemented and enforced. If carried out alongside tourist education, these measures will contribute to the protection of whale sharks within SAMPA and beyond. Furthermore, our results can aid research direction, alongside regulation and enforcement development, at similar sites worldwide.

Wound-healing capabilities of whale sharks (Rhincodon typus) and implications for conservation management

Freya Womersley James Hancock, Cameron T. Perry and David Rowat

#### Abstract

Wound healing is important for marine taxa such as elasmobranchs, which can incur a range of natural and anthropogenic wounds throughout their life history. There is evidence that this group shows a high capacity for external wound healing. However, anthropogenic wounds may become more frequent due to increasing commercial and recreational marine activities. Whale sharks are particularly at risk of attaining injuries given their use of surface waters and wildlife tourism interest there is limited understanding as to how whale sharks recover from injuries, and often insights are confined to singular opportunistic observations. The present study makes use of a unique and valuable photographic data source from two whale shark aggregation sites in the Indian Ocean. Successional injury-healing progression cases were reviewed to investigate the characteristics of injuries and quantify a coarse healing timeframe. Wounds were measured over time using an image standardization method.



This work shows that by Day 25 major injury surface area decreased by an average of 56% and the most rapid healing case showed a surface area reduction of 50% in 4 days. All wounds reached a point of 90% surface area closure by Day 35. There were differences in healing rate based on wound type, with lacerations and abrasions taking 50 and 22 days to reach 90% healing, respectively. This study provides baseline information for wound healing in whale sharks and the methods proposed could act as a foundation for future research. Use of a detailed classification system, as presented here, may also assist in ocean scale injury comparisons between research groups and aid reliable descriptive data. Such findings can contribute to discussions regarding appropriate management in aggregation areas with an aim to reduce the likelihood of injuries, such as those resulting from vessel collisions, in these regions or during movements between coastal waters.

Can marine protected areas serve as climate refugia for whale sharks in the Maldives?

#### Bernadette Butfield

MSc in Marine Systems and Policies, University of Edinburgh

#### Abstract

Global climate change poses one of the greatest threats to whale sharks Rhincodon typus, Smith 1828. Rising sea surface temperatures, ocean acidification and changes in prey availability are expected to alter the behaviours and distribution of whale sharks, shifting their presence poleward. Such movements will have significant impacts upon the local livelihoods and the marine ecosystems that depend upon whale sharks. Despite this, very little research has identified potential sites of climate refugia for whale sharks. The South Ari Atoll (the Republic of Maldives) hosts one of the 25 whale shark aggregation sites known globally, yet literature suggests that the country is one of the most vulnerable in places the whole world to climate change.

Notably, the high occurrences of juvenile male whale sharks in the South Ari Atoll Marine Protected Areas (S.A.MPA) make it a globally significant aggregation site and a likely secondary nursery for the species. Species distribution models have been used been used to predict the impacts of climate change on whale shark distribution but have been limited by the seasonal variability of aggregation sites. Using the S.A.MPA as a study site, this research offers an opportunity to expand upon existing distribution studies elsewhere in the world and provide a more thorough overview of the predicted impacts of climate change whale shark distribution. To understand the environmental drivers of whale shark presence in S.A.MPA, multiple regression models and geographic information systems analysis were used.

The results identified proximity to reef slope, sea surface temperature and chlorophyll-a as significant environmental predictors and whale shark presence in S.A.MPA. Subsequently, this research developed a species distribution model to identify the S.A.MPA as a potential site of climate refugia for whale sharks under two different climate scenarios. The most optimistic (RCP26) and most pessimistic (RCP85) scenarios were selected (2.6 W/m2 and 8.5 W/m2, respectively) to forecast the future distribution of juvenile male whale sharks in the S.A.MPA between 2040 and 2050. The results suggested presence of whale sharks in the area is expected to shift southward, mimicking the recent findings of species distribution model studies on other aggregation sites.

#### "Distilling an ocean of data: A compliance tool to inform Marine protected area management by filtering data into useful indicators"

#### Neha Ram

Masters of Advanced Studies in Marine Biodiversty and Conservation. Scripps Institution of Oceanography, UC San Diego

#### Abstract

The Maldives Whale Shark Research Programme (MWSRP) collects spatial, biological, oceanographic, and anthropogenic data on whale sharks in the South Ari Atoll Marine Protected Area (SAMPA). There is a need to develop GIS capabilities within the organization in order to further explore, visualize, and analyze data, create 2D maps, and share their findings in a more effective and efficient manner.

This need is all the more important in the present time due to the push for better management of SAMPA. In my capstone, I aim to build the GIS capacity at MWSRP by creating a visualization and mapping tool to help create the communication material to contribute to the planning process for better management of SAMPA and to ensure the best conservation measures are taken for the protection of the whale sharks.



# **Community Outreach Summary**

# Presentations

#### **Maldives**

Despite COVID-19, a virtual third Maldives Marine Science Symposium was organised. Jessica Harvey-Carroll and Iru Zareer presented the scientific article "*The impact of injury on apparent survival of whale sharks (Rhincodon typus) in South Ari Atoll Marine Protected Area, Maldives*".

#### Liveaboard presentations

As in previous years the in-field team continued delivering presentations to guests from liveaboards related to whale shark consevation in the Maldives. During the two months they managed to be in-field, they were invited onboard MV Felicity and MV Ecoblue.

### Schools

## AMERICAN SCHOOL OF DOHA

A series of three interactive talks about whale shark research, citizen science, and megafauna were presented to students from the "Effect Club" from the American School of Doha. In the past students from this school had joined us in-field but due to the unforeseen circumstances their trip didn't take place in 2020. Additionally an on-line session about "Ecotourism" was organized for the IB (International Baccalaureate<sup>®</sup>) French classes.

#### BELLVER INTERNATIONAL COLLEGE

Clara our Operations Manager organised a session about "Career, Professional and Personal Development" at a school in Mallorca, Spain.

#### Interviews

#### **WISEOCEANS**

"WiseOceans is a specialist Marine Education and Conservation company striving to engage, educate and inspire people everywhere to love the oceans and the life within them, connecting communities to our marine life and empowering them to make small changes in their lives so that together we make a big difference"

Chloe Winn, one of our in-field coordinators was interviewed by Wise Oceans in November. Have a look at the <u>interview</u>!

#### WATER WOMEN PODCAST

"A podcast for those who are passionate about the ocean, sciences and lifestyle alike, and the women who have invested their lives in the ocean. Aiming to provide education and entertainment for all!"

Chloe chatted all things whale shark this week, with the wonderful Jill from Water Women Podcast, the episode is available to listen to on Spotify! Chloe bounced around from various whale shark topics including a bit of ecology and distribution, how to best help protect whale sharks and the work carried out in the field.

#### WOMEN IN OCEAN SCIENCE PODCAST

"We're Women in Ocean Science - a global community of women in marine sciences. We're all about inspiring, empowering, connecting and educating women and creating change for our blue planet"

Chloe took on another opportunity and was interviewed by Hannah Rudd marine biologist and science communicator, who joined us a couple years back in Dhigurah.



coral reef ecology fisheries research ecosystem dynamics resilience climate change biodiversity resource dependence oceanography spatial planning











SCRIPPS INSTITUTION OF

DCEANOGRAPHY

UC San Diego



Due to COVID-19 we were only present in Dhigurah (the island were we used to be based at) for two months in 2020. During this time several beach clean ups were organised but the most notable one was the one organised by the Women's Committee of Dhigurah!

# World Oceans Day 2020

Neha Ram a previous volunteer and student in Scripps Institute of Oceanography participated in the Annual event for the Master of Advanced Studies Students in Marine Biodiversity and Conservations specifically during World Oceans Day. She presented her captsone research project "Distilling an ocean of data: A compliance tool to inform Marine protected area management by filtering data into useful indicators".



## In Sharks We Trust

In Sharks We Trust (ISWT) funded the Divemaster training programme for our in-field coordinator Basith Mohamed. Thanks to this opportunity, Basith was able to work on a liveaboard for a short period of time whilst MWSRPs operations were on standby due to COVID-19. Additionally due to this opportunity Basith will be able to increase his underwater skills for future research operations. On a similar note ISWT will help us make it to Fuvahmulah in 2021 in order to carry out research surveys and community outreach programmes.



# Code of Conduct Briefing Package

The MWSRP Team has started working on an updated briefing package. A visual aid, equipping tour guides across the industry to deliver a clear, standardised set of key messages to their guests that will ensure their guests are well informed, safe and that the impact of their excursion has a minimal impact on the whale sharks they seek. The briefing pack will include visual aids and notes for the excursion guide. A big thank you to Exodus Travel for your financial aid for this specific matter and for helping us recover and rebuild in the wake of the impact of COVID-19.



# Stakeholder Outreach Summary

#### Big Fish Network updates and other additions

There are now 141 people, organisations or operators that contribute their sightings information to MWSRP. Some are not quite so active but many have given a great deal of their time, are passionate and very committed!

Here we take a minute to salute the top contributors from each area;

The top three resort contributors during this period were;

<ol> <li>Conrad Maldives</li> </ol>	(51
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- 2) Lti Maafushivaru (32)
- 3) LUX\* Maldives (22)

These three resorts are located in South Ari atoll.

Top 3 Liveaboard Contributors were;

- 1) MV Emperor Explorer (16)
- 2) MV Blue Voyager (6)
- 3) Submaldives (6)

Top Guest House/local Dive Center Contributor \*Indico Secret\*

Top Guest House/Dive Center Contributor from Dhigurah \*Bliss Dhigurah and Boutique Beach

We really appreciate the time dedicated by all of you by submitting these encounters during these difficult times the world is facing. A heartfelt thank you for all of you who have joined the online training courses and being ace citizen scientists in aid of the whale sharks!

### News and media



In 2020, our very own Chloe has written an article for Oceanographic. Oceanographic is a bi-monthly marine lifestyle magazine with a focus on ocean conservation, exploration and adventure. She speaks about the whale sharks of SAMPA and her hopes for the future of whale sharks globally. <u>"The whale sharks</u> of South Ari" is available to read online.

Q

A couple more articles have been released which are related to some of the most recent research outputs regarding injury rates and survival (see below). Conservation Mag is a magazine focused on the importance of wildlife and educating people about the crucial role that animals and nature have in our lives. Mongabay on the other hand, is a U.S.-based non-profit conservation and environmental science news platform. Additionally after the presentation delivered at the virtual Maldives Marine Science Symposium an article was published by SunOnline International from the Maldives.

Check the articles at: <u>Conservation Mag</u>, <u>Mongabay</u> and <u>SunOnline International-Maldives</u>. Thank you to the authors of the articles for speading the message.

Finally, Lewis Jefferies, filmmaker and photographer joined us in-field in 2020. He produced a short documentary "Fehurihi" that explores the culture, history, conservation and future of the whale sharks in the Maldives.

Conservation | may

Boat Strikes Linked to Decline in the World's Largest Fish - Whale Sharks



سترقى ريمرة كرمير مريد فامتومهة روق





Boat strikes in Maldives put pressure on whale sharks' survival odds

RAINFORESTS OCEANS ANIMALS ENVIRONMENT BUSINESS SOLUTIONS FOR KIDS DONATE IMPACT MORE





# Plans for the future

#### Continuation of observational research

We aim to increase understanding of; a) The physical characteristics, distribution and behavioural ecology of whale sharks in the Maldives and b) Further explore the significance of the primary aggregation site, South Ari atoll.

#### Significance of South Ari Marine Protected Area

The abundance of surface swimming whale sharks in South Ari might suggest the presence of a reliable food source. However, the apparent lack of feeding behaviour exhibited by the individuals encountered near the surface has led MWSRP to hypothesise that the South Ari area may provide the optimum combination of habitats for these juvenile whale sharks. It is thought that the proximity of a deep water channel may offer opportunities for whale sharks to seek food at depth or facilitate long range movements, whilst also remaining in close proximity to a warm shallow water habitat for post-dive recuperation and thermoregulation. It is a key objective of the MWSRP to further understand why whale sharks are encountered in South Ari so consistently compared to other areas of the Maldives. We would like to establish what physical parameters make South Ari such an important aggregation

site and which environmental conditions may affect the frequency of whale shark sightings in this area.

The MWSRP aims to:

- Continue to build a central register of whale shark individuals identified using photo-identification
- Keep an encounter log of observational data including shark characteristics, shark behaviour and environmental parameters
- Establish and maintain a national citizen-science monitoring network, through which tour operators from across the Maldives can submit encounter information and photographs via an online portal
- Identify key environmental and oceanographic parameters within the South Ari area and compare these with other sites in the Maldives.
- Opportunistically collect whale shark fecal samples for genetic testing
- Use empirical data to explore the potential seasonal movements of whale sharks between regions in the Maldives
- Deduce whether any differences exist in terms of population demographics between South Ari and the other regions of the Maldives.
- Continue monitoring the incidence of injuries which may affect residency and or apparent survivability of individual whale sharks in South Ari atoll.

# CODE OF CONDUCT

The primary behaviors of whalesharks observed at the surface is cruising, feeding, evasive, and inquisitive. We want our interaction with whalesharks to be as nonintrusive as possible so we do not alter their natural behaviors.

Whalesharks come up to the surface to thermoregulate after deep diving. They can be quite slow and sluggish so we should be careful while we're in the water and give them space for their recovery.

To make the best of your encounter, we recommend the following guidelines while snorkelling or diving with whale sharks.



and it might cut your encounter short if there's a camera flash.

**ALERT THE BOAT** CAPTAIN IF WHALE SHARK MOVES CLOSE TO THE BOAT.

Curious whalesharks can swim up to boats, and evasive whale sharks might try to leave under the boat. Tell the captain to keep their propeller turned off if this happens.



This is for your safety and for the whalesharks comfort - if it's feeling threatened, it will show you it's back or try to move away.



DO NOT OBSTRUCT A WHALE SHARK BY SWIMMING INFRONT OF IT.

Whale sharks have the biggest smiles in the ocean - be sure to view it from the sides!



# Acknowledgements

From the bottom of our hearts we want to thank you in advance for your consideration and help during these difficult times.

The MWSRP would like to sincerely thank the Maldives Marine Research Institute, the Environmental Protection Agency of Maldives and the Ministry of Fisheries, Marine Resources and Agriculture for their continued support of our work.

To the people and island councillors of Dhigurah and the islands of South Ari atoll and the South Ari atoll councillors, we appreciate so much you allowing us to spend time in your islands over these years and thank you for your hospitality and for sharing your wealth of knowledge with us.

Our Dhigurah island hosts TME Retreats Maldives for their logistical support, especially Fayaz Mansoor.

Dhigurah school principle and other teachers – with special mention to Jackson – of Dhigurah school. We really appreciate you giving your time to work with us.

We also thank Hogan & Lovells for their legal assistance and Bryan Kemsley for his accountancy service.

To our volunteer partners Natucate, The Great Projects and Zublu Diving. Thank you for your continued support.

To our fellow conservation NGO's Manta Trust, Olive Ridley Project and IUCN thank you for sharing a vision and working with us to realise this.

To Critter Earth for their support in the continued innovation in developing the Big Fish Network platform.

To the Shark Trust, In Sharks We Trust, EcoProDivers, Secret Paradise Maldives (specifically Ruth for her dedication), Exodus Travels, Conrad Rangali Maldives, Saltydogstudio Hawaii and private donours for their fundraising support.

The volunteers and interns of MWSRP (as well Master's students and BSc students), visiting teachers and school students who share their time and knowledge with us on the ground and who's donations allow us to continue our work we say a big 'shukuriyaa'!

Basith Mohamed, Chloe Winn, Clara Canovas Perez, Kaushiik Subramaniam, Gregor Kervina, Melody Sky, Lewis Jefferies, Nicki Meharg, Hoodh Ahmed, Mette Ellis Nussbaumer for providing us with awesome footage! As well as some of our contributions!

Thank you to the American School of Doha and University of Edinburgh for your support of our charity as well as Wise Oceans.

To our wonderful, enthusiastic staff (Iru, Shameel, Basith, Clara, Chloe, Richard...) and extended "family" branch of the programme who's constant efforts have enabled the programme to stay afloat.

And lastly one more big thank you to those contributors of the Big Fish Network for the knowledge you help to grow!

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# **Tables and Figures**

# **Tables**

## Table 1; Summary of the whale shark encounter information collected by MWSRP

From	May 2011	Nov 2011	May 2012	Oct 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019	Feb 2020
То	May 2011	Feb 2012	June 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019	Feb 2020	Feb 2021
No. of Whale Shark Encounters	6	171	51	155	352	308	319	365	306	175	140	70
No. of different Individual Sharks	4	36	20	33	44	50	45	49	43	35	40	25
Known Sharks	3	34	20	28	14	45	39	40	34	30	28	16
of which Male	3	32	19	28	13	40	35	47	32	30	27	15
of which Female	0	2	1	0	1	3	3	1	1	0	0	0
of which Sex Unknown	0	0	0	0	0	2	1	1	1	0	1	1
New Sharks	1	2	0	5	30	5	2	9	7	5	9	9
of which Male	1	0	0	5	26	4	1	8	4	5	4	1
of which Female	0	2	0	0	1	0	0	0	1	0	2	1
of which Sex Unknown	0	0	0	0	3	1	1	1	2	0	3	7
Average Shark Length (Metres)	4.5	6.08	5.64	5.58	5.82	5.92	6.2	5.46	6.11	5.61	5.75	5.70
Total Individual Whale Sharks in MWSRP Database	161	168	172	181	206	226	275	302	354	391	472	509

Table 2; Summary of the whale shark encounter information collected over the whole research period by contributors to the Big Fish Network.

From	May 2011	Nov 2011	Mar 2012	May 2012	Jul 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019	Feb 2020
То	Oct 2011	Feb 2012	Apr 2012	Jun 2012	Feb 2013	Feb 2014	Feb 2015	Feb 2016	Feb 2017	Feb 2018	Feb 2019	Feb 2020	Feb 2021
No. of Whale Shark Encounters	32	55	38	10	122	493	388	361	283	388	366	330	286
No. of Different Individual Sharks	24	25	23	7	33	U/Av	63	91	60	91	85	109	72
Known Sharks	19	25	19	6	27	U/Av	48	47	42	50	48	39	41
of which Male	17	23	18	5	26	U/Av	44	35	37	43	43	36	35
of which Female	2	2	1	1	1	U/Av	2	2	2	2	3	0	0
of which Sex Unknown	0	0	0	0	0	U/Av	2	10	3	5	2	3	6
New Sharks	5	0	4	1	7	U/Av	15	44	18	41	37	70	31
of which Male	5	0	3	1	7	U/Av	6	11	11	5	10	11	5
of which Female	0	0	1	0	0	U/Av	2	12	3	2	14	30	7
of which Sex Unknown	0	0	0	0	0	U/Av	7	21	4	34	13	29	19
Average Shark Length (Metres)	5.26	6.07	5.54	5.65	5.39	U/Av	5.17	5.59	5.71	5.53	5.36	5.78	5.82
Total Individual Whale Sharks in Database	161	168	172	173	181	206	226	275	302	354	391	472	509