

Maldivian Manta Ray Project

LAAMU ATOLL | ANNUAL REPORT 2021

*Conservation through
research, education, and collaboration*

- The Manta Trust



WHO ARE THE MANTA TRUST?



The Manta Trust is a UK and US-registered charity, formed in 2011 to co-ordinate global research and conservation efforts around manta rays. Our vision is a world where manta rays and their relatives thrive within a globally healthy marine ecosystem.

The Manta Trust takes a multidisciplinary approach to conservation. We focus on conducting robust research to inform important marine management decisions. With a network of over 25 projects worldwide, we specialise in collaborating with multiple parties to drive conservation as a collective; from NGOs and governments, to businesses and local communities. Finally, we place considerable effort into raising awareness of the threats facing mantas, and educating people about the solutions needed to conserve these animals and the wider underwater world.

Conservation through research, education and collaboration; an approach that will allow the Manta Trust to deliver a globally sustainable future for manta rays, their relatives, and the wider marine environment.

MALDIVIAN MANTA RAY PROJECT



Formed in 2005, the Maldivian Manta Ray Project (MMRP) is the founding project of the Manta Trust. It consists of a country-wide network of dive instructors, biologists, communities and tourism operators, with roughly a dozen MMRP staff based across a handful of atolls.

The MMRP collects data around the country's manta population, its movements, and how the environment and tourism / human interactions affect them. Since its inception, the MMRP has identified over 5,250 different individual reef manta rays, from more than 100,000 photo-ID sightings. This makes the Maldivian manta population the largest, and one of the most intensively studied populations in the world. The MMRP has also identified over 790 different individual oceanic manta rays.

The long-term and nationwide data collected by the MMRP has allowed researchers to record and identify key patterns within this population over time. Not only does this invaluable information improve our understanding of these animals, but it informs their ongoing management and protection both in the Maldives, and around the world.

OUR PARTNERSHIP WITH SIX SENSES LAAMU



For years, Six Senses Laamu has contributed to the research efforts of the Manta Trust and the MMRP, through external submissions of manta ray ID photos. In 2014, a closer partnership began to blossom, with the Manta Trust launching an exciting five-month pilot project in Laamu Atoll. The project focused on investigating the nearby manta aggregation site at Hithadhoo Corner. The pilot phase was so successful that the Manta Trust team were invited back in 2015, this time for an extended period of nine months.

In 2016, a full 12-month partnership between both parties was born, and since then the project has gone from strength to strength. The Manta Trust's MMRP now has a permanent presence on the island, working closely with the resorts' resident marine biologists and sustainability manager, to raise awareness surrounding the unique, yet vulnerable marine environment of Laamu Atoll.



Photo by Jasmine Corbett

EXECUTIVE SUMMARY

This report is the eighth of its kind in a series that presents data collected by the Maldivian Manta Ray Project (MMRP) on Laamu Atoll's manta ray (*Mobula alfredi* and *M. birostris*) populations from January through December 2021. The MMRP (the founding project of the Manta Trust) has been collecting data on manta rays in the Maldives consistently since 2005. However, data for Laamu Atoll only dates to 2012, a short time after Six Senses Laamu opened in 2011. The Manta Trust team are incredibly proud and grateful to continue to have Six Senses Laamu as one of the MMRP's Key Regional Partners.

Laamu Atoll supports year-round manta ray sightings, although sightings historically peak from May to June and again from October to November annually. Two primary aggregation sites have been identified, Hithadhoo Corner in the south of the Atoll, and Fushi Kandu in the Northeast, with a third potential aggregation site (Maabaidhoo Kandu) being increasingly monitored by the MMRP team. Both Hithadhoo Corner and Fushi Kandu are characterised by cleaning stations, which support frequent cleaning behaviour and seasonal courtship activities. At Maabaidhoo Kandu, cleaning has been observed over an area of high coral cover at the reef drop-off. However, there have also been anecdotal reports of manta rays utilising a well-defined cleaning station within the channel.

In 2021, surveys ($n=869$) were conducted on a total of 330 days by either the MMRP, Six Senses Laamu staff, or citizen scientists from outside the resort. This was the highest number of surveys recorded annually to date in Laamu

Atoll thanks to the resort dive centre (Deep Blue Divers) contributing survey records every time they visited manta aggregation sites, which the Manta Trust Laamu team were grateful to receive. Key findings in 2021 include a total of 448 confirmed sightings of 67 individual reef manta rays (*M. alfredi*), recorded over five sites. Hithadhoo Corner continued to support the highest number of confirmed sightings throughout the region ($n=340$), followed by the Northeastern channel of Fushi Kandu ($n=100$), which presented the highest annual sightings to date. The number of sightings recorded at secondary sites in 2021 ($n=8$) was significantly lower than the average recorded in previous study years.

Of the 67 *M. alfredi* individuals recorded, each manta ray was observed on average 6.69 times. The mean number of confirmed manta ray sightings per survey in 2021 ($n=1.94$) was significantly higher than 2020 ($n=0.19$), due to an increase in research activity after the global pandemic. In 2021, June presented the highest sightings per survey ($n=0.91$), whilst December presented the highest number of confirmed sightings overall ($n=87$). As with previous years, a Residency Index (RI) was calculated to gauge the extent of movement amongst those frequenting Laamu Atoll. The RI for 2021 (2.48) was at its highest since 2018 (2.92).

As of 2021, the *Mobula alfredi* population demographics of Laamu Atoll constitute 59% female ($n=81$), 41% male ($n=56$), and <1% ($n=1$) for which sex cannot be determined. Overall, 55% ($n=76$) comprise adult individuals, 42%

($n=58$) juveniles, and 3% ($n=4$) are considered sub-adult. Of the population known to Laamu Atoll ($n=138$), 90% ($n=125$) have been re-sighted, presenting a small but highly residential sub-population.

In 2021, four individuals were identified as new to both the Maldives database and Laamu Atoll. This number was higher than the new individuals observed in Laamu Atoll in 2020 ($n=2$), possibly due to increased survey efforts. In 2021, there was only one pregnancy recorded, continuing the low fecundity trend recorded in 2020 (zero pregnancies); levels which are significantly lower than in previous years ($n=7$

in 2019, and $n=11$ in 2018). Courtship sightings in 2021 ($n=6$), were higher than 2020 ($n=2$), but also lower than previous years ($n=15$ for 2019).

Research projects in 2021 included photo-ID surveys, stereo video photogrammetry, remote underwater video cameras, “eyes on the reef” long life time-lapse camera deployments, aerial surveys, and social science surveys. Outreach led to increased citizen science submissions, online education sessions within the community, and an educational social media campaign in response to ongoing COVID-19 restrictions concerning inter-island movement.

MONSOONS & LAAMU ATOLL

The South Asian Monsoon heavily influences weather patterns in the Maldives. There are two defined monsoons (seasons) in the Maldives, characterised by wind speed and direction. The Northeast Monsoon (*Iruvai*) runs from December to March, while the Southwest Monsoon (*Hulhangu*) runs from May to October. April and November are classified as transition months; here, wind speed and direction can be highly variable.

As the winds change with each monsoon, so do ocean currents. The islands and atolls within the Maldives act as barriers to these currents, creating regions of deep-water upwelling, which drives nutrient-rich water to the surface. This increases the production of phytoplankton and drives subsequent blooms of zooplankton - the primary food source of manta rays.

The central and northern atolls of the Maldives are “double-chained”, with numerous channels dividing the fringing reefs. These characteristics cause plankton to accumulate on either the western or eastern sides of atolls depending on the monsoon, and manta rays migrate accordingly to take advantage of the varying abundances of their zooplanktonic food. Between periods of feeding, manta rays often utilise cleaning stations to clean and engage in other social interactions.

Located at the southernmost tip of the south-central Maldives, the topography of Laamu Atoll differs from that of the more northern atolls (Fig. 1). Laamu Atoll does not form part of a double chain, and few (six) channels break the outer reef. While Laamu Atoll experiences strong oceanic currents, water movement through the Atoll is restricted, and no clear seasonal manta ray migration pattern has been documented.

Hithadhoo Corner, located near the southern edge of Laamu Atoll, has historically supported year-round manta sightings, with peaks at the start and end of the Southwest Monsoon. Fushi Kanduu, located on the northeastern edge of the atoll, appears to be used primarily during the Southwest Monsoon (Fig. 1). Both sites have well-defined cleaning stations and support cleaning and courtship behaviours.



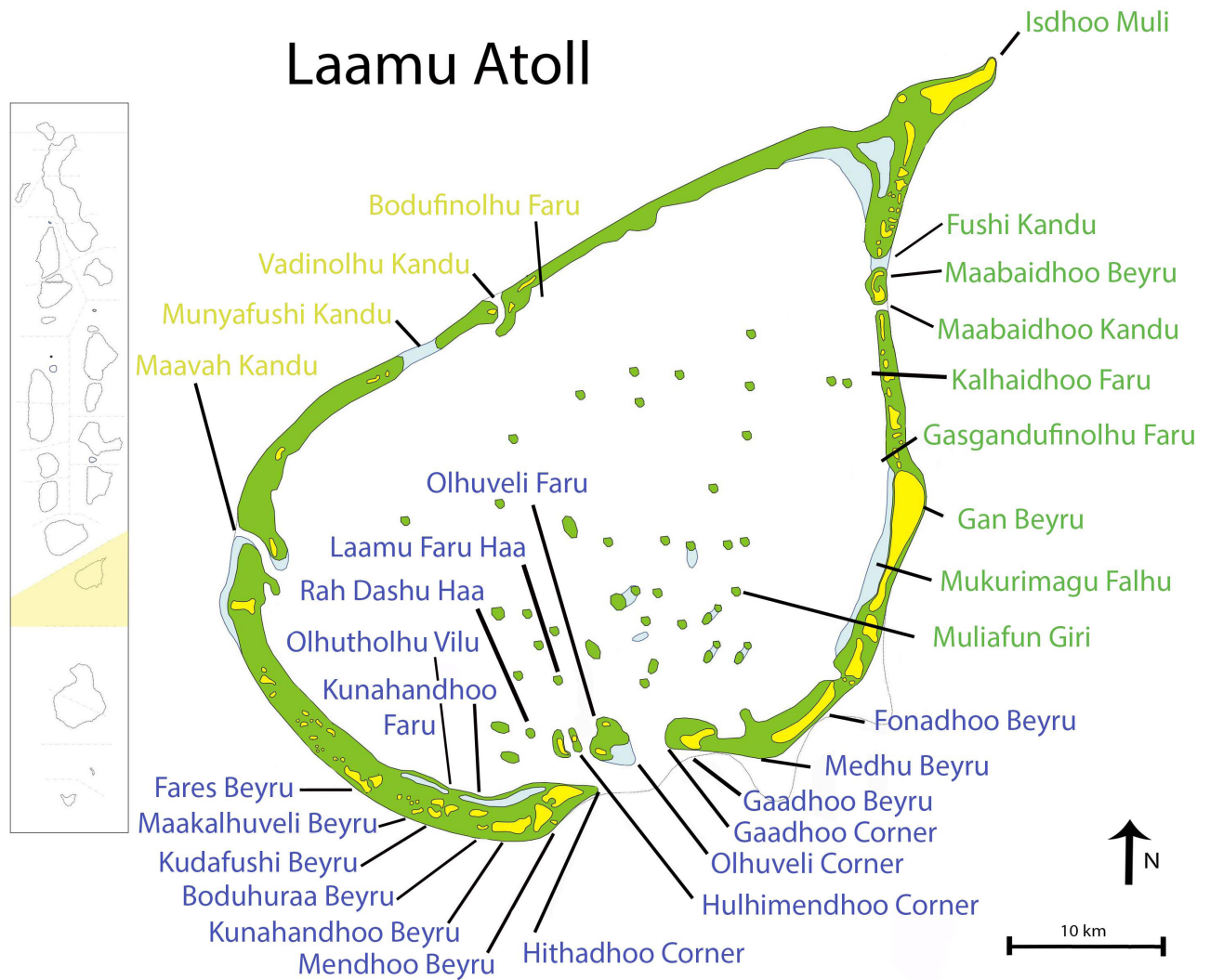


Figure 1: Map of Laamu Atoll showing the thirty-one locations in the atoll where reef manta rays (*Mobula alfredi*) have been observed (2014 - 2021).

STUDY PERIOD & SAMPLING METHODOLOGY

Throughout the Maldives, the MMRP records sightings of manta rays through photographs of the unique ventral spot patterns of individuals. Since 2013, most sightings data on the local manta population in Laamu Atoll has been collected by the MMRP researchers ($n=4,376$). However, sightings have also been submitted by resort partners and guides ($n=250$), and outside contributors, including guests ($n=108$). For this report, a sighting is defined as a confirmed photo identification (photo-ID) of an individual manta ray on a given day at a specific location (survey site).

manta ray numbers, behaviour (e.g., cleaning, courtship, feeding, cruising), duration of encounters, environmental variables (including wind direction, current direction, and plankton density), and anthropogenic factors (including the number of divers/snorkellers and the number of boats). Most data were collected while scuba diving due to the depth of aggregation sites. In 2021, the overall survey time increased significantly using remote underwater video and remote underwater photo cameras (RUV and RUP respectively), primarily at Hithadhoo Corner.

For each survey, information was collected on the location,

Two-thousand and fourteen marked the first year that

a dedicated research boat was provided by the resort to the Manta Trust team to conduct survey dives, with every month of the year being surveyed from 2016 onwards. From 2020 onwards, there was no longer a dedicated research boat available for use, due to restrictions resulting from the global pandemic. Boats could be booked for research only during quiet periods in the resort, when they had not already been booked for use by the dive centre. In 2021, no boat was available for regular surveys until April 2021, which resulted in limited manta ray research at the beginning of the year. The Manta Trust team were able to conduct surveys on Deep Blue Divers guest boats to manta aggregation sites, however research equipment use was limited as the Manta Trust team often assisted with guiding dives, and therefore guest care and safety was the priority. Visits to manta ray aggregation sites were sporadic and occurred only upon optimal conditions, such as full or new moon, or upon guest request. Therefore, it was difficult to obtain a reliable overview of manta ray abundance in 2021. As a solution to this, the Manta Trust team significantly increased RUP survey efforts from April 2021 onwards, which delivered continuous data even when visits to manta aggregation sites were not possible. These factors must be recognised when assessing the 2021 data, which presented a reliable overview of manta ray abundance only from April 2021 onwards.

For this report, a survey is defined by the start and end time of an activity (such as diving and snorkelling) at a single location. Remote underwater sensing is included in the survey effort, and a remote survey is also defined

by the start and end time of recording within one day at a single location. A survey day refers to the number of days when surveys were conducted in the Atoll irrespective of location. There were additional reports of manta ray sightings received in 2021, such as surface observations during guest excursions.

In all reports prior to 2020, surveys were defined by time spent at a single location each day. This meant that if two dives were conducted at one location, collectively the two dives plus the surface interval would be considered as one survey. If there was a long break in-between the morning and afternoon survey effort, the second visit to the location would be considered as a separate survey. Additionally, remote underwater sensing was previously included within the dive or snorkel surveys, but from 2020 onwards, remote underwater sensing was considered as a separate entity. Whilst data numbers may vary from previous year's reports, the comparison between years will not vary, as all the historical data were re-formatted for the purpose of these reports.

Before April 2015, MMRP researchers were not based in Laamu Atoll during all 12 months of the year, and therefore, data was not recorded on all dives to the manta aggregation sites. For this reason, averages where survey effort could be accounted for only include data between 2016 through 2021. Where possible, data has been standardised for survey effort to provide comparable results by both months and years.

2021 Study Period

In 2021, all surveys conducted at the primary aggregation sites of Hithadhoo Corner and Fushi Kandu by staff members of the Manta Trust, the Maldives Underwater Initiative, or Deep Blue Divers were recorded regardless of whether manta rays were observed during the dive or snorkel. For all other locations, surveys were only recorded if manta rays were present, or if MMRP staff participated in the dive.

In 2021, surveys were undertaken ($n=869$) on as many days ($n=330$) as conditions and logistical operations allowed (Fig. 2). Data was collected on the manta ray population through a combination of dedicated MMRP research dives ($n=76$), Six Senses Laamu (SSLM) activities with guests ($n=360$ dives, $n=2$ snorkels, and $n=2$ excursion

boats), remote underwater photo camera deployment days ($n=208$), remote underwater video camera surveys ($n=15$), and survey data collected from contributors outside the resort ($n=13$).

Hithadhoo Corner and Fushi Kandu continued to be the two primary survey sites, with data collected from Hithadhoo Corner on 288 days, and Fushi Kandu on 73 days in 2021 (Fig. 3). The MMRP has now collected reports of manta ray sightings from 31 sites in the Atoll and confirmed photo-ID sightings from 16 locations (Fig. 1 and Table 1). Regular monitoring of these sites in the future is necessary to determine the reliability of these locations for supporting manta ray sightings.

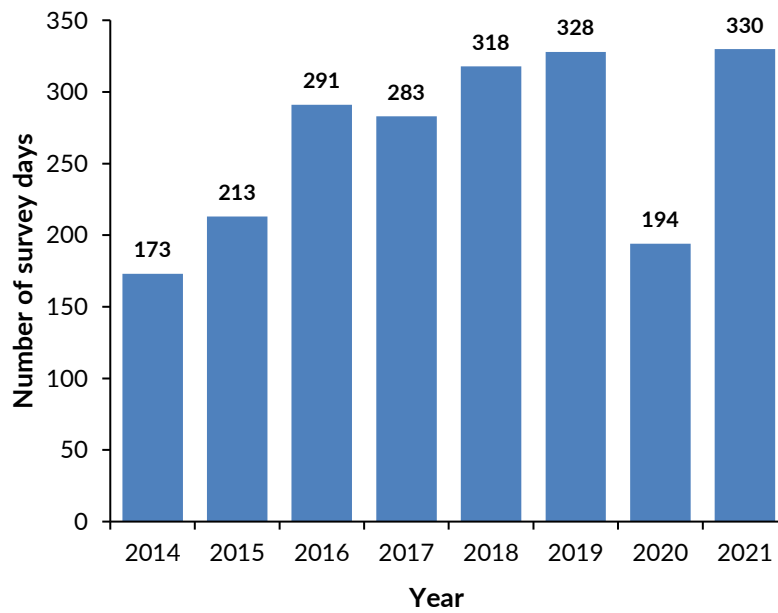


Figure 2: Number of days that surveys were undertaken in Laamu Atoll annually.

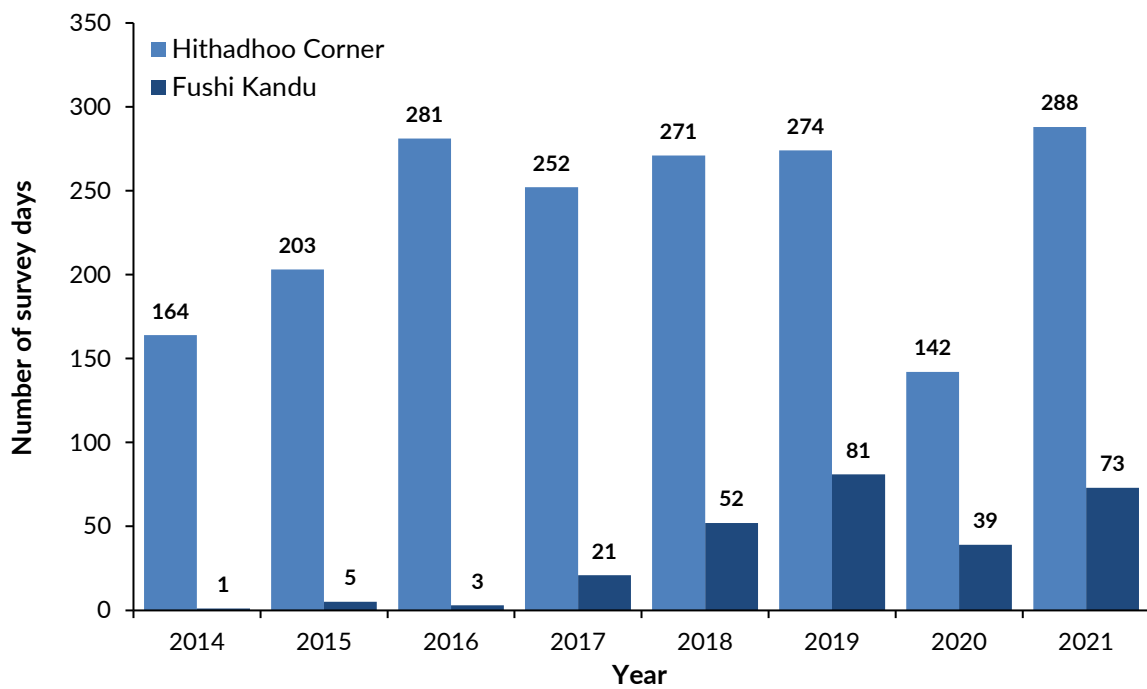


Figure 3: Number of days where surveys were conducted at Hithadhoo Corner and Fushi Kandhu in Laamu Atoll annually.

Overall, manta rays were encountered on 33% ($n=195$) of all dives ($n=599$), and identification photographs were recorded during 71% ($n=139$) of dives with manta rays. This is significantly more than in 2020 (41%) and is due to MMRP researchers previously being allocated to mainly guiding dives instead of joining as researchers. Manta rays were observed on 68% ($n=151$) of the remote underwater camera deployments, which is twice that of 2020 (34%). Snorkelling surveys were recorded from any resort or MMRP

led snorkel trips carried out at the two main aggregation sites (Hithadhoo Corner and Fushi Kandhu), or any other snorkel sites where manta rays were identified. Manta rays were observed on 20% ($n=5$) of the snorkel surveys ($n=25$), with confirmed identification photos collected for 8% ($n=2$) of the surveys. These figures are not reflective of snorkelling conducted across Laamu Atoll, as it remains rare to see manta rays while snorkelling in the Atoll.

Table 1: Thirty-one sites in Laamu Atoll where reef manta rays (*Mobula alfredi*) have been observed; grouped by their geographical location within the atoll.

*Indicates primary study site. Locations in bold indicate locations where manta rays were seen in 2021.

Group	Site Name	Reef Type	Location
1	Fares Beyru	Outer Reef	Southwest
	Maakalhuveli Beyru	Outer Reef	Southwest
	Kudafushi Beyru	Outer Reef	Southwest
	Boduhuraa Beyru	Outer Reef	Southwest
	Kunahandhoo Beyru	Outer Reef	Southwest
	Mendhoo Beyru	Outer Reef	Southwest
	Hithadhoo Corner*	Channel	South
	Hulhimendhoo Corner	Inner Reef	South
	Olhuveli Corner	Outer Reef	South
	Gaadhoo Corner	Channel	South
	Gaadhoo Beyru	Outer Reef	Southeast
	Medhu Beyru	Outer Reef	Southeast
	Fonadhoo Beyru	Outer Reef	Southeast
	Olhutholhu Vilu	Lagoon	Southwest
	Kunahandhoo Faru	Inner Reef	Southwest
	Rah Dashu Haa	Inner Reef	South
	Olhuveli Faru	Inner Reef	South
Laama Faru Haa	Inner Reef	South	
2	Isdhoo Muli	Outer Reef	Northeast
	Fushi Kandhu*	Channel	Northeast
	Maabaidhoo Beyru	Outer Reef	Northeast
	Maabaidhoo Kandhu	Channel	Northeast
	Kalhaidhoo Faru	Inner Reef	Northeast
	Gasgandufinolhu Faru	Inner Reef	East
	Gan Beyru	Outer Reef	East
	Mukurimagu Falhu	Lagoon	East
	Muliafun Giri	Inner Reef	East Central
3	Bodufinolhu Faru	Inner Reef	Northwest
	Vadinolhu Kandhu	Channel	Northwest
	Munyawushi Kandhu	Channel	Northwest
	Maavah Kandhu	Channel	West

REMOTE UNDERWATER SURVEYS

Remote underwater photo and video surveys (RUP and RUVs) are commonly used in research to monitor specific areas, and their use by marine life, whilst humans are absent. In 2019, RUP and RUVs became a regular surveillance tool at the manta aggregation sites in Laamu Atoll; deployed by MMRP researchers and left to record between dives to increase the opportunity of collecting manta identification and behavioural data. With improvements in the Manta Trust's remote underwater equipment, 2020 saw the introduction of extended life remote surveys. RUVs were able to record for up to 24 hours whilst "eyes on the reef" (EOTR) time-lapse cameras were able to record for up to 10 days, capturing images every 60 seconds. In 2021, EOTR survey efforts increased significantly, and from April onwards, one system was constantly deployed on one cleaning station at Hithadhoo Corner to offer a permanent insight of manta ray activity at this site. This data will be used as part of a year-long study by a Marine Environmental Management master's student, from Exeter University. Their thesis will assess data collected between May 2021 and May 2022 to understand the temporal use of cleaning stations by manta rays, and to determine the effects of environmental variables, such as changing seasons, lunar cycles, tides, and temperatures on manta ray presence at this site.

Of the 869 surveys conducted in 2021, 223 (26%) were undertaken using RUV/RUPs, a significant increase from 2020 (11%). A total of 20 hours of survey time were recorded over 15 RUV surveys, whilst 2029 hours of survey time were recorded over 208 RUP surveys. A total of 187 sightings were recorded over the surveys, which makes up 42% of the total 2021 sightings ($n=448$), which proves the benefits of remote sensing techniques to the Manta Trust's research.

Forty-seven individuals were sighted during RUV and RUP surveys, which was a significant increase from 2020 ($n=25$); most likely due to increased remote sensing effort. The highest number of monthly sightings recorded by RUP/RUVs was 86 (May), and the lowest was 0 in January and February . From January to April, only a small number of sightings ($n=9$) were recorded because of lack of boat access and reduced survey effort. The team will be receiving more RUP models in 2022, which will allow them to make more deployments across multiple sites, with the aim of better understanding site use and seasonality of reef manta rays across the entirety of Laamu Atoll.

SIGHTING TRENDS

Oceanic Manta Rays

Oceanic manta ray (*Mobula birostris*) sightings in Laamu Atoll remain rare. Thirteen oceanic manta rays have been identified in Laamu Atoll since 2014, at five different sites. The MMRP is working to increase their understanding of this species through research conducted in Fuvahmulah and Addu Atolls, where oceanic manta rays are sighted seasonally in much larger numbers than in other regions of the Maldives. The team in Laamu Atoll will continue to monitor for this species throughout 2022. The remainder of this report refers solely to reef manta rays (*Mobula alfredi*); any subsequent reference to manta rays refers only to this species.



Reef Manta Rays

Since 2012, a total of 4,745 sightings of reef manta rays have been recorded in Laamu by full-time MMRP researchers, citizen scientists, and remote underwater cameras. Between 2015 – 2018, numbers of confirmed sightings remained consistent, ranging between 727 and 780 sightings per year (Fig. 4). From 2019 onwards there was a significant decline in the number of manta ray encounters, with only 490 confirmed sightings (Fig. 4), followed by 118 in 2020, which was the lowest recorded figure since the establishment of a permanent research base in Laamu

Atoll. In 2021 ($n=448$), sightings rebounded close to 2019 levels. The mean number of sightings per survey ($n=1.12$) was lower than that in 2019 ($n=1.4$) (Fig. 4). Tourism levels remain low in the Atoll, therefore the general decrease in sightings is not likely linked to an increased presence of divers or other possible human disturbances. Changes in environmental conditions may offer more favourable conditions elsewhere or reduce drivers of cleaning station use.

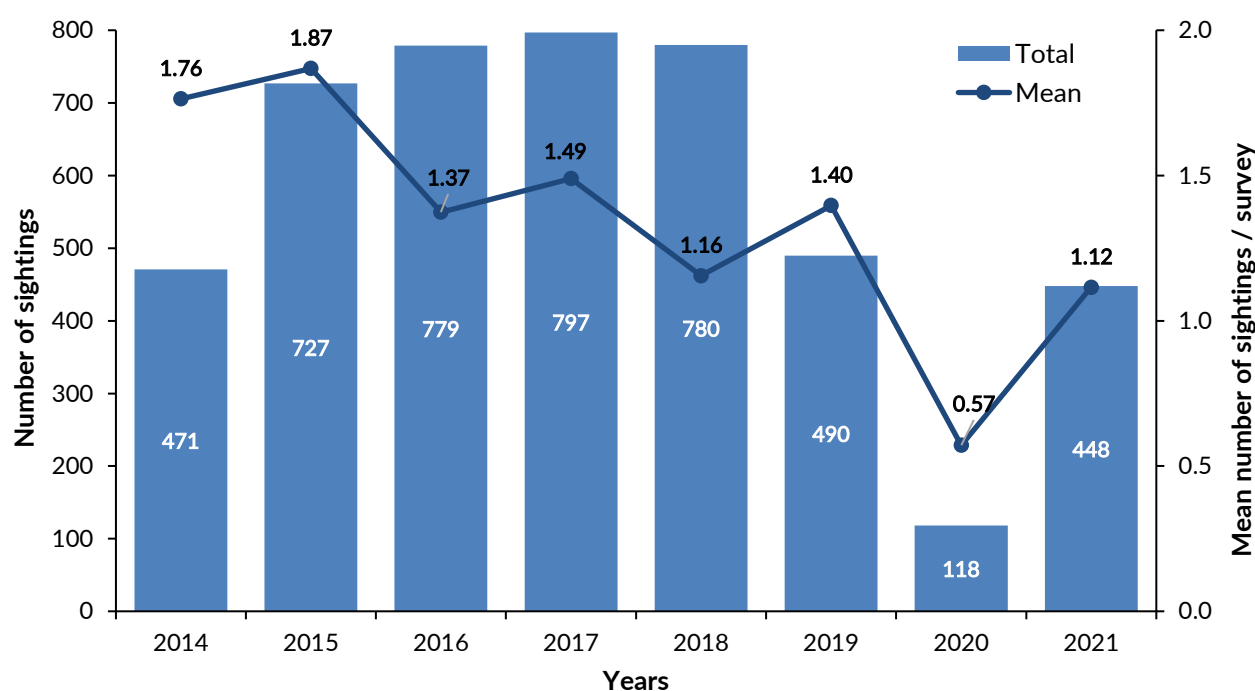


Figure 4: Annual sightings of reef manta rays (*Mobula alfredi*) in Laamu Atoll, and the mean number of sightings per survey for each year (2014 – 2021).

Sightings trends in Laamu Atoll were relatively consistent from 2014 through 2018, with peaks in sightings typically recorded annually at the start and the end of the Southwest Monsoon (May to June, and October to November) (Fig. 5). Since 2018, not only have seasonal sightings trends varied, but sightings per survey are significantly below previous averages (2014 – 2018); as evidenced in 2021 (Fig. 6). In 2021, the highest number of sightings occurred in December ($n=87$), while October (which historically usually has the highest number of sightings) had the lowest sightings of the peak months ($n=56$). It must be noted that survey effort was low for the first three months of 2021, and there was an increase in guest dives to manta ray aggregation sites in December, which will have influenced the inconsistencies in sightings trends when compared to 2014 – 2018. Two-thousand and nineteen and 2020 were

not included in this comparative analysis because they were not representative of the consistent trends noted over previous years. However, it is worth noting a potential new trend developing in recent years, with peak sightings occurring earlier in the year, at the start of the Northeast Monsoon (January in 2019, and January – February in 2020). This will need to be further monitored and continuously evaluated in upcoming years to decipher whether this is a new trend in sightings and seasonal presence of manta rays in the Atoll, which could be the result of changing environmental conditions.

In 2021, most sightings were recorded at Hithadhoo Corner (76%, $n=340$), and at Fushi Kandu (11%, $n=100$). These numbers reflect manta ray encounters confirmed through photo-IDs.

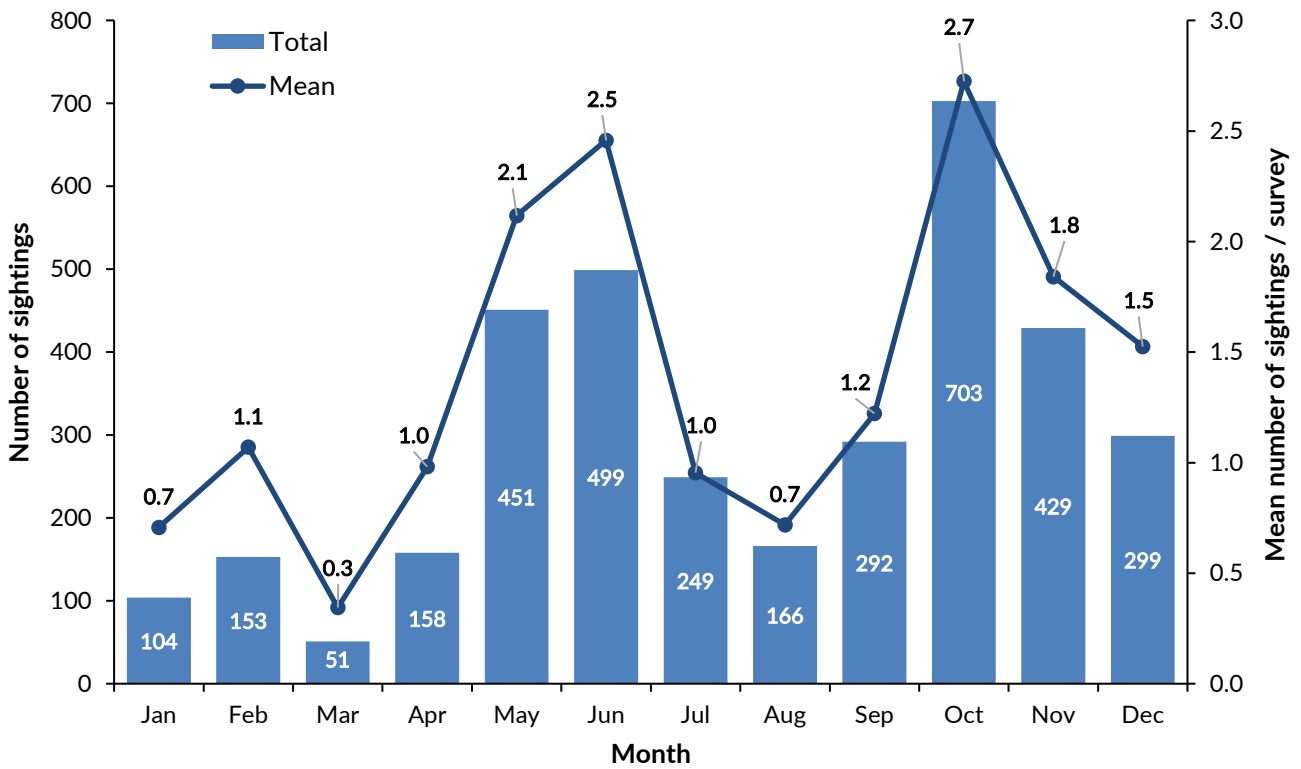


Figure 5: Monthly sightings of reef manta rays (*Mobula alfredi*) in Laamu Atoll (2014 - 2018) and the mean number of sightings per survey.

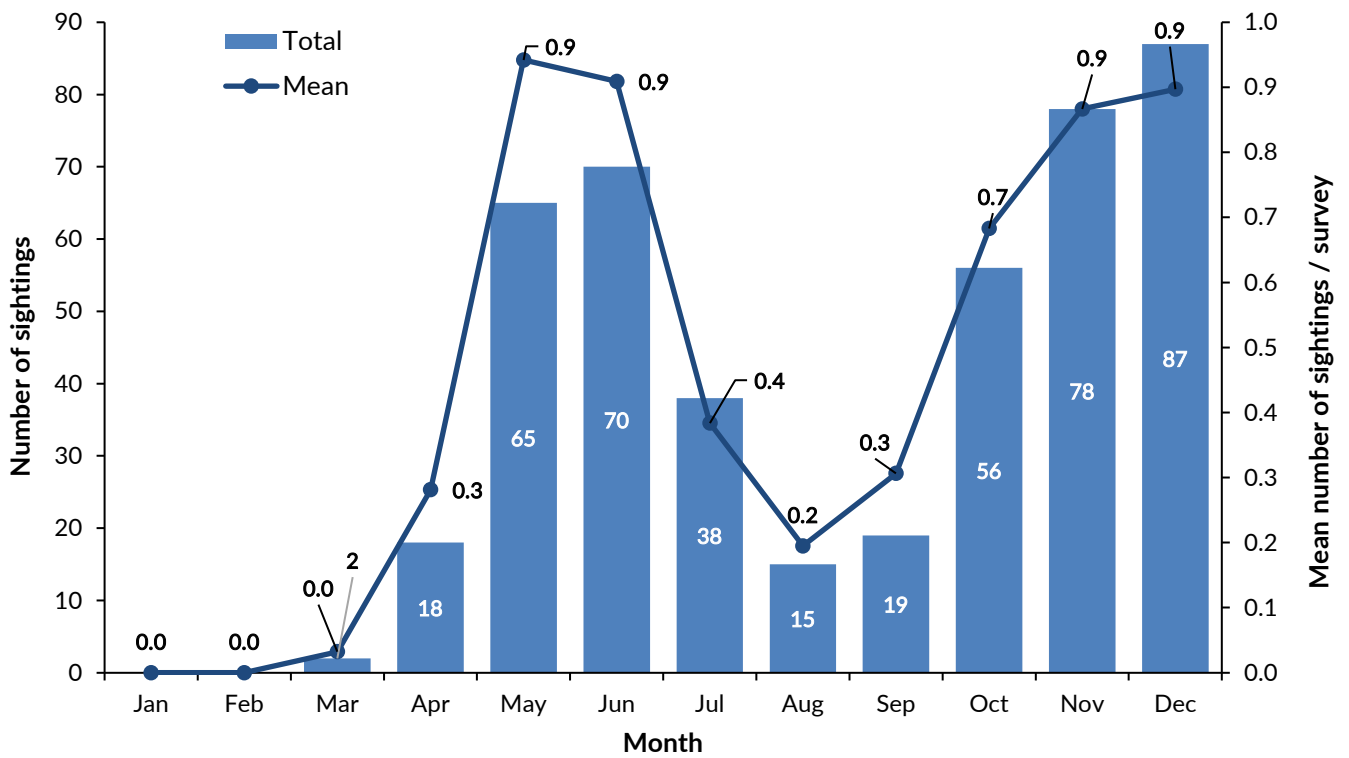


Figure 6: Monthly sightings of reef manta rays (*Mobula alfredi*) in Laamu Atoll (2021) and the mean number of sightings per survey.

Hithadhoo Corner

In 2021, sightings at Hithadhoo Corner were at their lowest since 2014 ($n=340$), excluding 2020, which was not considered as part of analysis due to limited research opportunity and temporary resort closure. Between 2014 – 2018 there was an average of 669 sightings noted per year, followed by a steep decline from 2019 ($n=396$) onwards (Fig. 7). When accounting for survey effort, a drop in the mean number of sightings per survey day was also apparent

($n=1.45$ and $n=1.18$ in 2019 and 2021 respectively, compared to $n=2.89$ between 2014 – 2018) (Fig. 7). Peaks in sightings were recorded at Hithadhoo Corner in May, June, and November 2021, with the highest numbers of individuals recorded in May, June, and December (Fig. 8). Excluding December, the peak sighting months aligned with those between 2014 – 2018.

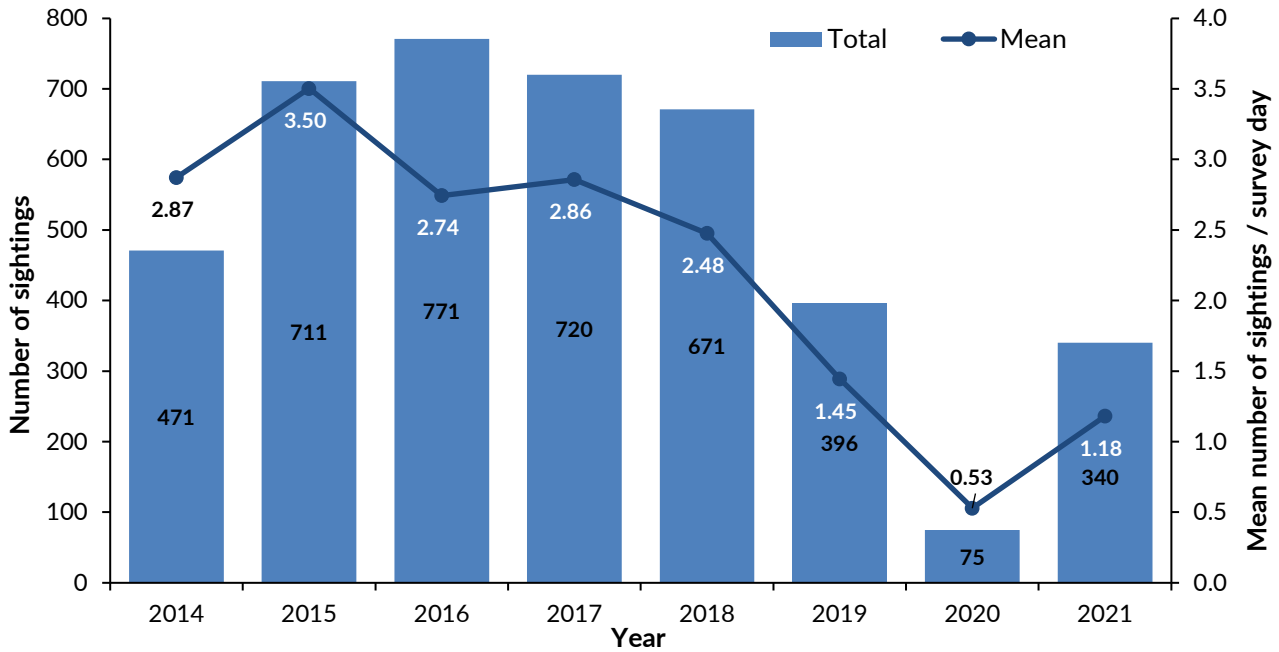


Figure 7: Annual sightings of reef manta rays (*Mobula alfredi*) at Hithadhoo Corner in Laamu Atoll and the mean number of sightings per survey day.

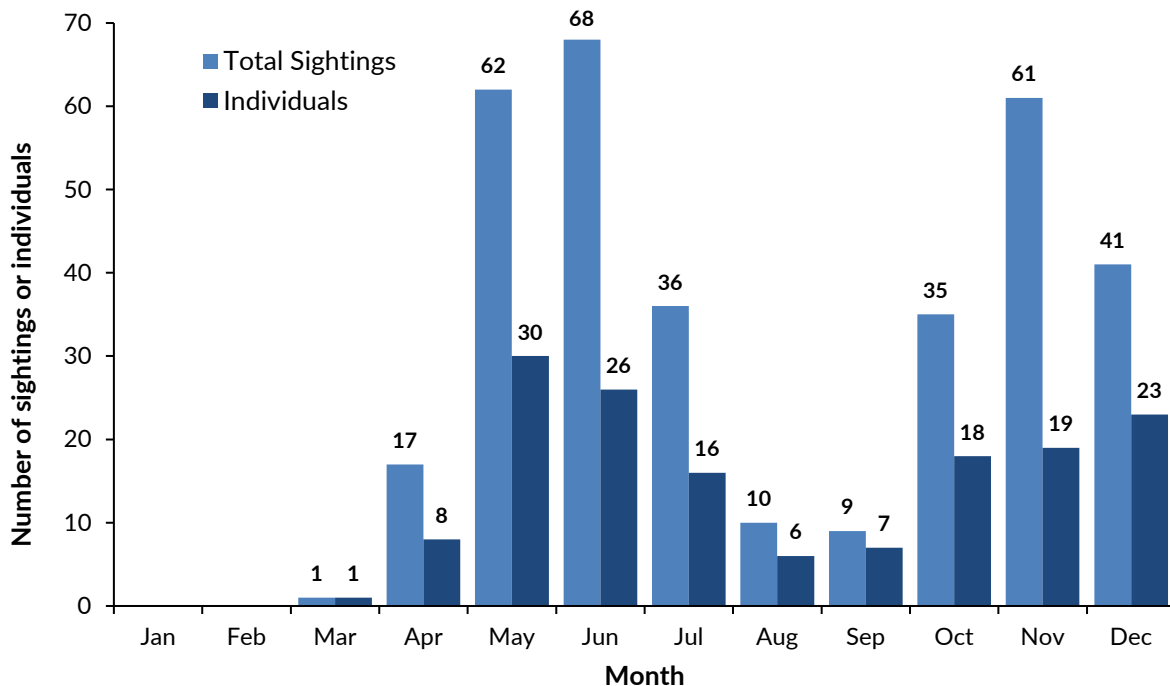


Figure 8: Monthly sightings and the number of individual reef manta rays (*Mobula alfredi*) recorded at Hithadhoo Corner in Laamu Atoll (2021).

Eighty-nine percent (n=301) of sightings recorded at Hithadhoo Corner in 2021 were associated with cleaning behaviour, whilst cruising behaviour made up 10% of observations (n=33) (Fig. 9). The average encounter duration (17 min) showed an increase from 2019 (13 min) but was similar to the average encounter time noted between 2014 – 2021 (19 min) (Fig. 10). This may be due to increased remote sensing data collection, which records manta sightings with minimal human disturbance, and potentially increases the duration of time that the manta rays spend at the site.

One hundred percent (n=187) of all RUV/RUP sightings in 2021 were captured at Hithadhoo Corner; due to a project which involved permanent monitoring of this site. Of these sightings, 25% (n=46) were recorded in May, when access to the site began to increase. Of the 67 individuals encountered in 2021, 70% (n=47) of these were sighted on remote cameras, which signifies the importance of deploying the systems on a regular basis to develop further insight into manta ray site utilisation and population dynamics.

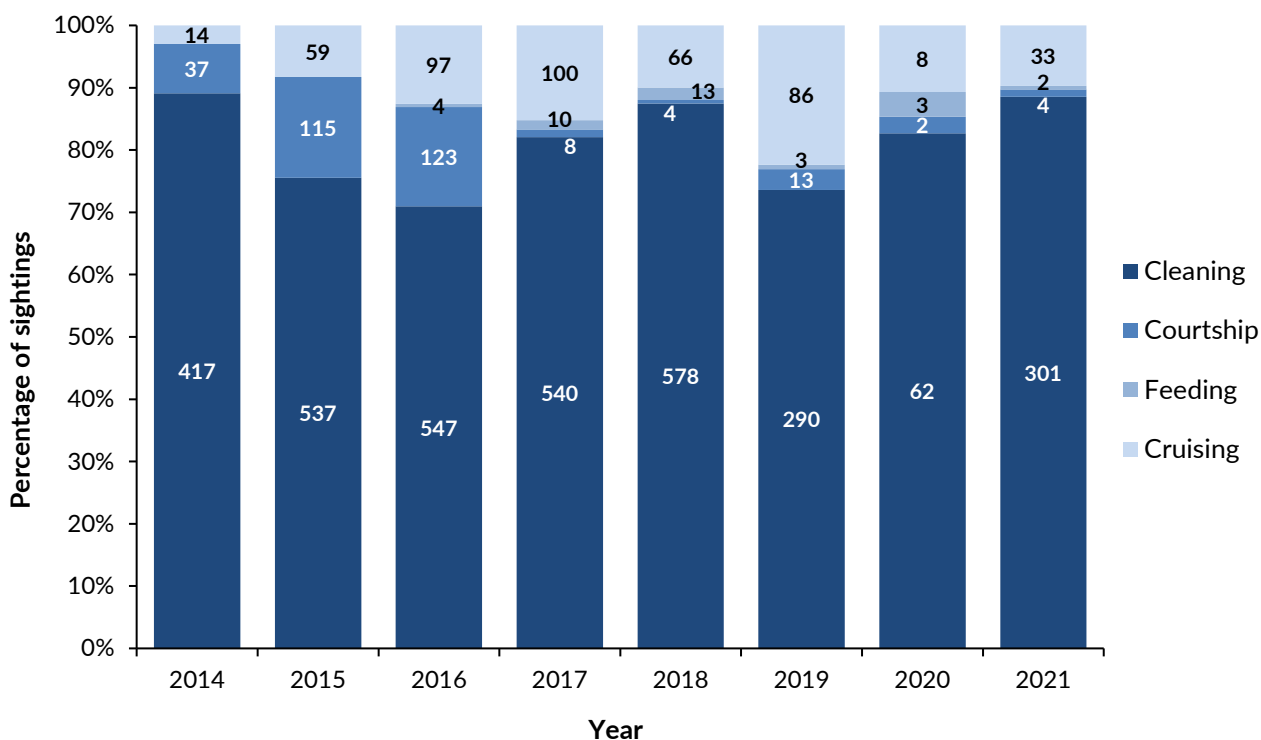


Figure 9: Predominant behaviour recorded during each reef manta ray (*Mobula alfredi*) sighting at Hithadhoo Corner in Laamu Atoll annually. Actual number of sightings above bars.

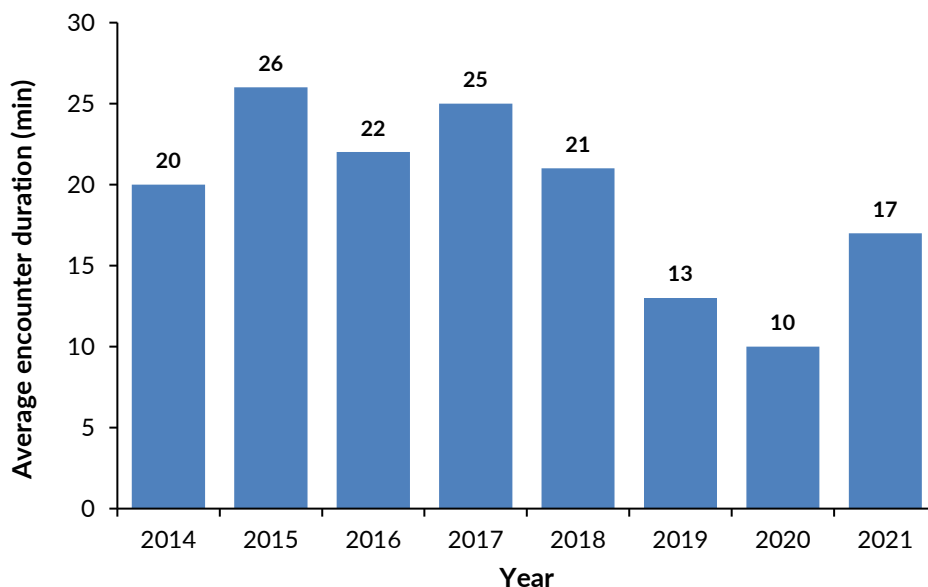


Figure 10: Average duration (min) of reef manta ray (*Mobula alfredi*) encounters recorded by divers at Hithadhoo Corner in Laamu Atoll annually.

Northeastern Channels

In 2018, Fushi Kandu was identified as a second key aggregation site based on preliminary surveys conducted in previous years, and surveys at this site increased in 2019 ($n=81$ survey days). Although survey days were lower in 2021 ($n=73$), the total sightings at this site were the highest on record ($n=142$). The average sightings per survey day in 2021 were higher than in both 2019 and 2020 ($n=0.6$ and $n=1.3$ in 2019 and 2020 respectively, compared to $n=1.9$ in 2021) (Fig. 11). At Maabaidhoo Kandu, a nearby channel, there were only six unconfirmed sightings, and zero confirmed sightings. To calculate sightings per survey day at these sites, the approximate number of manta rays observed was used when there were no confirmed

sightings, as data for these sites remains limited.

In 2021, 28 individuals were collectively recorded from 100 confirmed sightings from the Northeastern channels (Fig. 12). The most confirmed sightings ($n=46$), and the highest number of individuals ($n=24$), were observed in December. Sighting numbers at Hithadhoo Corner were similar in December ($n=41$). However, only 18% ($n=7$) of the 40 individuals seen between the two sites in December were encountered at both locations. The highest numbers of individuals sighted per survey occurred at Fushi Kandu in November ($n=11$), followed by eight at Fushi Kandu in December.

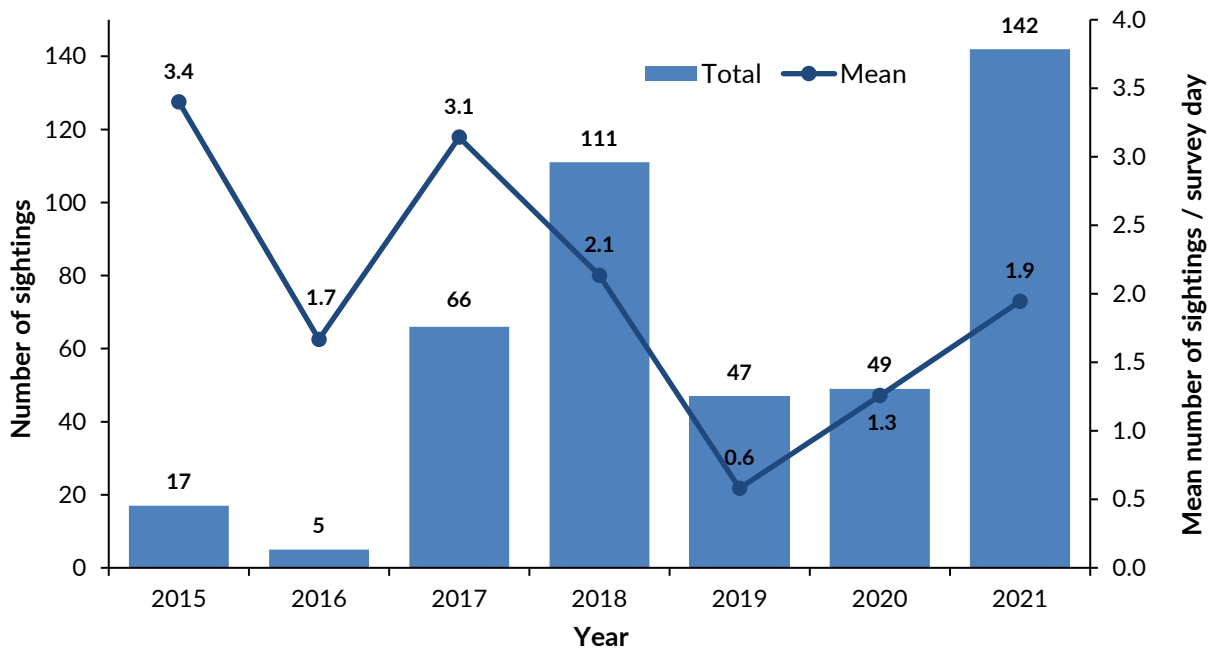


Figure 11: Annual sightings of reef manta rays (*Mobula alfredi*) at Fushi Kandu in Laamu Atoll, and the mean number of sightings per survey.

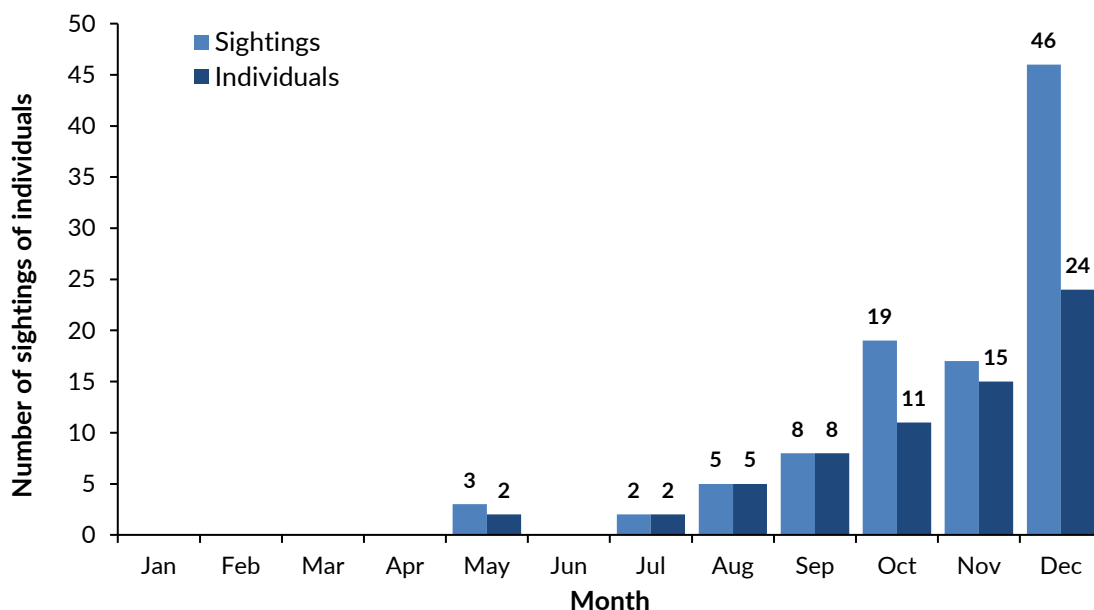


Figure 12: Monthly sightings and the number of individual reef manta rays (*Mobula alfredi*) recorded at Fushi Kandu and Maabaidhoo Kandu in Laamu Atoll (2021).

Of the 138 individuals known to Laamu Atoll, 92% ($n=127$) have been sighted at Hithadhoo Corner, and 43% ($n=59$) at the Northeastern Channels. There are only seven individuals that have been sighted at the Northeastern Channels, but not at Hithadhoo Corner; two of which were new to Laamu Atoll in 2021. As the peak sighting months for Hithadhoo Corner and the Northeastern Channels are similar overall (Fig. 13), and since most of the individuals sighted at the Northeastern Channels have also been seen at Hithadhoo Corner, the most plausible hypothesis remains; that Fushi Kandu and Hithadhoo Corner represent key aggregation sites of a single manta ray population within Laamu Atoll. Individuals likely move along the outer atoll reef (including Maabaidhoo Kandu) to travel between these sites.

Total sightings since 2014 remain low from the Northeastern Channels ($n=321$), mainly due to less frequent visitation to these sites. Wind direction data was recorded during 92%

of these sighting occasions. Of these sightings, the highest proportion were recorded during the Southwest Monsoon (31%, $n=59$), whilst very few sightings ($n=24$) were recorded during the Northeast Monsoon. Interestingly, in 2021 a high proportion of sightings were recorded during North-westerly winds (26%, $n=12$), however South-westerly winds still influenced the highest number of sightings (43%, $n=20$).

The overall seasonality at Fushi Kandu and Maabaidhoo Kandu is consistent with observations from the MMRP's study sites in the central atolls, whereby eastern sites experience higher numbers of sightings during the Southwest Monsoon and western sites during the Northeast Monsoon. This indicates that there may be a more significant correlation between monsoons and sightings than was previously thought.

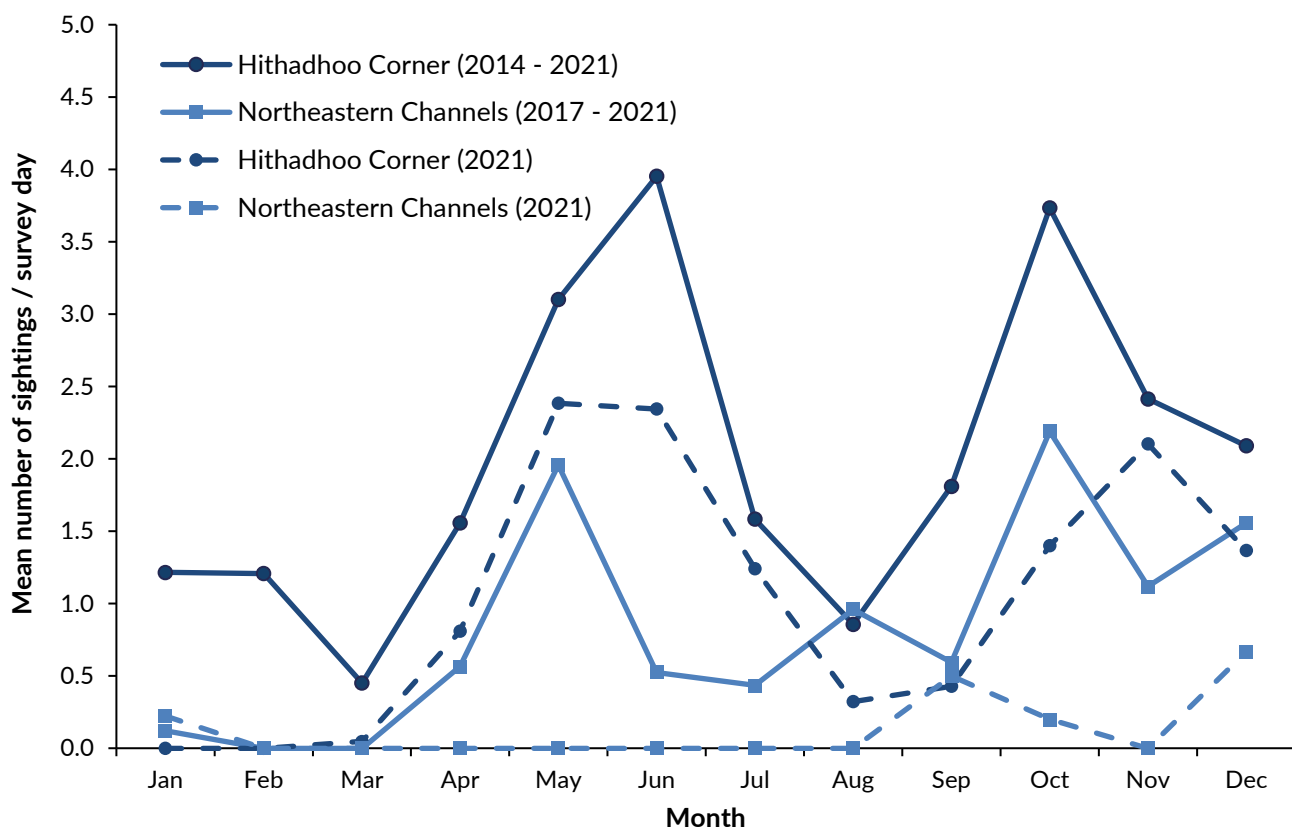


Figure 13: Mean number of reef manta ray (*Mobula alfredi*) sightings per survey day at Hithadhoo Corner and the Northeastern Channels in Laamu Atoll.

Secondary Sites

Ninety-two reef manta ray encounters were reported at an additional seventeen survey sites in 2021, with a further 27 encounters at unknown sites. Of these 92 sightings, most of which were seen by Deep Blue Dive Centre dive guides, just eight sightings (of eight individuals) were confirmed through photo-IDs, reiterating the importance of Manta Trust researchers visiting additional survey sites to obtain photo-ID data. These sightings constituted just 2% of the total sightings in 2021, which is a significant decrease from the proportion of total sightings recorded at secondary sites in 2020 ($n=25\%$). However, they aligned with the ratios between 2014 - 2021 (3%, $n=151$ out of $n=4612$ sightings). However, it must be noted that visits to primary research sites were limited in 2020. In 2021, 82% ($n=76$) of unconfirmed sightings from secondary locations were of cruising behaviour, 11% ($n=10$) of feeding activity, 2% ($n=2$) of both cruising and feeding, 2% ($n=2$) of courtship, and 3% ($n=3$) of unknown behaviour.

Of the confirmed sightings recorded at secondary locations between 2014 - 2021, 82% ($n=123$) were along outer reefs predominantly on the southern edge of Laamu Atoll, 13% ($n=10$) were at channels, and 5% ($n=8$) were recorded at inner reef sites. It appears there may be some seasonality to

the sightings on the southern edge of the Atoll, with these increasing during the Northeast Monsoon. Data remains limited and additional research is needed to determine if sightings in these areas are linked to environmental conditions.

Of the eight confirmed sightings recorded at secondary locations in 2021, five of these were recorded at Mendhoo Beyru (also known as Hithadhoo West) between June to October, which would suggest that manta rays frequent this site during the Southwest Monsoon, when sightings are high at nearby Hithadhoo Corner. A cleaning station has been identified at this site, so further monitoring is recommended to understand the significance of this site for manta ray use.

In 2021, reef manta rays were sighted in seven new sites, and a further four locations with exact coordinates unconfirmed by submitters. Seven of these sighting submissions came from Laamu Atoll's community members, following a sponsored social media campaign in Dhivehi, promoting the Manta Trust research projects, and calling out for manta ray sightings.

Environmental Influence

Throughout the Maldives, site usage by manta rays has been linked to wind direction, which changes with the South Asian Monsoon. Research in Laamu Atoll has been ongoing since 2014, but the wind has never been considered as a key variable in determining site use, as Hithadhoo Corner was the only aggregation site identified until 2018, and the site supports year-round encounters. However, preliminary analysis of the Laamu Atoll data since 2014 on the approximate number of manta rays observed at a site in relation to wind direction has revealed that sightings at Hithadhoo Corner generally are recorded under all wind conditions, but typically peak when winds are blowing from the southwest and west (Fig. 14). At the Northeastern Channels of Fushi Kandu and Maabaidhoo Kandu, sightings also peak when winds are from the southwest (Fig. 14). Very few sightings have been recorded at Fushi Kandu or Maabaidhoo Kandu during the Northeast Monsoon, which suggests these sites may be used more seasonally, but surveys remain limited for these locations. In other areas of

the Atoll, there may also be correlations, particularly on the southern outer edges of the Atoll where sightings peaked when winds were from the northeast (Fig. 14). While topography may be somewhat different in Laamu Atoll to the more northern atolls, manta ray site usage in the Atoll appears to still be heavily influenced by wind direction. As sightings in the atoll decrease during the Northeast Monsoon, it is likely that the manta rays are using sites on the Western edge of Laamu, that are rarely visited by the Manta Trust and Deep Blue Divers teams, or are utilising Western sites within Thaa Atoll; the closest atoll to Laamu. Understanding the influence of wind in Laamu Atoll is important as it allows the MMRP to prioritise survey areas depending on the prevailing wind direction and monsoon. Data at sites away from Hithadhoo Corner remains limited and further research is needed during both monsoons to determine the environmental influence on sightings trends at these locations.

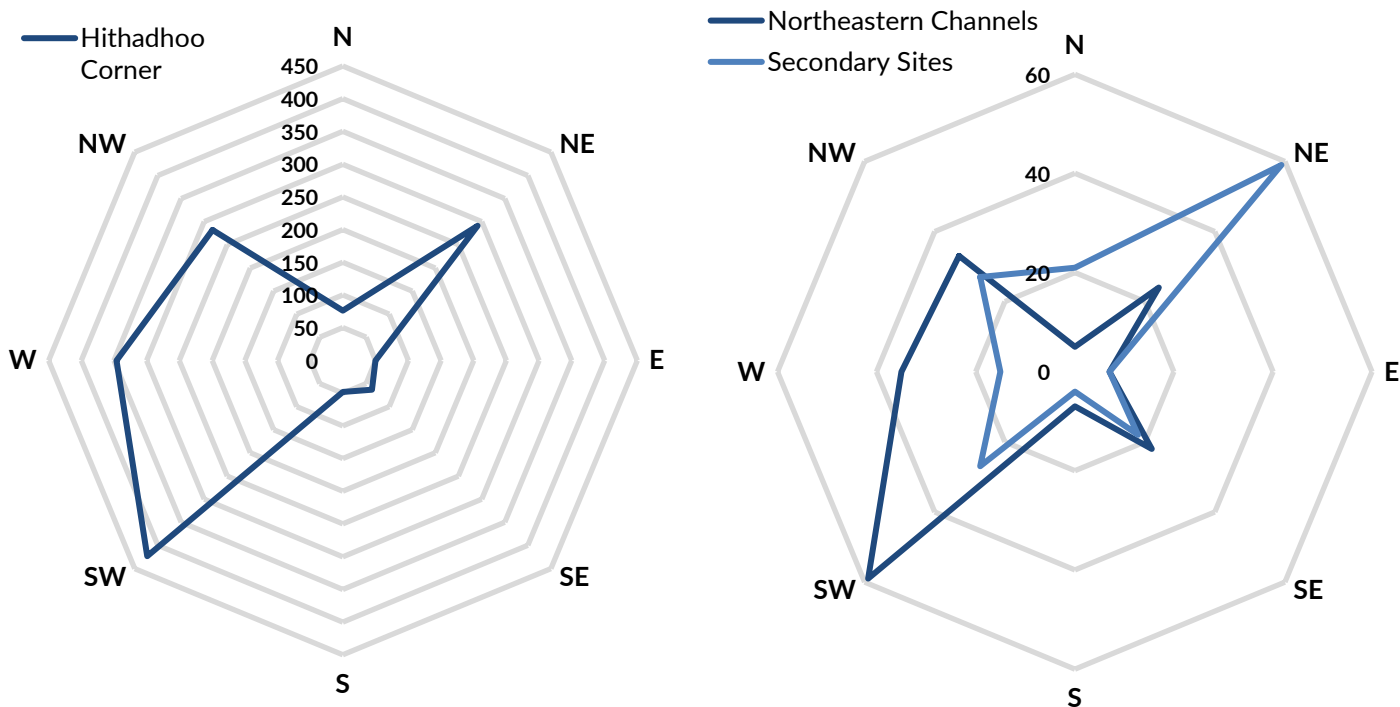


Figure 14: Number of reef manta ray (*Mobula alfredi*) sighting records in relation to the prevailing wind direction at Hithadhoo Corner, the Northeastern Channels, and at all the combined secondary sites in Laamu Atoll (2014 – 2021).

POPULATION DEMOGRAPHICS

As of the 31st December 2021, 138 individual reef manta rays (81 females, 56 males, and 1 individual of unknown gender) have been identified in Laamu Atoll, comprising 2.6% of the known Maldives population. At study locations further north, the ratio of female to male manta rays observed is roughly 50:50. By contrast, Laamu Atoll supports a female dominated and predominantly adult population (Fig. 15). This is to be expected as most sightings

in Laamu Atoll occur around cleaning stations, which are commonly visited by adult manta rays, and are typically dominated by females, who invest more time in cleaning than male individuals. If more feeding sites and juvenile aggregation areas are identified within Laamu Atoll, the population demographics are likely to reflect the national average more closely.

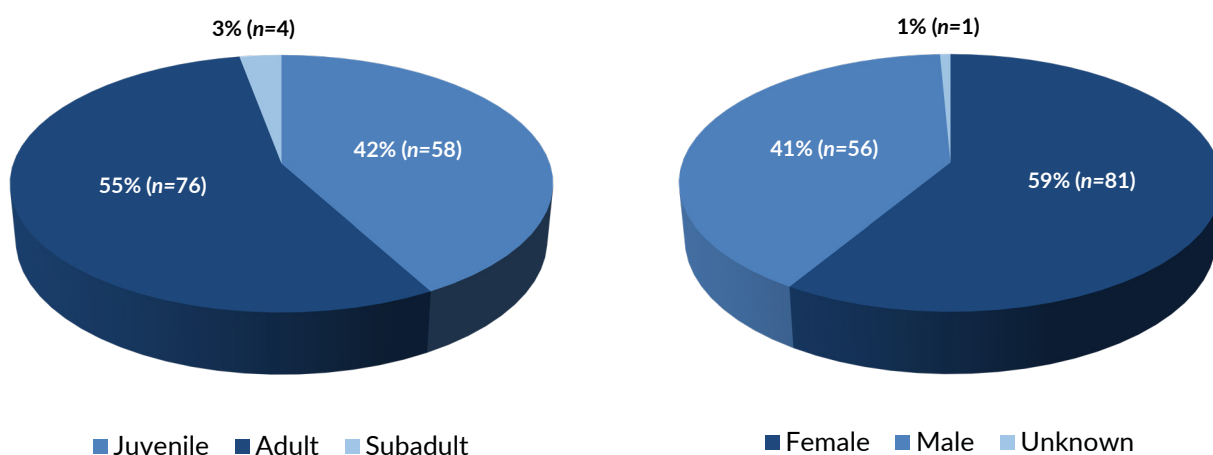


Figure 15: Demographics of the Laamu Atoll reef manta ray (*Mobula alfredi*) population (n=138).

Of the 138 known individuals, 49% were photographed in 2021 ($n=67$), an increase from 2020 ($n=53$), but a decrease from records in previous years ($n=80$ in 2019) (Fig. 16). Four new individuals were recorded in Laamu Atoll, all of which were new to the Maldives. All these individuals were identified as juveniles, two of which were female and two males. This gives promising insight into the health of the Laamu Atoll population, following only one newly identified juvenile in 2020.

Between 2015 – 2018, the percentage of males sighted had remained consistent at 40 to 41% per year. In recent years there has been a shift in ratio, because of below-average sightings of female manta rays. In 2021, 48% ($n=32$) of individuals sighted were male, and 52% ($n=35$) were female.

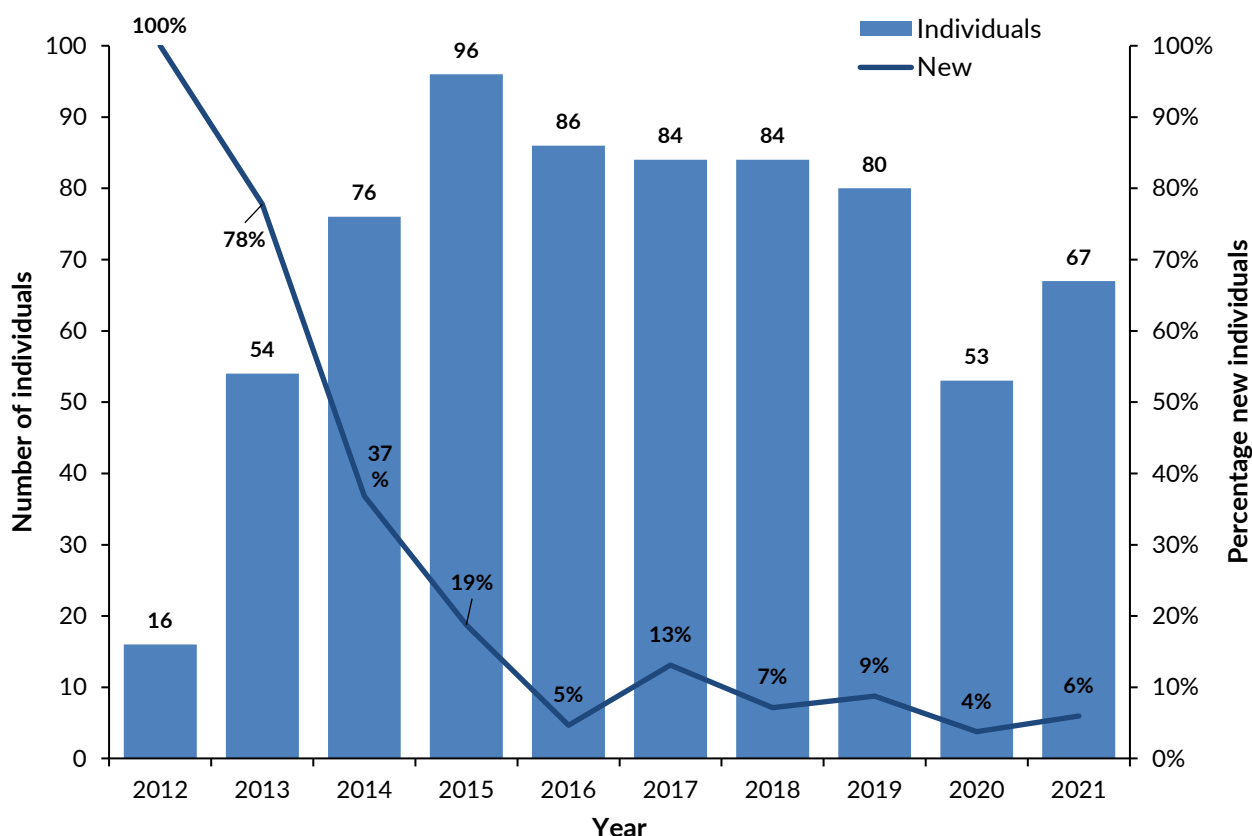


Figure 16: Number of reef manta rays (*Mobula alfredi*) sighted annually in Laamu Atoll and the percentage of those individuals that were newly recorded.

Maturation status in manta rays can be determined by the presence of mating scars or visible pregnancies in females, or by the enlargement and calcification of claspers in males. If visual features are not apparent, the size and historical sightings records of individuals can also be considered to estimate maturation. If an individual was estimated or measured to be at, or larger than, 320 cm (centimetres) disc width in females, or 270 cm disc width for males, they were considered as adults. Research on measuring manta rays is currently being conducted in Laamu Atoll as part of a PhD study with Cambridge University. More information about measuring manta rays is also available in the project activities report.

Maturation demographics in 2021 remained like previous

years. Sixty-one percent of individuals sighted in 2021 were adult manta rays ($n=41$) (Fig. 17), with demographics of the overall population appearing relatively consistent. From 2016 to 2019 there was a steady increase in the proportion of juveniles sighted in Laamu Atoll (Fig. 18). This may be the result of young recruits utilising the study sites after a period of population fecundity. However, it could also indicate that the study sites in Laamu Atoll are utilised more by adults when conditions are favourable for courtship. Another possibility, and the most likely hypothesis, is that research effort in recent years has diversified focus to collect data from more varied manta ray aggregation sites, opportunistically capturing younger individuals in the process, which are less likely (less often) to frequent the cleaning stations at sites like Hithadhoo

Corner. Interestingly, this pattern was not followed in 2020, with an increase in adults and decrease in juveniles sighted. Survey effort drastically reduced in 2020 and a lower variety of sites were visited, reducing the opportunity to

encounter new juveniles. Although four new individuals were identified in 2021, the ratio of adults to juveniles remained like that recorded in 2020 (Fig. 18).

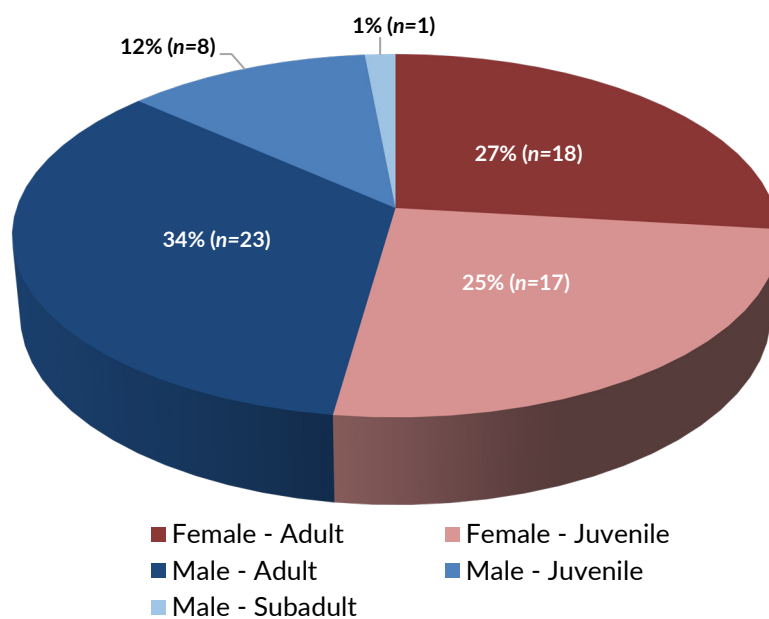


Figure 17: Demographics of the Laamu Atoll population of reef manta rays (*Mobula alfredi*) sighted in 2021.

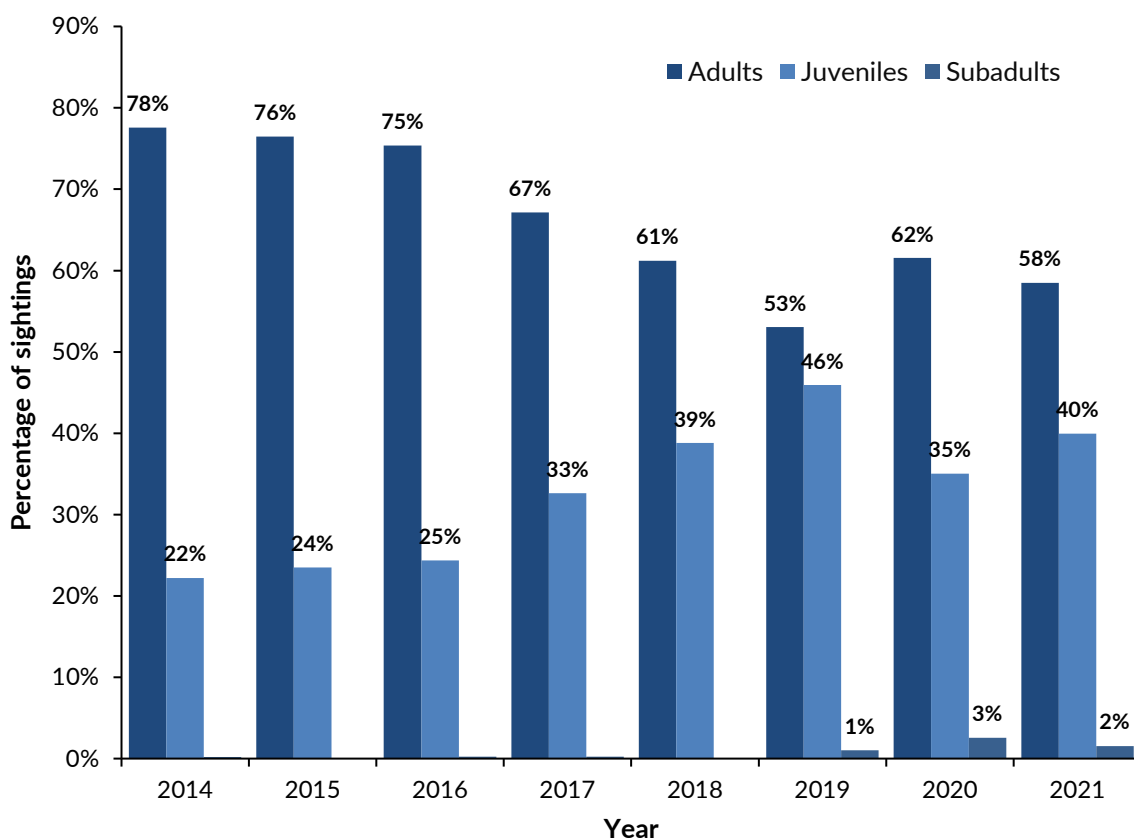


Figure 18: Percentage of confirmed sightings of juvenile, subadult, and adult reef manta rays (*Mobula alfredi*) in Laamu Atoll between 2014 and 2021.

MIGRATION & RESIDENCY

The population of reef manta rays in Laamu Atoll is small, yet highly resident. Individuals show high site fidelity and are rarely sighted elsewhere in the Maldives. Despite the number of sightings per individual in 2021 being higher than 2019 and 2020, which was a low survey effort year, they were lower than previous years (an average of 6.69 sightings per individual in 2021, compared to an average

of 8.85 sightings per individual between 2015 – 2018) (Fig. 19). The proportion of manta rays observed on more than one occasion (58%) was the lowest recorded between 2014 - 2021 (Fig. 19). This suggests that the manta rays of Laamu Atoll were spending more time away from the identified study sites, utilising habitats unknown to the Manta Trust, but most likely still within the Atoll.

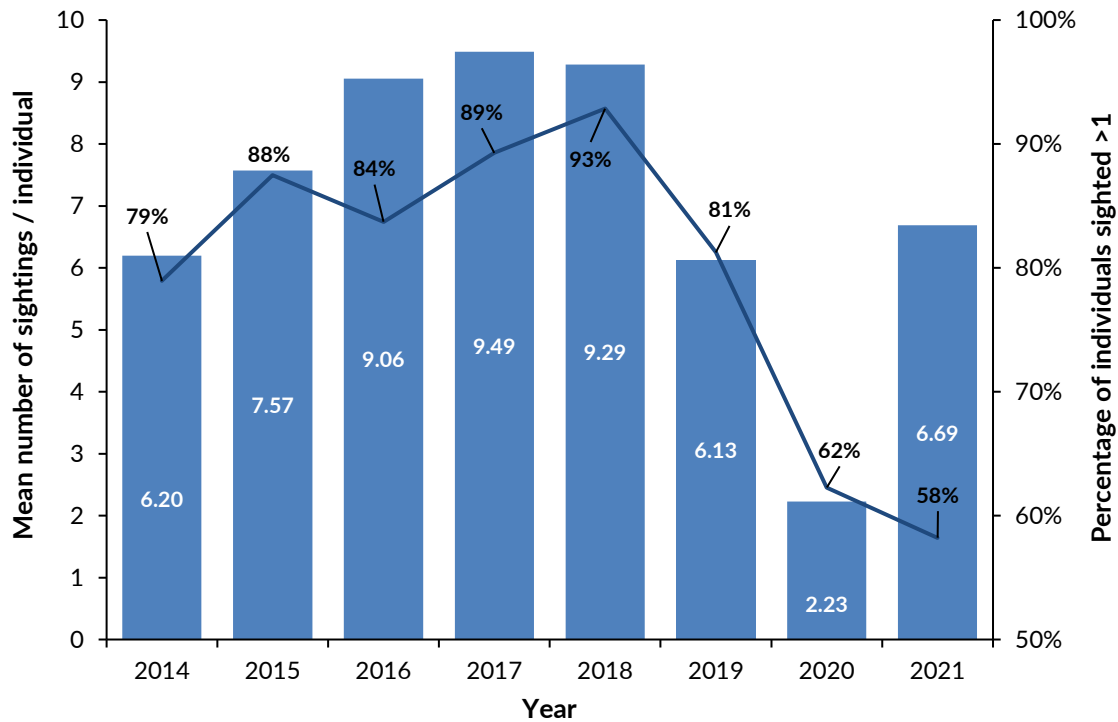


Figure 19: The mean number of sightings per individual reef manta ray (*Mobula alfredi*) annually in Laamu Atoll and the percentage of those individuals sighted more than once.

To account for variations in survey effort, an average Residency Index (RI) was calculated for each year based on the ratio between the number of times each individual manta ray was sighted and the total number of surveyed days (e.g., an RI of 3% means that, on average, each manta ray was sighted on 3% of the total surveyed days). The average RI in Laamu Atoll had been steadily decreasing each year, from 3.6% in 2014 to 1.15% in 2020 (Fig. 20). Changes in RI can be linked to environmental fluctuations or changes in survey effort within each year. As survey effort was consistent between 2016 and 2019, the decrease in residency is likely due to environmental or behavioural changes. Optimistically, 2021 presented the highest RI since 2018, at 2.48% (Fig. 20). However, the length of time per survey increased in 2021. With remote sensing surveys having an average survey time of 12 hours, this may have

increased the residency index, due to more individuals on average being recorded within one survey day.

While we cannot determine the exact movements of individual manta rays, it appears that the population exhibited more transient behaviour between 2019 – 2021, perhaps searching for more favourable conditions elsewhere. Up until the end of 2020, 17 individuals (12% of Laamu Atoll’s population) have been recorded elsewhere. Some individuals have been sighted in more than one atoll outside Laamu Atoll, resulting in a total of 33 recordings of these 17 individuals across other atolls in the Maldives (Fig. 21). The 2021 analysis for the collective dataset from all research bases in the Maldives is still in process, so the figures for Laamu Atoll manta rays sighted in other atolls in 2021 will be published in the 2022 report.

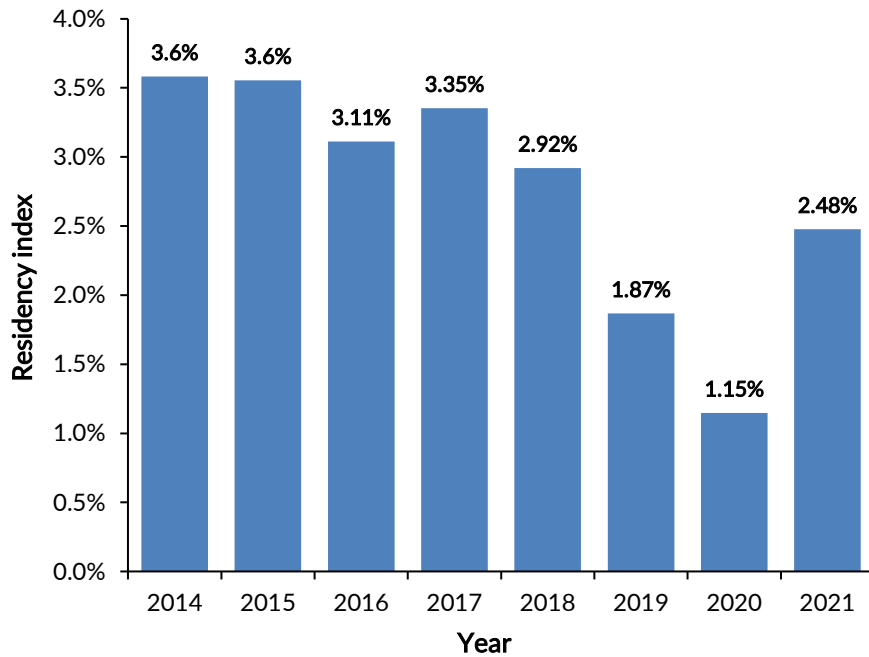


Figure 20: Annual Residency Index (RI) of the reef manta rays (*Mobula alfredi*) sighted annually within Laamu Atoll. RI was calculated as the average of each individual’s residency score (equal to the number of times sighted annually divided by the number of surveyed days in the atoll).

To determine if manta rays are utilising additional sites, it is necessary to increase survey effort in unexplored areas of Laamu Atoll. Increasing numbers of exploratory dives presents logistical challenges and this would mean a decrease in dives at Hithadhoo Corner. However, decreased

sightings at crucial aggregation sites provide significant justification. This should be accompanied by increased outreach to liveaboard operators and dive centres in Laamu Atoll in the hope of obtaining additional sightings updates from study sites.



Photo by Jasmine Corbett

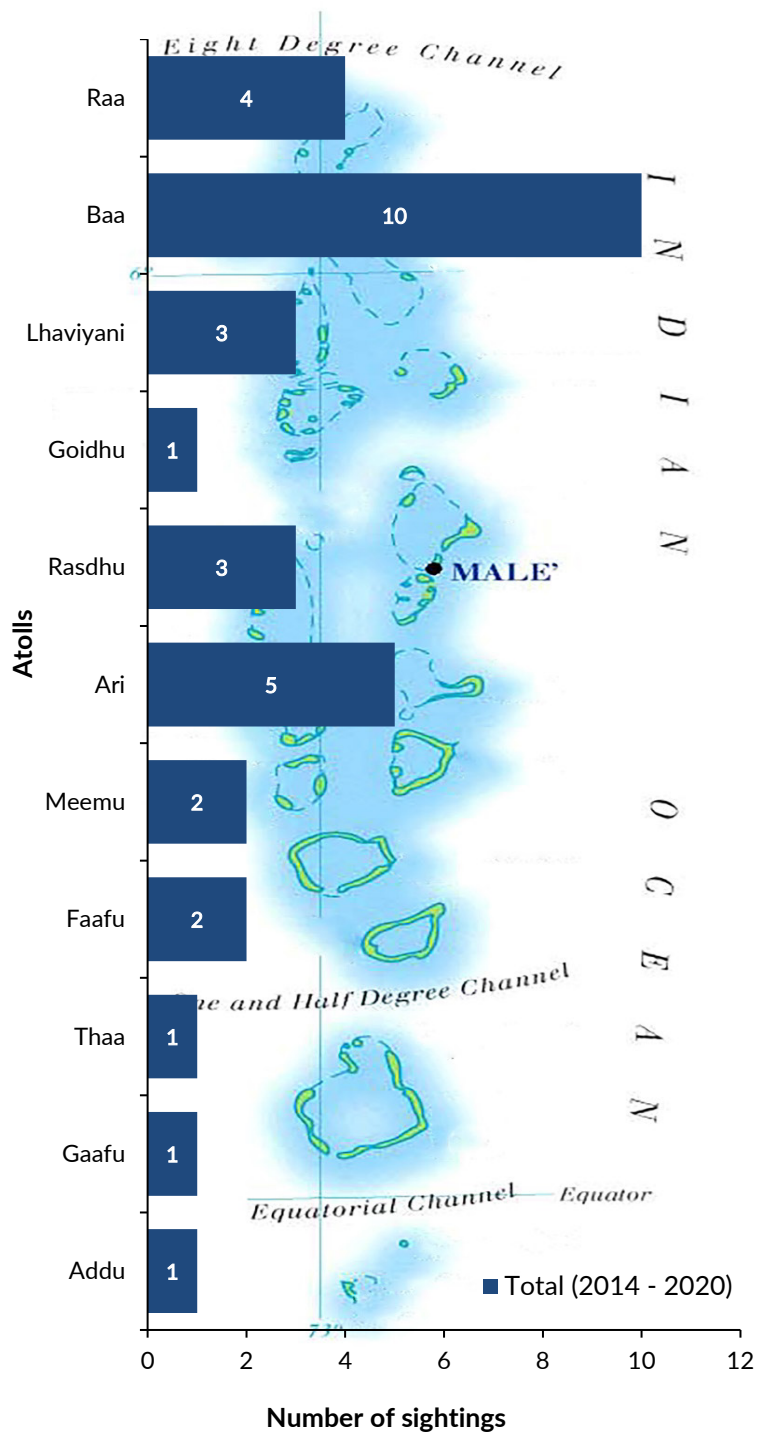


Figure 21: Number of sightings ($n=33$) of reef manta rays (*Mobula alfredi*) from the Laamu Atoll population which have been sighted in other atolls throughout the Maldives. Note – some individuals have been sighted in more than one atoll throughout the Maldives Archipelago.

PREGNANCIES & COURTSHIP

Prior to 2018, Laamu Atoll was considered to support a bi-annual courtship season (May – June and October – November). Following minimal courtship behaviour in 2018 ($n=4$ sightings) but high pregnancy records ($n=73$ sightings of $n=16$ individuals), 2019 saw a slight increase in courtship behaviour ($n=15$ sightings of $n=14$ individuals) with pregnancy records greatly reduced (Fig. 22). This could be due to a combination of lower sightings in 2019, and individuals recorded as pregnant in 2018 having given

birth and in a period of recovery between gestations. In both 2020 and 2021, courtship behaviour was extremely low, with only two and six sightings recorded, respectively (Fig. 22). It must be noted however that surveys were not conducted consistently throughout 2020 and 2021, which reduced potential courtship sightings significantly. As a result, no seasonality to courtship behaviour could be determined in 2020 and 2021. Following zero pregnancies in 2020, just one pregnancy was recorded in 2021.

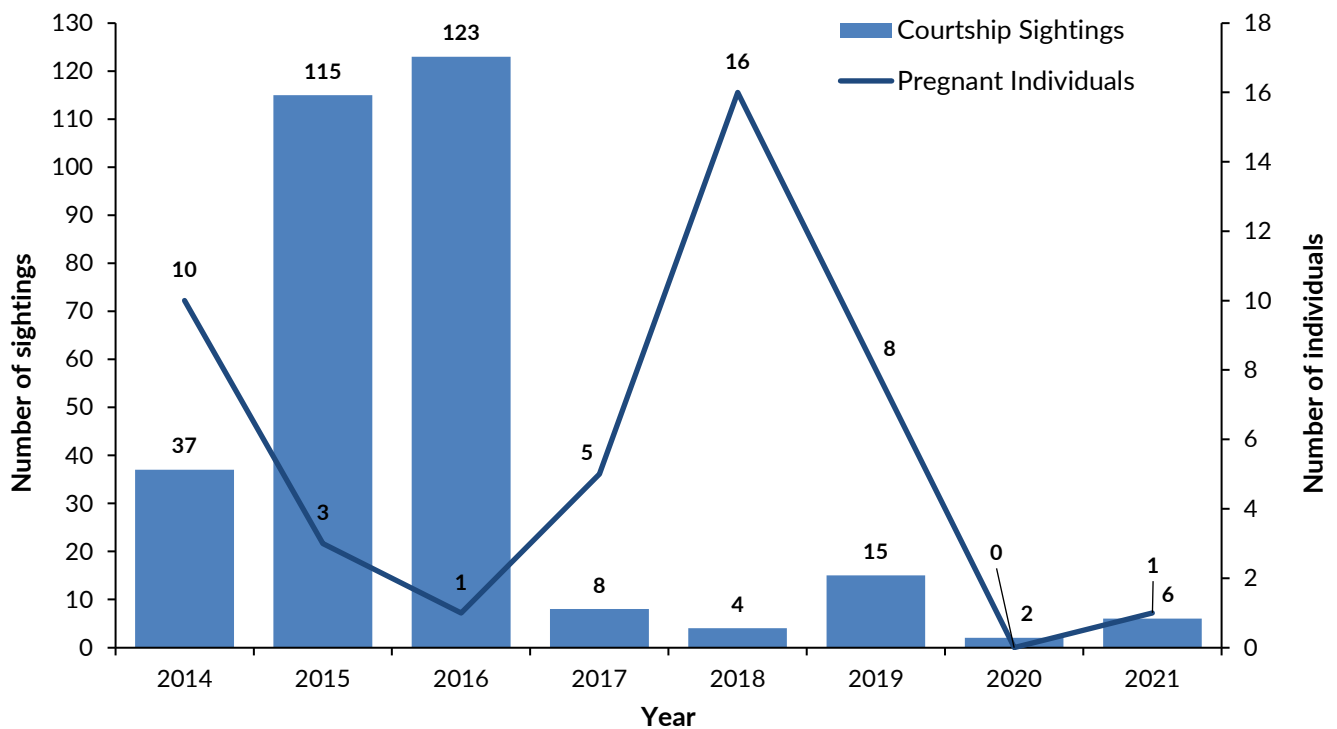


Figure 22: Number of sightings annually during which courtship was the primary behaviour, and the number of individual reef manta rays (*Mobula alfredi*) which were recorded pregnant annually.

Of the 32 mature females known to Laamu Atoll, 81% ($n=26$) have been recorded on at least one occasion since 2017. Of these individuals sighted since, 58% ($n=15$) were recorded as pregnant in 2018 or 2019. Given the low instances of courtship activity recorded in 2019, the high number of pregnancies documented in recent years, the recovery time required between pregnancies, and reduced overall survey effort, the absence of pregnancies seen in 2020 and 2021 can be easily understood.

In 2019, Six Senses Laamu, the Manta Trust, IMV Imaging,

and the University of Cambridge released the first images of pregnant and non-pregnant reef manta rays using the world's first contactless underwater ultrasound scanner. Unfortunately, no scans were obtained in 2021 due to technical issues with the equipment and logistical restraints. However, the ultrasound scanner was refurbished at the end of the year, so the Manta Trust team hope to increase scanning effort in 2022. For additional information about the ultrasound scanner, please see the press release or project activities report.

SUB-LETHAL INJURIES

Of the 138 identified individuals in Laamu Atoll, 25% (n=35) have been recorded with at least one sub-lethal injury, with a total of 50 injuries now documented in Laamu Atoll. Of the 50 injuries, 26% (n=13) were of natural origin, 24% (n=12) of anthropogenic origin, and 50% (n=25) of unknown origin (Fig. 23). Of the 50 records denoting where the injury took

place on the body (injury location), 46% (n=23) were to the pectoral fins, 12% (n=6) to their cephalic fins, 12% (n=6) to their head, 10% (n=5) to the body, 10% (n=5) to the pelvic fins, claspers, or tail, and 10% (n=5) were unknown (Fig. 24).

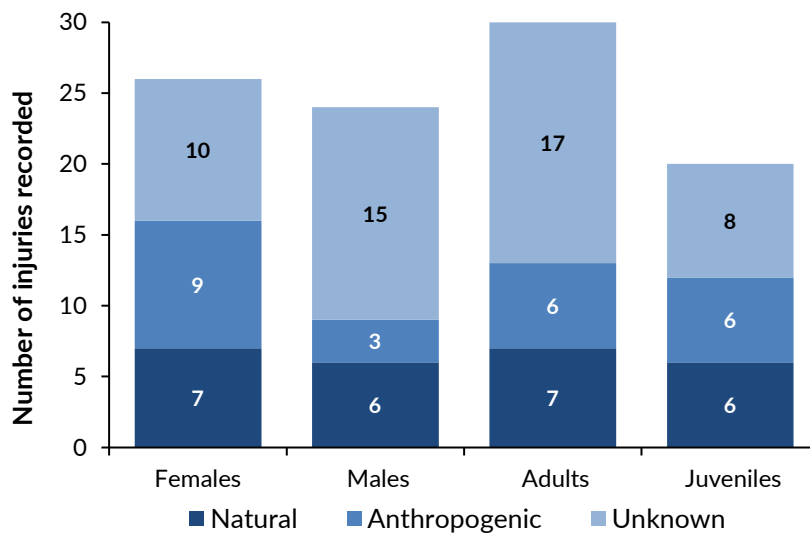


Figure 23: Demographic variation in the likely origin (natural, anthropogenic, or unknown) of sub-lethal injuries (n=50) within the injured reef manta ray (*Mobula alfredi*) population of Laamu Atoll (n=35).

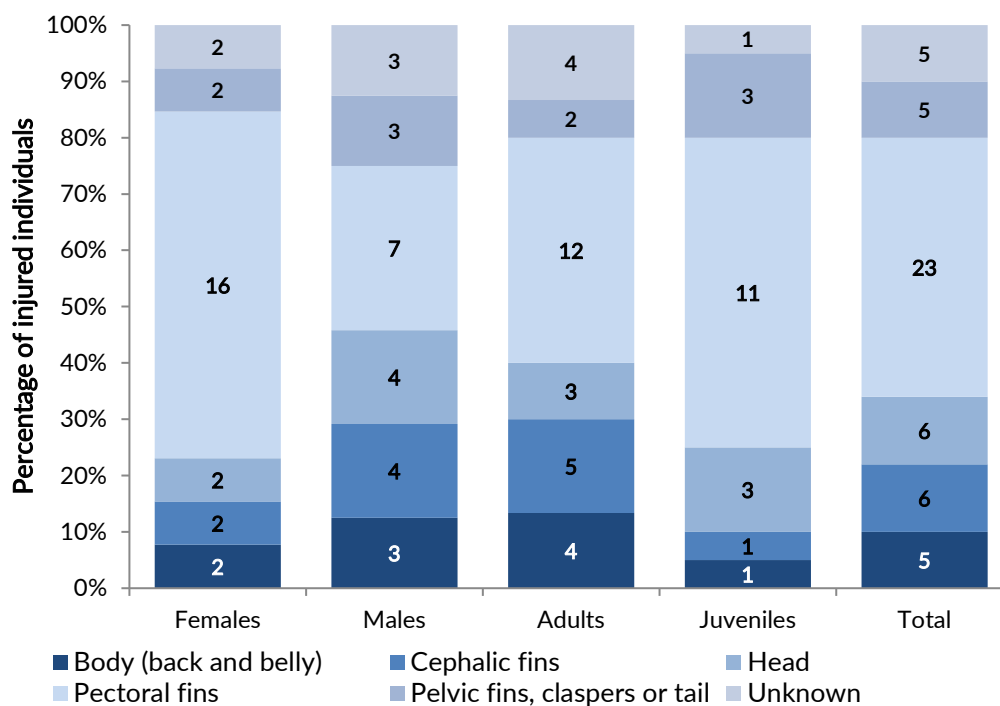


Figure 24: Variations in the location of sub-lethal injuries (n=50) within the injured reef manta ray (*Mobula alfredi*) population of Laamu Atoll (n=35). Actual number of individuals on bars.

Twenty-two percent (n=11) of the recorded injuries have resulted from entanglement in fishing line (Fig. 25). Most fishing line entanglements have caused injury to the pectoral fins of individuals (n=5), but there have also been injuries of concern to the cephalic fins or head (eyes or mouth) (n=5). Despite Six Senses Laamu actively discouraging fishing at Hithadhoo Corner, and the Maldives Underwater Initiative team working hard to protect the area, fishing continues at this site. Active fishing is rarely observed. However, the MMRP removed fishing line from the reef and cleaning stations on multiple occasions. This fishing line likely originates from reef fisheries as tuna fishing takes place

further offshore. Without observing individuals becoming entangled, it is impossible to determine whether fishing at Hithadhoo Corner constitutes the cause of injuries observed or whether these injuries are sustained elsewhere.

Only one injury consistent with a boat strike has been recorded in Laamu Atoll. The low prevalence of this injury type in the Atoll is likely due to the low level of tourism and boat traffic. As tourism and boat traffic increases, particularly near the aggregation sites, operators need to be vigilant in looking for marine megafauna on the surface.

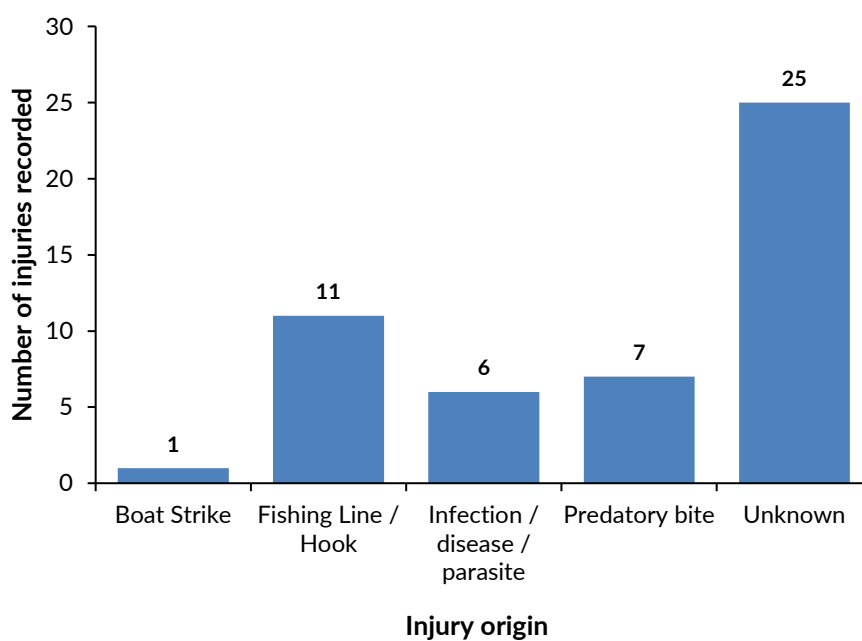


Figure 25: Variations in the origin of sub-lethal injuries (n=50) within the injured reef manta ray (*Mobula alfredi*) population of Laamu Atoll (n=35).

Predatory bites, originating from natural causes, were inflicted upon 14% (n=5) of individuals. Interestingly, 80% of these manta rays were female. This may be coincidental but could also suggest that predatory attacks occur near cleaning stations where female manta rays spend more of their time cleaning. Cleaning stations are typically located in channels and are therefore more exposed to large predators. Infection/disease/parasite made up the highest proportion of natural injuries (54%, n=7). However, without enough data available on the state of their habitat health, no assessment on this finding can be deduced.

In 2021, there were six individuals recorded with new minor injuries to their pectoral fins, pelvic fins, head (mouth), and body (belly), originating from fishing line, predatory bites, and unknown causes.



FISHERMAN INTERVIEWS

Since the MMRP's partnership with Six Senses Laamu in 2014, the Manta Trust's work has primarily focused on in-water surveys. In 2019, the Manta Trust's Laamu Atoll team broadened its reach and conducted fishermen interviews to gather information from the local community.

Throughout the Maldives, fishermen spend a vast amount of time on the water and therefore are likely to encounter manta rays on their fishing trips. The Laamu Atoll team conducted preliminary fishermen interviews to gain a greater understanding of current and historic manta sightings in the region and to determine whether night light trials may be more successful at different sites within the Atoll. These interviews also provided a fantastic opportunity to gain knowledge about fishermen's perceptions of manta rays and manta ray conservation.

Thirty-one preliminary interviews were conducted in 2019, on six local islands (Hithadhoo, Kunahandhoo, Maamendhoo, Gan, Maabaidhoo, and Isdhoo). Ninety percent ($n=28$) of the interviewed fishermen reported that they had encountered manta rays during fishing trips. Of these, 75% ($n=21$) reported encounters within the Atoll and 61% ($n=17$) reported encounters farther offshore (1 - 70 miles). Seven fishermen reported either catching a manta ray, or a manta ray becoming entangled in fishing line. Most

fishermen understood that manta rays were a protected species in the Maldives. However, 51% ($n=16$) were unaware of what this protection means regarding their fishing activities. Ninety-four percent ($n=29$) of fishermen agreed that manta rays should be protected and 6% ($n=2$) did not answer the question.

In 2020 and 2021, the team planned to conduct more formalised interviews on each of the inhabited islands in Laamu Atoll. However, with a national lockdown and bans on inter-island movement, this was not possible.

These interviews have now been scheduled for April - May 2022, and a Marine Environmental Management student from Exeter University will use this data as part of their master's thesis; investigating how local ecological knowledge (LEK) can inform manta ray research and conservation. We are hopeful that through collaboration and information sharing, the MMRP team in Laamu Atoll can learn more about the habitat use and movement of manta rays in the Atoll.

To learn more about our education and outreach programs with schools, liveboards, and community members in Laamu Atoll, please see the 2021 project activities report.

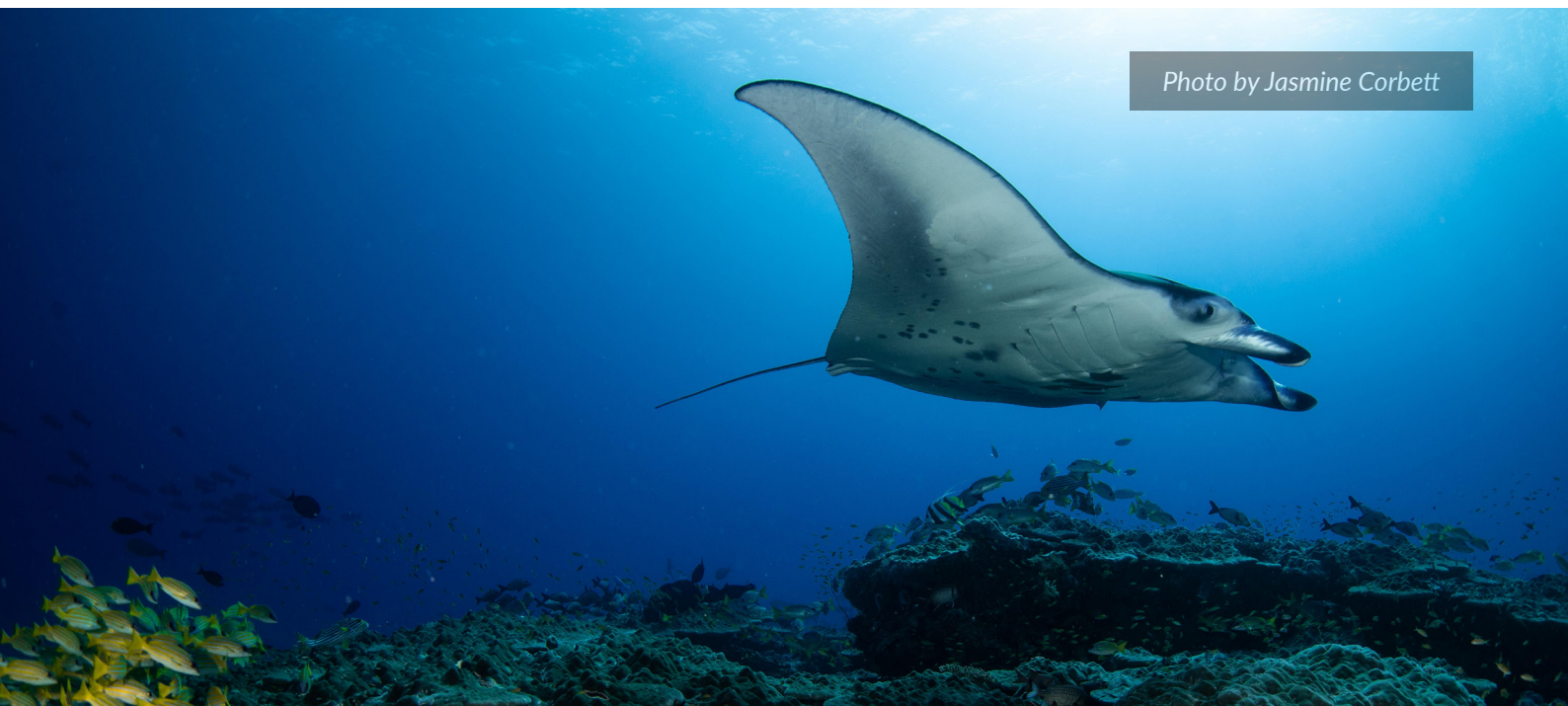


Photo by Jasmine Corbett

CONCLUSION

Following a limited survey effort year in 2020, the Manta Trust researchers gained increased access to their primary research sites from April 2021 onwards and were able to intensively study Laamu Atoll's manta ray population once again. The team recorded shifts in many trends, including encounter locations, residency patterns, and seasonality of manta ray sightings. Whilst these changes could be a result of inter-annual fluctuations in the ecological needs of the population, it is not possible to determine an exact cause due to limited survey effort at the start of the year. Consistent survey effort in 2022 will be essential to provide a robust scientific analysis of the abundance and seasonality of Laamu Atoll's manta ray population.

The manta ray population in Laamu Atoll remains highly resident, with few individuals known to visit other atolls. Hithadhoo Corner continues to support year-round manta sightings; it is a crucial habitat for the species in this region. While it is a key aggregation site, it is likely that other sites in the Atoll also support the local reef manta ray population. Whilst little is known about manta ray sightings at alternate sites, the increase in sightings submissions from the local community in 2021 helped the Manta Trust team gain a better understanding of potential study sites to monitor in 2022 and revealed manta aggregation sites that had not been recorded before.

Despite having reliable study sites during the Southwest Monsoon (Hithadhoo Corner and Fushi Kanduu), further monitoring is needed at additional sites during the Northeast Monsoon, when sighting numbers drop at these two locations. Following the local ecological knowledge surveys across Laamu Atoll, the team plan to conduct exploratory dives at sites highlighted as manta aggregation sites in the surveys to gain additional insight into manta ray movements and habitat use within the Atoll.

With a reduction in consistent access to the main research sites in 2021, particularly up until April, the Manta Trust team's survey methodology transitioned to primarily RUP and RUV surveys, to continue to collect data on manta rays and their habitats even when the team could not be in the water. These tools drastically increased survey effort, with 42% of confirmed sightings recorded through RUP and RUV systems, proving how essential these systems were in 2021. The team plan to increase remote sensing survey effort in 2022, with the aim of deploying more systems over multiple locations, all year round, to truly gauge the

movements and seasonality of Laamu Atoll's reef manta ray population. This data will be combined with environmental data collected through CTD (current, temperature, depth) meters, scheduled to be deployed in 2022, which will provide an accurate analysis on the physical processes that determine manta ray aggregations at these sites.

Drone surveys have proven an invaluable tool to not only the Laamu Atoll team, but to other Manta Trust research teams throughout the Maldives. They have enabled teams in the northern atolls to identify shallow water manta ray cleaning stations and feeding aggregations. In Laamu Atoll, drone surveillance has provided a unique perspective of the manta rays, allowing the team to study these animals in a way that does not have any effect on their natural behaviour. Aerial studies will be conducted regularly in 2022, from each island during the local ecological surveys, and throughout the year to search for new manta ray aggregation sites throughout Laamu Atoll.

Unfortunately, with ongoing Covid-19 related restrictions to inter-island movement throughout 2021, community engagement opportunities were limited. However, the team were able to connect with the community virtually, increasing awareness of the research project and goals through an effective social media campaign. Following the success of this campaign, the team hopes to further increase their online presence locally in 2022.

Given the small size of Laamu Atoll's reef manta ray population, and the high site fidelity observed in the Atoll, key aggregation habitats in Laamu Atoll are of utmost importance to the local manta ray population. As development and tourism continues to increase in the Maldives, we need to be mindful of all potential impacts to habitats and recognise the stressors already altering the environment in the Maldives.

We remain incredibly grateful to Six Senses Laamu for supporting our research, education, and outreach initiatives, and providing the team with an all-year-round research base. Through collaboration with the Maldives Underwater Initiative team, local stakeholders, and government agencies, it is our hope that significant areas of manta ray habitat in Laamu Atoll can be protected to safeguard this species, and to conserve the wider biodiversity and marine resources in the Atoll.

This report was made possible thanks to



MALDIVIAN MANTA RAY PROJECT (MMRP)

The MMRP is highly regarded within the scientific community. It is the largest and one of the longest running manta ray research programmes in the world. We would welcome the opportunity to continue to work with the Maldives government and our other partners for the long-term management and conservation of these species in Maldivian waters. The opportunity we have to learn about manta rays in the Maldives is unique and has many implications on a global scale for manta ray conservation.

The MMRP and the Manta Trust are happy to share with the Maldives government any data collected as part of this study.



SIX SENSES

LAAMU

SIX SENSES RESORT LAAMU

The MMRP expresses its sincere appreciation for the ongoing partnership between Six Senses Laamu Resort and the Manta Trust. Without their support, this important work would not have been possible. The Manta Trust and the MMRP are looking forward to a continued and successful partnership with Six Senses Laamu.



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