Manta TRUST

Maldivian Manta Ray Project

NORTH & SOUTH MALÉ ATOLL | ANNUAL REPORT 2018

Conservation through research, education, and collaboration

- The Manta Trust

MALDIVIAN MANTA RAY PROJECT

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 20 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 4,650 different individual reef manta rays, from more than 60,000 photo-ID sightings. This makes the Maldives manta population the largest, and one of the most intensively studied populations in the world. The MMRP has also identified nearly 380 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.

THE CONSERVATION CHALLENGE

In the last two decades, manta and mobula rays have faced increasing threats from both targeted and bycatch fisheries, due in part to a growing trade in Asia for their gill plates. The gill plates are what these rays use to filter zooplankton from the water. In Traditional Asian Medicine, it is believed these gill plates will filter the human body of a variety of ailments when consumed in tonic. There is no scientific evidence to support this claim.

Unregulated and badly managed tourism is also negatively affecting manta rays, while climate breakdown, reef degradation and pollution is reducing the manta's food supply and suitable habitat.

Manta and mobula rays are particularly vulnerable because of their aggregating behaviour and conservative life-history; they grow slowly, mature late in life, and give birth to few offspring. These traits make it very easy to wipe out entire populations in a relatively short period of time. With protection in place, populations are still slow to recover.

EXECUTIVE SUMMARY

This report presents data collected by the Manta Trust's Maldivian Manta Ray Project (MMRP) on the reef manta ray (*Mobula alfredi*) population of North and South Malé Atolls in 2018. Data used in this report was collected by MMRP staff and volunteers, by collaborating tour guides, and citizen scientists through the Manta Trust's IDtheManta database.

The geographical atolls of North (NMA) and South (SMA) Malé (collectively, the Malé Region) support a year-round presence of reef manta rays (*Mobula alfredi*). In contrast to the general sightings trend recorded in previous years, in 2018 there was an intra-annual peak in sightings during the Northeast Monsoon (January-March) at sites along the western edge of the atoll, and a decrease in sightings during the Southwest Monsoon (September-November) at sites along the eastern edge of the atoll. The current recorded population of reef manta rays in the Malé Region is 783 individuals (17% of the total known Maldives population) recorded from 36 different sites throughout the two atolls. Key findings of this 2018 study include a total of 1,007 sightings of 252 individual reef manta rays. Ninety-eight percent (*n*=986) of all sightings have been recorded from the ten key reef manta ray aggregation sites within the Malé Region. Compared to previous years, there was a shift in peak sightings witnessed at Lankan Beyru and Sunlight Faru in 2018, with an increase in sightings seen in September (*n*=151) and a decrease in October (*n*=95) and November (*n*=107). In December 2018, a sudden increase in sightings (*n*=139) was seen at Rasfari North and Boduhithi Thila, suggesting an unseasonably early change in the monsoon.

Ninety-seven percent of all sightings (*n*=972) in 2018 were recorded in NMA, where considerably more research effort was focused during this study. The NMA reef manta ray sub-population is comprised of 93% (*n*=725) of the total recorded regional population, while only 101 individuals (13% of the total recorded regional population) were documented in SMA to date. The demographics of the NMA sub-population is split almost equally between sexes; with 48% (*n*=349) females, 52% (*n*=375) males, and one individual for which sex could not be determined. The majority (77%) of the NMA sub-population are mature adults (*n*=558), whilst only 3% (*n*=22) are subadults, and 20% (*n*=144) juveniles. However, in 2018, the demographics of individuals sighted that year showed a sex bias; with 61% (*n*=147) males and 39% (*n*=95) females. By contrast, the SMA sub-population demographics overall exhibit a male bias; with 62% (*n*=63) males, and 38% (*n*=38) females. Furthermore, 53% of the recorded SMA population is comprised of juveniles (*n*=39) and subadults (*n*=15), while only 47% (*n*=47) are mature adults. Similar to NMA, in 2018 the demographics of individuals sighted in SMA that year showed an increase in sex bias; with 84% (*n*=16) males and 16% (*n*=3) females.

Of the 783 individual reef manta rays recorded in the Malé Region, 89% (*n*=695) have been re-sighted within the region, or elsewhere in the Maldives, suggesting that the vast majority of the individuals which frequent this region have now been identified. Forty-four percent (*n*=318) and 74% (*n*=75) of the recorded reef manta ray sub-populations

of NMA and SMA respectively have also been recorded in other geographical atolls throughout the Maldives. This migratory behaviour suggests a large proportion of these sub-populations are, at least some of the time, highly mobile; travelling hundreds of kilometres throughout the archipelago.

In 2018, courtship and mating behaviour was recorded only 10 times within NMA. With no recordings of courtship along the eastern side of the atoll during the Southwest Monsoon for the first time since 2011. This reduced courtship activity in 2018 correlates with the lower number of individuals seen at Lankan Beyru and Sunlight Faru, favoured cleaning stations and courtship sites during the Southwest Monsoon. A total of 16 individuals out of 51 adult females (31%) were recorded pregnant throughout the Malé Region during 2018; considerably higher than all previous years since 2007. This observation correlates with the high level of courtship witnessed in 2016 (*n*=40) and 2017 (*n*=35).

Tourism pressures in the Malé Region have escalated over the years, with the number of snorkellers or divers, and tourism vessels, increasing again in 2018. In general, the increasing numbers of tourists frequenting manta aggregation sites throughout the Maldives shows the importance of these animals to the Maldives' economy. The Manta Trust continue to distribute a 10-step Code of Conduct (available in multiple languages) among tour operators throughout the Malé Region and other atolls, to ensure more sustainable manta ray tourism is practiced within the Maldives.

Efforts to conserve the natural heritage of the Malé Region and manage the increasing human impacts upon the environment are encouraging. However, it is crucial that active research into manta rays and other marine life continues in order to monitor the effects of both tourism and environmental change. Manta rays are an incredibly important economic resource for the Maldives, bringing tens of thousands of people to the country each year to dive and snorkel with them, generating millions of USD for the economy annually. Being able to pinpoint the reasons for any observed trends in, or threats to, the Maldives manta ray population is crucial for the ongoing management and protection of these animals.

STUDY AREA & CHANGING MONSOONS

Located centrally within the Republic of Maldives' 26 geographical atolls, and encompassing the capitol island of Malé and the main international airport, North and South Malé Atolls (NMA & SMA) are the most developed and busiest atolls within the country. Malé City is geographically located at the southern edge of NMA, and with a population of approximately 142,000 people, it is among the most densely populated cities in the world. Annually, the Maldives now welcomes well over a million tourists to this tiny island nation, the vast majority of which travel through Malé during their visit. Virtually every island has been developed within the region, and throughout 2018 reclamation of new islands expanded, resulting in significant impacts on the terrestrial and marine ecosystems. North Malé Atoll is geographically larger (1,565 km²) and more populated than SMA (530 km²); it is comprised of 76 islands and sandbanks (28 resorts and 8 locally inhabited islands), compared to 47 islands and sandbanks (22 resorts and 3 locally inhabited islands) in SMA. In 2018, the hotel industry expanded within Malé Atoll with the opening of three new resort islands; two in NMA and one in SMA. Throughout the majority of this report, data from the two geographical atolls has been combined to encompass the entire Malé Region. However, in some instances, the data has been analysed separately to allow comparisons to be made between each atolls' reef manta ray population, and to determine differences or similarities in site use between atolls.

The fluctuating monsoons (seasons) within the Maldives play an important role in determining manta ray distribution. Therefore, understanding the South Asian Monsoon is critical to interpreting the sightings of manta rays in the Malé Region. The monsoons, which dictate the weather in the Maldives, are characterised by their winds, which blow consistently and reverse direction seasonally. The Maldives Northeast Monsoon, or Iruvai, runs from December-March, while the Southwest Monsoon, or Hulhangu, runs from May-October each year, with the months of April and November acting as transitional periods of change between the two seasons. The Southwest Monsoon is typically characterised by more rain and cloud cover, along with reduced underwater visibility and rougher seas.

The strong monsoonal winds create oceanic currents that flow either from the northeast towards the southwest (Northeast Monsoon), or from the southwest towards the northeast (Southwest Monsoon). The Maldives' islands and atolls, rising 2,000 metres from the sea floor, act as a barrier to these currents, displacing the water as it flows through and around the atolls, creating deep-water upwelling. These upwellings bring nutrient rich water within reach of the sun's rays, enabling photosynthetic phytoplankton to flourish, and generating a bloom of predatory zooplankton that feed on the phytoplankton. Zooplankton is the prey of manta rays and, as strong lunar currents flow through the channels, the concentrated zooplankton is so abundant that the Maldives' waters support the world's largest known population of reef manta rays. It is at these sites where we are likely to observe feeding planktivorous megafauna. Manta rays tend to frequent cleaning stations that are in close proximity to their plankton-rich feeding areas, and thus, will migrate seasonally to utilise feeding areas and cleaning stations on the monsoonal down-current edge of the atolls. Due to the seasonal migration patterns of the manta rays, research efforts are focused on the west side of the atolls during the Northeast Monsoon, and on the east during the Southwest Monsoon.

To date, reef manta ray sightings have been confirmed at 36 different sites within the Malé Region between 1987-2018. Ten of these sites were classified as key aggregation areas due to the high number of individual manta rays which visited. These primary sites were pooled into four sub-regional groups for comparative analysis based on their geographical position within the region and population demographics (Fig. 1) (Table 1).

With a year-round presence of MMRP staff in NMA in recent years, our understanding of the manta ray population frequenting this atoll has developed considerably, allowing us to assess the importance of these sites and learn more about the known key aggregation areas. The MMRP project base in NMA will continue to conduct regular research monitoring throughout 2019 with the hope of building on the existing knowledge of this regional manta ray population, increasing public awareness, and providing guidance and recommendations for the protection of these charismatic animals and the conservation of their habitat.

Table 1: Ten key reef manta ray (*Mobula alfredi*) aggregation sites within North and South Malé Atolls: pooled into four sub-regional areas for comparative analysis based on their geographical position and population demographics.

Group	Site Name	Atoll	Location	Habitat	Demographic
1	Lankan Beyru	North Malé Atoll	East	Channel	Adults
	Sunlight Faru	North Malé Atoll	East	Inner Reef	
2	Kani Corner	North Malé Atoll	East	Channel	Juveniles
	Lhohifushi Aquarium	North Malé Atoll	East	Channel	
	Gasfinolhu Beyru	North Malé Atoll	East	Outer Reef	
	Thulusdhoo Beyru	North Malé Atoll	East	Outer Reef	
3	Rasfari North	North Malé Atoll	West	Channel	Adults
	Boduhithi Thila	North Malé Atoll	West	Channel	
4	Guraidhoo Falhu	South Malé Atoll	East	Inner Reef	Juveniles
	Guraidhoo Beyru	South Malé Atoll	East	Channel	

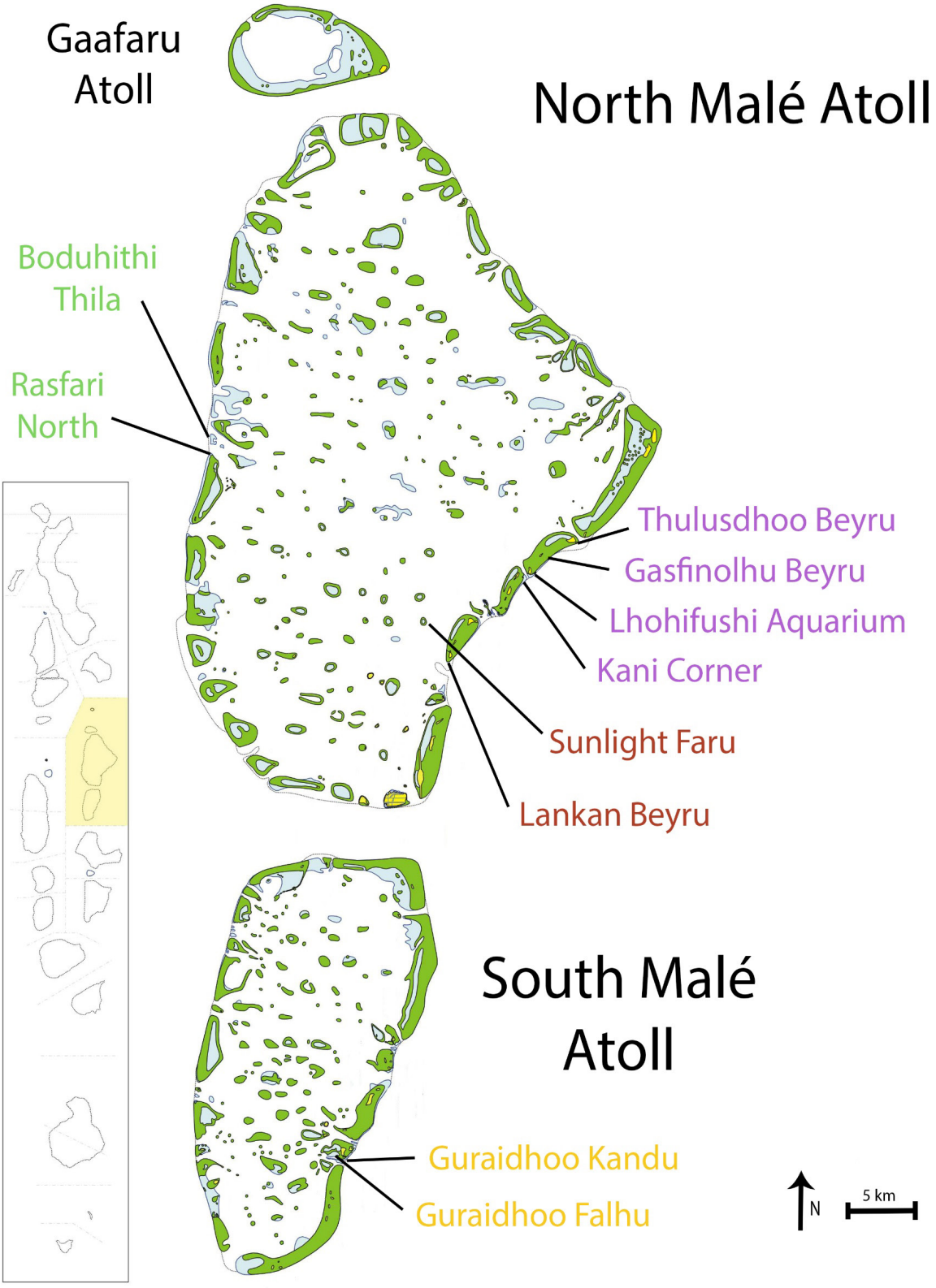

Figure 1: Map of North and South Malé Atolls showing ten key reef manta ray (*Mobula alfredi*) aggregation sites (colour-coded by four sub-regional areas) within the two geographical atolls.

STUDY PERIOD & SAMPLING METHODOLOGY

In 2018, surveys to look for manta rays (*n*=300) were carried out on as many days (*n*=170) that conditions and logistics allowed (Fig. 2). Forty-six percent of the surveys conducted in 2018 (*n*=138) were performed by MMRP trained researchers on guest excursions with the Euro-divers Meeru dive centre. A detailed briefing was given before every guest dive or snorkel excursion, including details of the Manta Trust's Code of Conduct and the ten steps on 'how to swim with manta rays' (swimwithmantas.org). The remaining fifty-four percent of surveys conducted (*n*=162), were external contributions from collaborating resort marine biologists and instructors, or survey data collected from the Manta Trust's 'IDtheManta' online submission forms. During each survey between 2006-2018 (*n*=2,818); location, wind speed, current direction, as well as other environmental weather variables were noted alongside manta ray numbers, and the manta's prevalent behaviours. Individual manta rays were documented by photographing the unique spot pattern on their undersides (ventral surface). In the context of this report, a sighting is defined as a confirmed photo-ID of an individual manta ray on a given day at a specific location.

Data for this report was compiled using both sightings and survey data. Sightings were collected by the MMRP team in addition to photographs and videos submitted by external contributors. Such contributors, known as 'citizen scientists', can provide important insights into the seasonal movements of many of Malé Region's reef manta ray population. As explained in the MMRP's Malé Atoll report (1987-2017), a more intense survey method was introduced in 2006, with an increase in survey effort by MMRP staff and volunteers occurring from 2013 onwards (Fig. 2). For this reason, throughout certain sections of this 2018 report, only the past six years of increased survey effort (2013-2018) have been analysed, to allow more accurate analysis of any observed trends. To account for changes in sampling effort, sightings data between 2006-2018 have been standardised where possible to allow for comparisons to be made between, and within years.

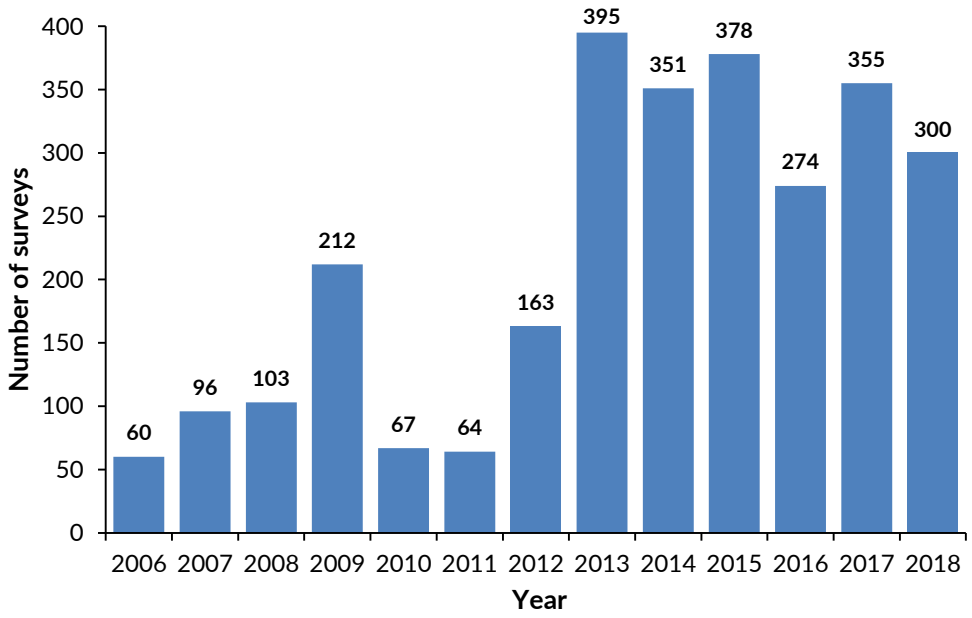

Figure 2: Number of surveys (*n*=2,818) undertaken annually in North and South Malé Atolls.

During 2018, survey effort (*n*=300) varied throughout the year (Fig. 3), with an increase in the number of surveys conducted between August-December. Generally, the average number of surveys per year (2013-2017) increase from June to November, with a decrease during May and December (the transitional months of change between monsoons) (Fig. 3), when there is usually a reduction in manta sightings at all key aggregation sites. However, in 2018 there was a decrease in the number of surveys throughout June (*n*=3) and July (*n*=5), probably as a result of rougher sea conditions at that time and therefore fewer opportunities to conduct guest excursions. Moreover, survey effort throughout December 2018 was much higher (*n*=43) compared to the average number of surveys conducted between 2013-2017 (*n*=7), possibly due to better environmental conditions, resulting in more excursions where surveys could be performed (Fig. 3).

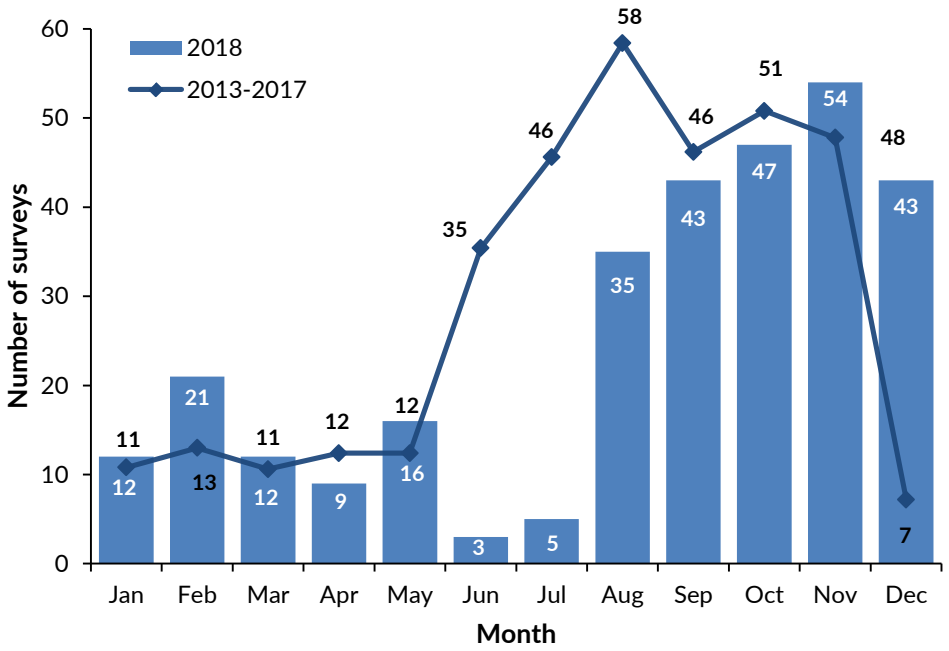

Figure 3: Number of surveys (*n*=2,053) undertaken monthly in North and South Malé Atolls (2013-2018).

Between 2013 and the end of 2018, survey effort varied between the four key manta aggregation areas (Fig.4) (Table 1). Throughout this period, the majority (56%) of surveys (*n*=974) were carried out at Lankan Beyru and Sunlight Faru (Group 1). Survey effort within this key area remained relatively consistent throughout the years, with a slight decline during 2017 (Fig. 4). Moreover, significant survey effort at Rasfari North and Boduhithi Thila (Group 3), only began in 2017. This was a result of an increased number of collaborating resorts located on the western edge of NMA, plus the establishment of a permanent MMRP research base in NMA in September 2017. In 2018, the majority (88%) of the surveys were collected from these two key aggregation areas; Group 1 (58%) and Group 3 (30%).

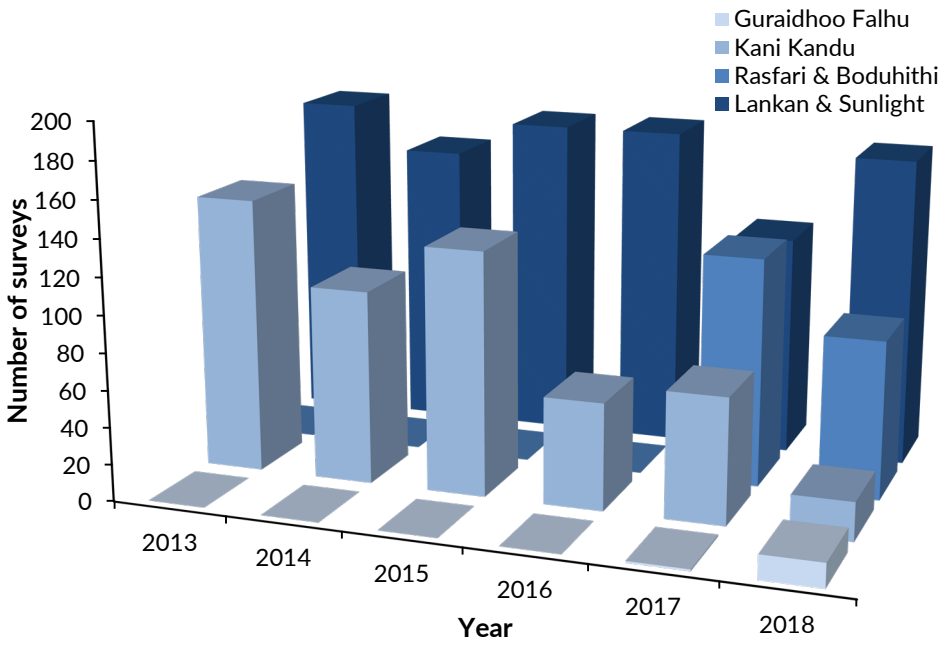

Figure 4: Number of surveys (*n*=1,731) undertaken annually at the four key manta aggregation areas.

REEF MANTA RAY SIGHTINGS

North and South Malé Atolls

A total of 8,103 sightings were recorded at 36 different sites throughout the Malé Region between 1987-2018. Ninety-seven percent (*n*=7,877) of these sightings were recorded between 2006-2018, which was also the period of significantly increased survey effort.

In 2018, a total of 1,007 reef manta ray sightings were recorded in the Malé Region. The data shows an increase (28%) in reef manta ray sightings compared to the previous year (*n*=784 in 2017). The number of sightings documented in the Malé Region during 2018 is the third highest on record (*n*=1,314 in 2016 and *n*=1,030 in 2007) (Fig. 5). In general, years of increased manta ray sightings have previously been recognised during years of high average wind speeds. However, this was not the case in 2018 (*see Environmental Variables section of this report*).

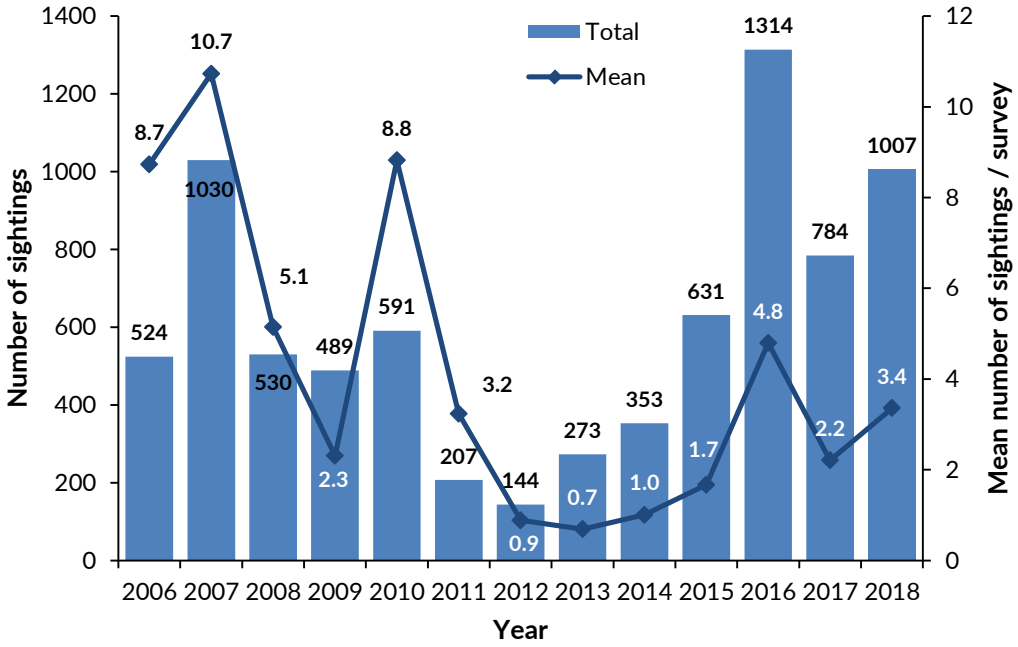

Figure 5: Annual sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls, and the mean number of sightings per survey.

A monthly breakdown of manta sightings across previous survey years (2006-2017), when standardised for effort, shows that the mean number of individuals sighted per survey typically peaks during the Northeast Monsoon months of January-March, with another peak occurring towards the end of Southwest Monsoon, during the months of September-November (Fig. 6). These peaks reflect the increased activity recorded at manta ray cleaning stations during these months. Reef manta ray sightings in 2018 followed a slightly different trend, with the typical spike in sightings recorded at the start of the Northeast Monsoon, but with the second sightings peak rising at the start of the Southwest Monsoon (Fig. 7). Thereafter, there was a marked drop in sightings in July, remaining consistently low for the remainder of the season (Fig. 7). When accounting for survey effort, November produced the lowest average number of sightings per survey (*n*=54). This decline in sightings during the Southwest Monsoon may be explained by a noted reduction in courtship activity, which historically occurs during the months of October-November at cleaning stations in the region (*see Courtship & Reproduction section of this report*).

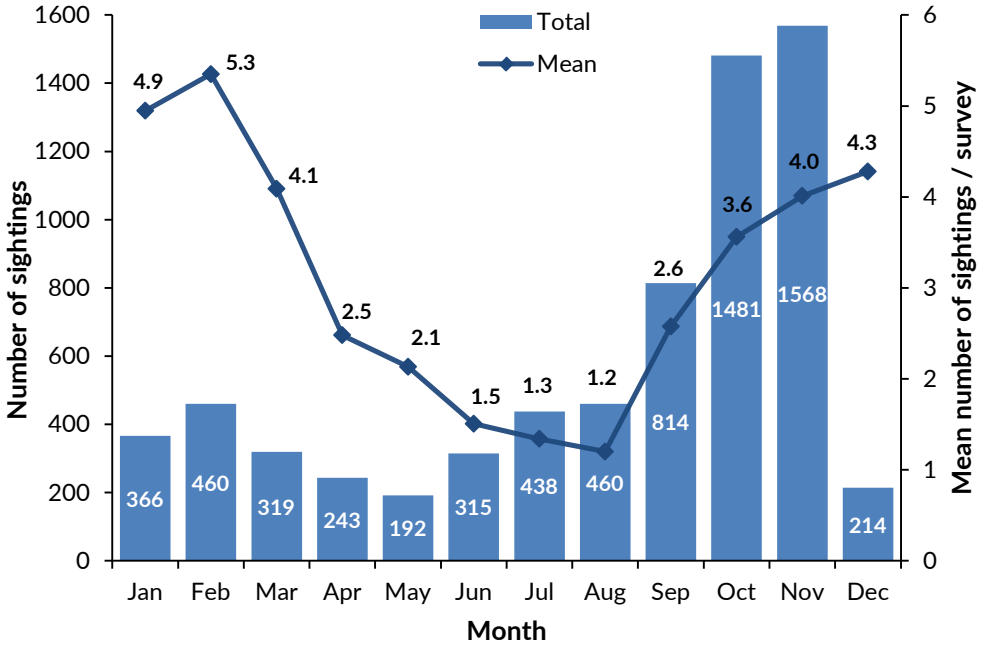

Figure 6: Monthly sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls, and the mean number of sightings per survey (2006-2017).

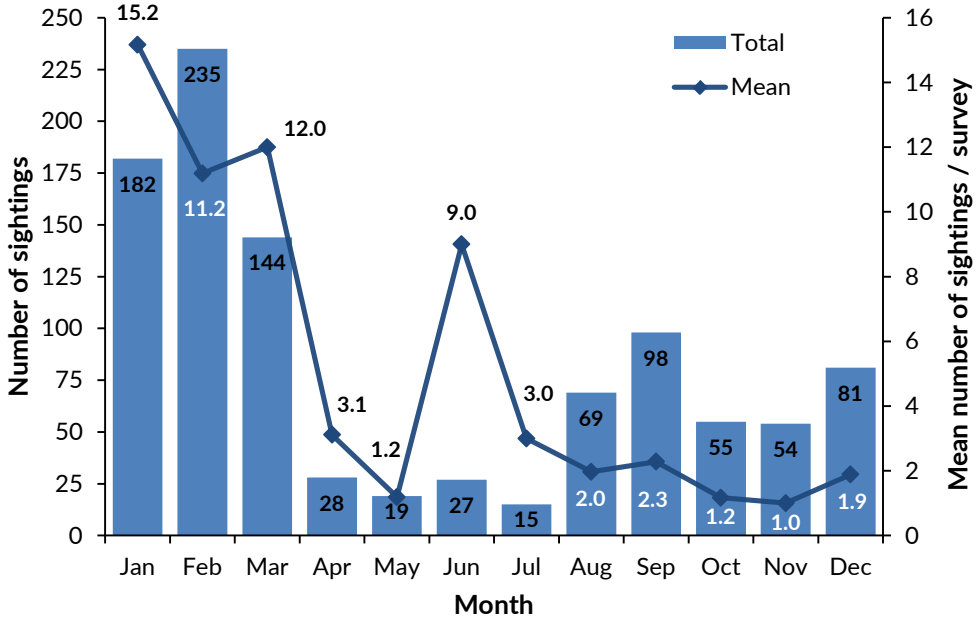

Figure 7: Monthly sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls, and the mean number of sightings per survey during 2018.

During 2018, a total of 252 different individual reef manta rays were recorded in the Malé Region. This accounts for 5.4% of the total recorded Maldives population (*n*=4,662); a slight increase from 2017 (*n*=229) (Fig. 8). In 2018, 44% (*n*=446) of sightings were recorded by MMRP researchers or volunteer staff, whilst 56% (*n*=561) were obtained through citizen scientist submissions. This highlights that even with a year-round presence of MMRP staff within the Region, citizen science is vital in developing our understanding of the Maldives reef manta ray population.

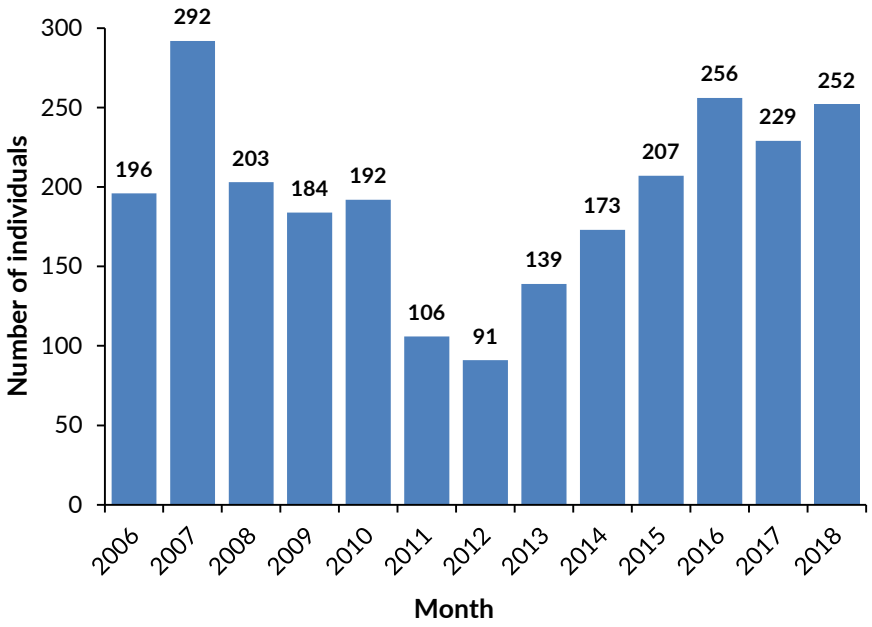

Figure 8: Number of individual reef manta rays (*Mobula alfredi*) recorded annually in North and South Malé Atolls.

Intra-Atoll Movements

Reef manta rays in the Maldives migrate seasonally, moving between the eastern and western sides of the atoll with the changing South Asian Monsoon. Overall, sightings in the Malé Region show the same seasonal movement patterns as the country's other large atolls, with reef manta rays visiting the western aggregation sites during the Northeast Monsoon (December-March) before returning to the eastern aggregation sites during the Southwest Monsoon (May-November). Ninety-eight percent (*n*=986) of all sightings from 2018 have been recorded from the ten key reef manta ray aggregation sites within the Malé Region (Fig. 1). Variations in site use within the region can be better understood by pooling sightings from these locations into four geographical groups based on their geographical position within the region and population demographics (Table 1).

In 2018, intra-annual sightings conformed to the expected migration patterns in the region. This was evident as the sightings peaked first during the months of January to April (Northeast Monsoon) at Rasfari and Boduhithi (Group 3), situated on the west of the atoll (Fig. 9). From May onwards, sightings at Rasfari North and Boduhithi Thila decreased, with a noticeable shift in manta ray site use as sightings gradually increased at Lankan Beyru and Sunlight Faru (Group 1), located on the east of the Atoll. The other two aggregation groups (Kani Kandu and Guraidhoo Falhu), which are predominantly utilised as feeding sites by sub-adult and juvenile reef manta rays, are also located on the eastern edge of the atolls. Despite far fewer sightings in total noted at these two locations compared to Groups 1 and 3 in 2018, sightings conform to a similar seasonal trend to previous years; peaking between July – November during the Southwest Monsoon, with little to no sightings recorded annually during the Northeast Monsoon (Fig. 9).

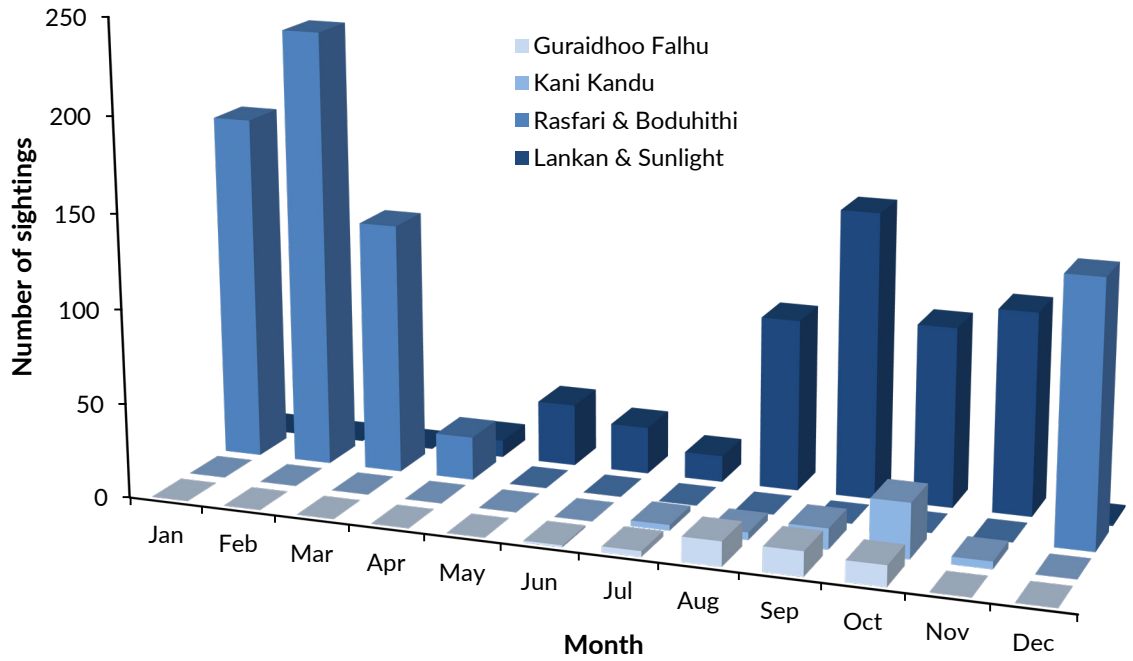

Figure 9: Intra-annual variations in sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls at four key manta aggregation areas (see Table 1) (2018).

During previous years (2005-2017), the months of October and November have represented peak sightings periods at Lankan Beyru and Sunlight Faru during the Southwest Monsoon (Fig. 10). Throughout the Maldives, these months are recognised as months when courtship behaviour is much more frequently observed. However, in 2018, sightings at Lankan Beyru and Sunlight Faru peaked earlier during the month of September (*n*=151) and decreased in October (*n*=95) and November (*n*=107) (Fig. 9); a possible reflection on the lack of courtship activity recorded during the later months of 2018 (*see Courtship & Reproduction section of this report*). In December 2018, a sudden increase in sightings (*n*=139) was noted at Rasfari North and Boduhithi Thila (Group 3) (Fig. 9), compared to a total of 45 sightings recorded at these sites during the month of December across the past twelve years (2005-2017) (Fig. 10). This increase in sightings on the west of the atoll during the month of December is possibly due to an earlier change between the seasons (switching from the Southwest to the Northeast Monsoon) in 2018. Increased survey effort at these Group 3 locations are likely to have also increased sighting records.

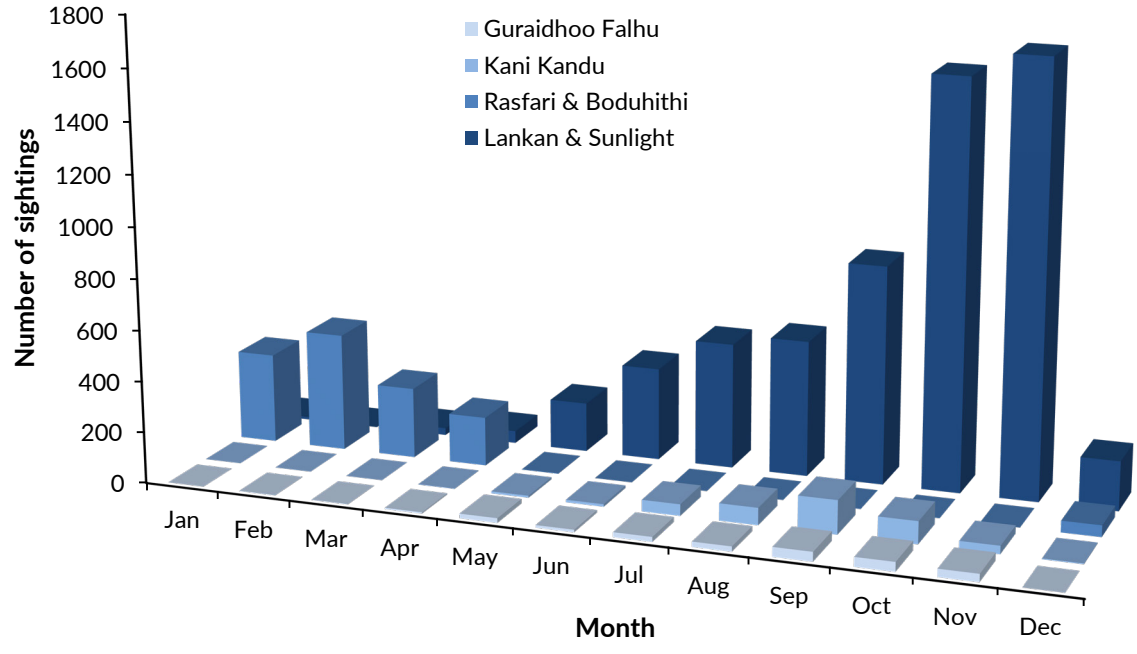

Figure 10: Intra-annual variations in sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls at four key manta aggregation areas (see Table 1) (2005-2017).

There was also a significant amount of inter-annual variation in reef manta ray sightings between, and within, these regional groups. The majority of sightings recorded between 2013-2017 occurred at the cleaning stations of Lankan Beyru and Sunlight Faru (*n*=2,437) (Fig. 11). However, the total number of reef manta ray sightings recorded at the key aggregation sites of Rasfari North and Boduhithi Thila (*n*=710) was higher than at Lankan Beyru and Sunlight Faru (*n*=526) for the first time in 2018 (Fig. 11). More consistent monitoring by MMRP researchers in the future will hopefully help to elucidate any trends in manta ray sightings frequency at these key aggregation areas.

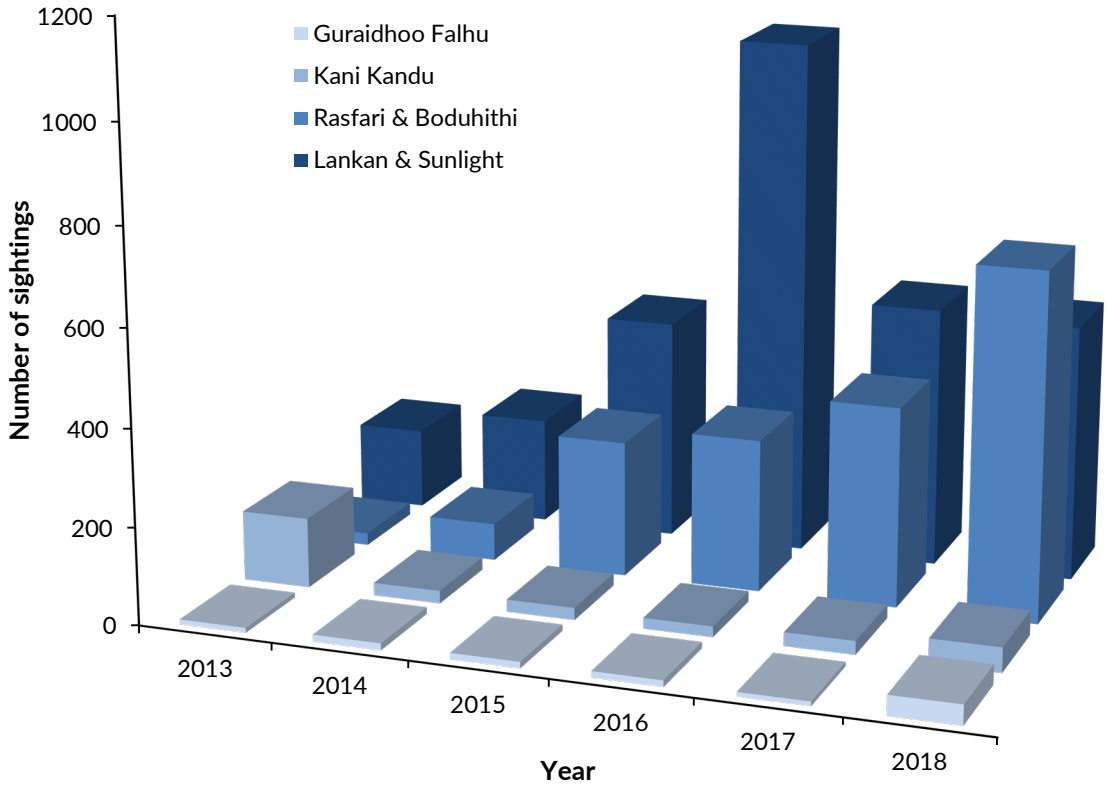

Figure 11: Inter-annual variations in sightings of reef manta rays (*Mobula alfredi*) in North and South Malé Atolls at four key manta aggregation areas (see Table 1).

Population Demographics

The current recorded population of reef manta rays in the Malé Region is 783 individuals, 17% of the total known Maldives population (*n*=4,662). In 2018, the majority (97%) of sightings (*n*=972) were recorded in NMA, similar to the previous Malé Atoll Report. The two sub-populations of manta rays have been analysed separately to determine any differences or similarities between populations frequenting these two atolls.

NMA has a population of 725 individuals, accounting for 93% of the overall population in the region. The population demographics in NMA are split almost equally between sexes, with 48% (*n*=349) females, 52% (*n*=375) males, and one individual for which sex could not be determined (Fig. 12). The population demographics in NMA were biased towards adults, with 77% (*n*=558) of individuals recorded as mature, while 3% (*n*=22) were subadults, and 20% (*n*=144) juveniles. Without knowing the sex of the one unknown individual, the maturity status could not be determined (Fig. 12). In 2018, the demographics of individuals sighted in NMA showed a sex bias; with 61% (*n*=147) males and 39% (*n*=95) females.

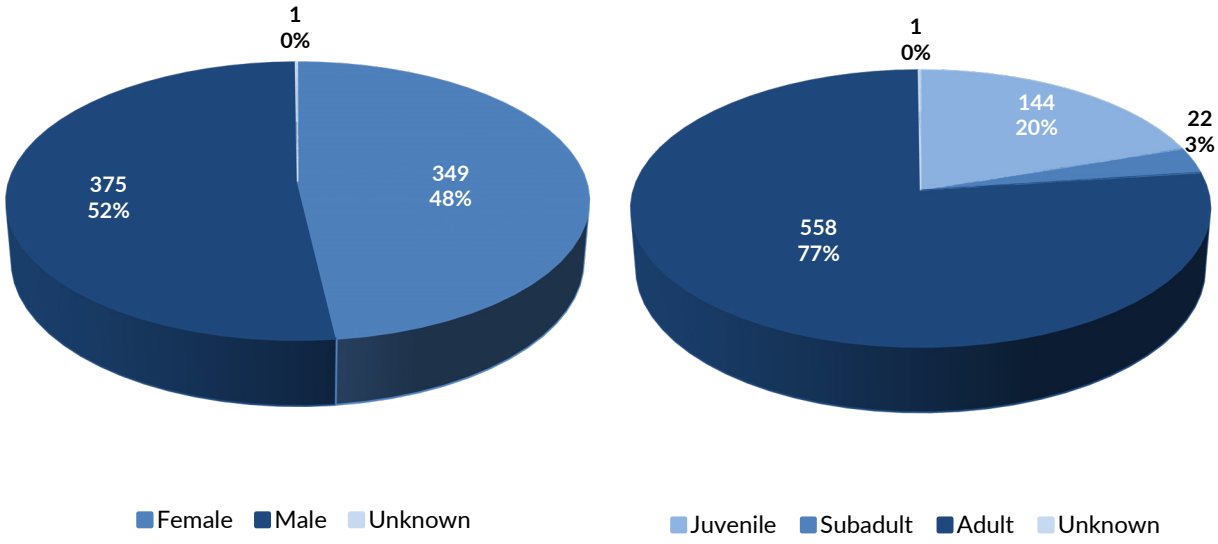

Figure 12: Demographics of the reef manta ray (*Mobula alfredi*) population (*n*=725) recorded in North Malé Atoll (1987-2018).

In SMA, although the recorded reef manta ray population only consists of 101 individuals (13% of the regional population), the population demographics is different to that of NMA. There is a sex bias; with 62% (*n*=63) males, and 38% (*n*=38) females (Fig. 13). Furthermore, in contrast to NMA, 53% of the recorded population in SMA are immature; with 39% (*n*=39) recorded juveniles, 15% (*n*=15) subadults, and only 47% (*n*=47) recorded as mature adults (Fig. 13). This suggests that SMA supports important aggregation sites for immature manta rays- e.g. Guraidhoo Falhu, which is noted as a key juvenile feeding site within the atoll. Similar to NMA, in 2018, the demographics of individuals sighted showed an increase in sex bias; with 84% (*n*=16) males and 16% (*n*=3) females.

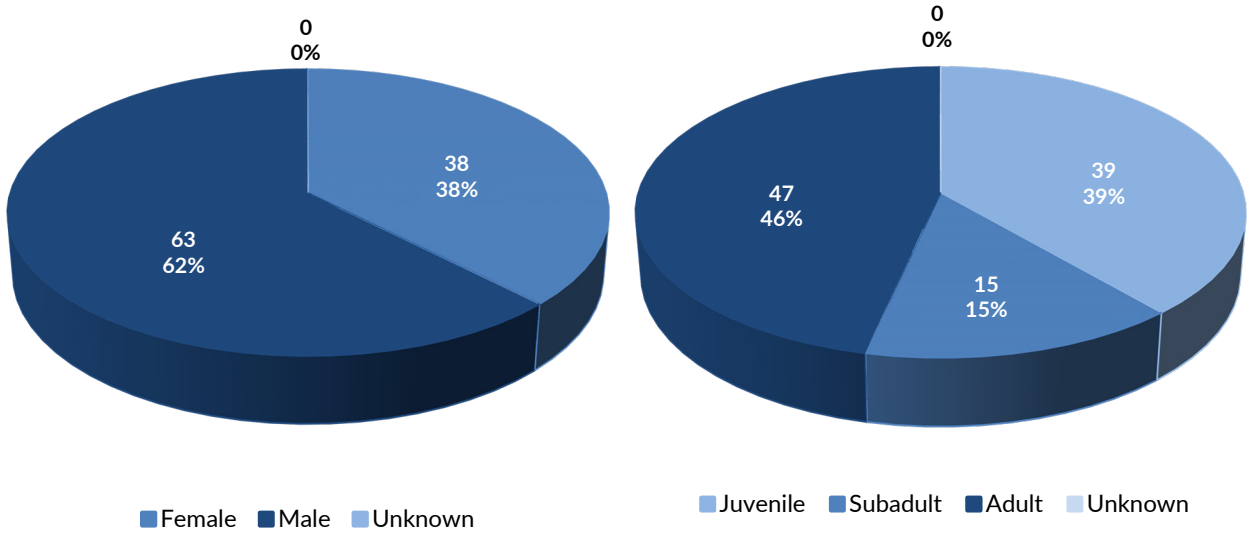

Figure 13: Demographics of the reef manta ray (*Mobula alfredi*) population (*n*=101) recorded in South Malé Atoll (1987-2018).

As recorded in the first Malé Atoll Annual Report, the proportion of newly sighted individual reef manta rays recorded annually has followed a downward trend over the study years as more of the Malé Region population is identified (Fig. 14). To date, 89% (*n*=695) of the recorded Malé Region reef manta ray population have been re-sighted within the region or elsewhere in the Maldives, suggesting that the vast majority of the individuals which frequent this region have now been recorded. In 2018, of the 252 individuals recorded within the Malé Region, 44 were new sightings for this atoll. Six of these individuals were estimated to be young of the year, based on their small disk widths (~150cm). Four of these individuals were recorded at Guraidhoo Falhu, a recognised juvenile feeding site in SMA. Of the remaining 38 new individuals, 15 had never been recorded anywhere else in the Maldives by the MMRP, while the remaining 23 individuals had previously been recorded in other atolls.

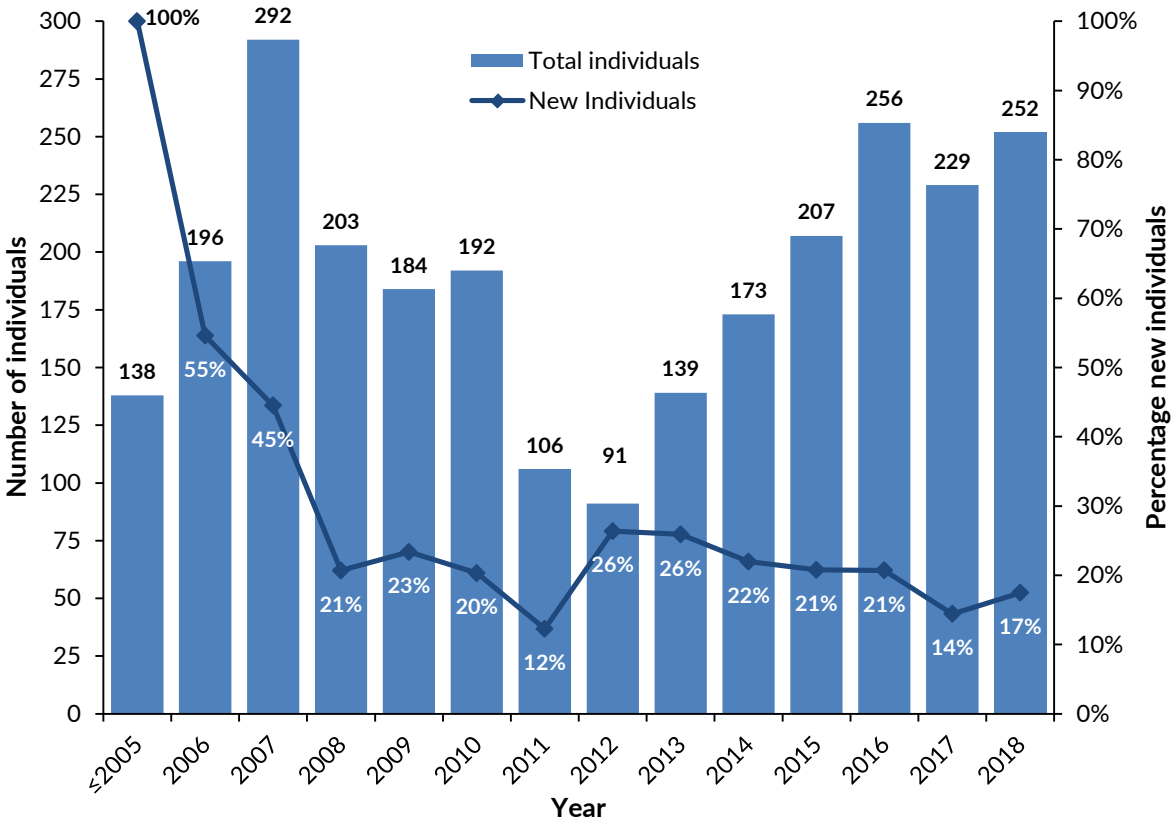

Figure 14: Number of individual reef manta rays (*Mobula alfredi*) sighted annually in North and South Malé Atolls, and the percentage of those individuals which were newly recorded (1987-2018).

Fifty-nine percent (*n*=26) of the new individuals in 2018 were recorded at Rasfari North and Boduhithi Thila (Fig. 15), a reflection of the increased survey effort at these sites throughout 2018. With a year-round presence of MMRP staff within NMA, and continued collaborations with resorts based on the western edge of the atoll, we can gain greater insight into the population dynamics of the Malé Region as a whole.

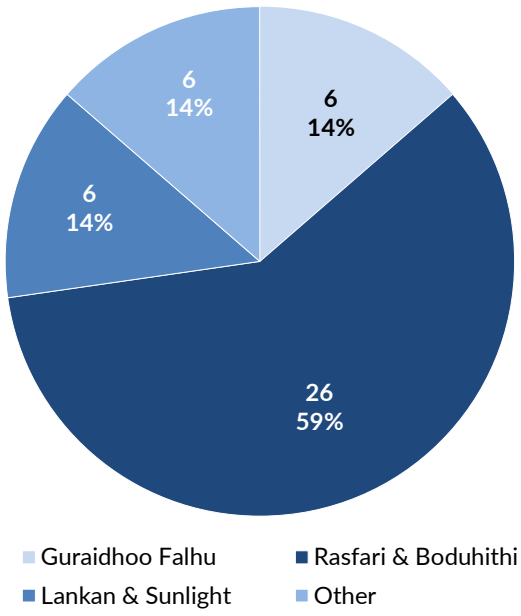

Figure 15: Number of newly recorded individual reef manta rays (*Mobula alfredi*) first sighted at key manta aggregation areas in North and South Malé Atolls (2018).

Inter-Atoll Migrations

Forty-four percent (*n*=318) and 74% (*n*=75) of the recorded reef manta ray sub-populations of NMA and SMA respectively have been recorded in other geographical atolls throughout the Maldives, compared to only 28% of the total recorded Maldives' reef manta ray population (*n*=4,662). As determined in the first Malé Atoll Annual Report, this migratory behaviour suggests a large proportion of these sub-populations are, at least some of the time, highly mobile; travelling hundreds of kilometres throughout the archipelago. The most common inter-atoll movement records occur between NMA, SMA, and those atolls closest geographically to the study region. In total, reef manta rays from NMA have been re-sighted in 15 different geographical atolls (including SMA), with the highest number of re-sightings in Baa Atoll (*n*=160), followed by Ari Atoll (*n*=126) (Fig.16). The recorded sub-population of reef manta rays in SMA are more transient, with 74% of individuals (*n*=75) recorded in nine other atolls, including 43 from NMA (Fig. 17). This suggests less suitable habitat is available for this species within the atoll year-round, but a lack of consistent survey effort is probably also confounding these results.

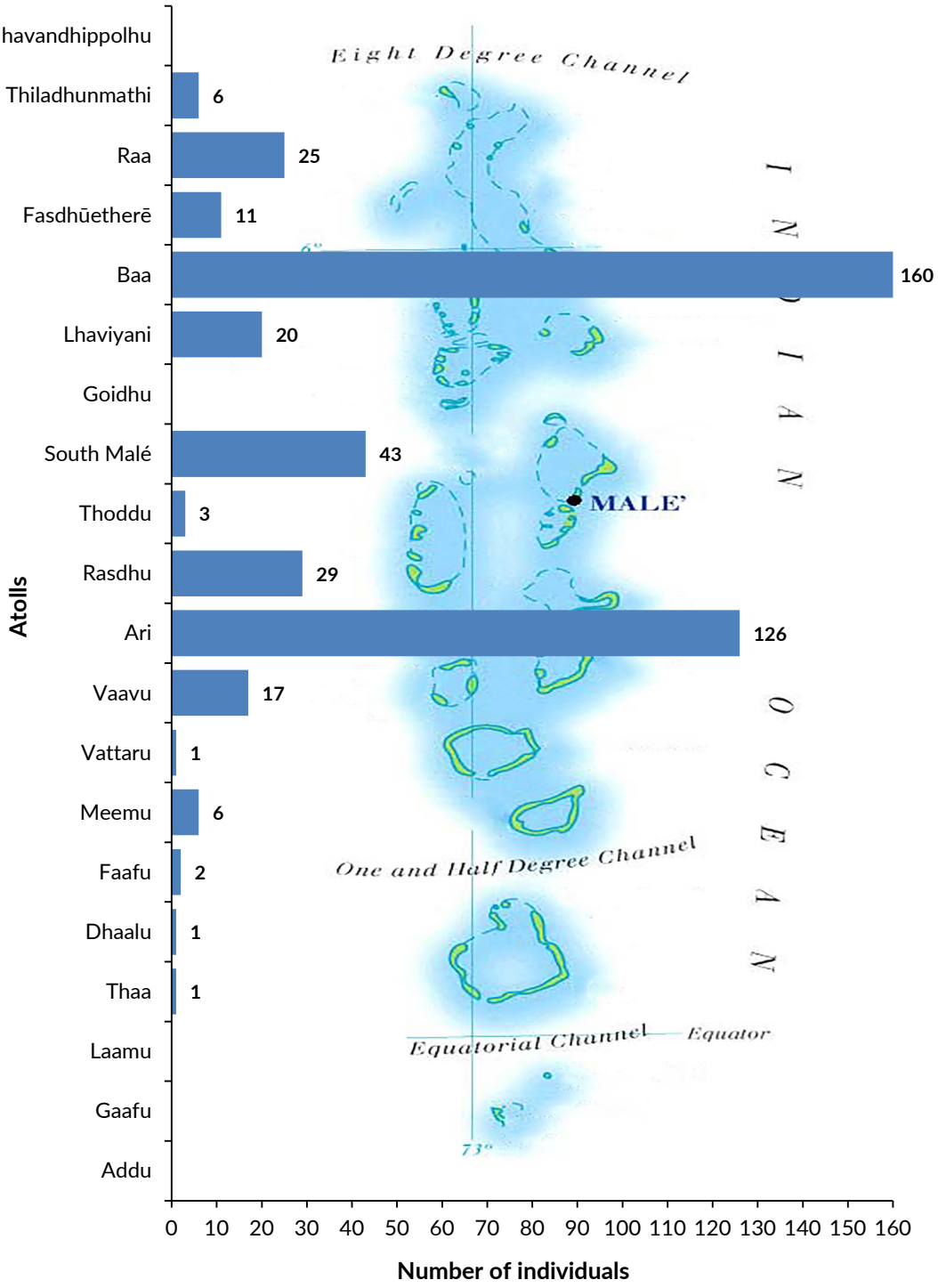

Figure 16: Number of reef manta rays (*Mobula alfredi*) (*n*=318) from within the North Malé Atoll population (*n*=725) which have been recorded in other atolls throughout the Maldives Archipelago.
Note: Some individuals have been sighted in more than one atoll outside North Malé Atoll.

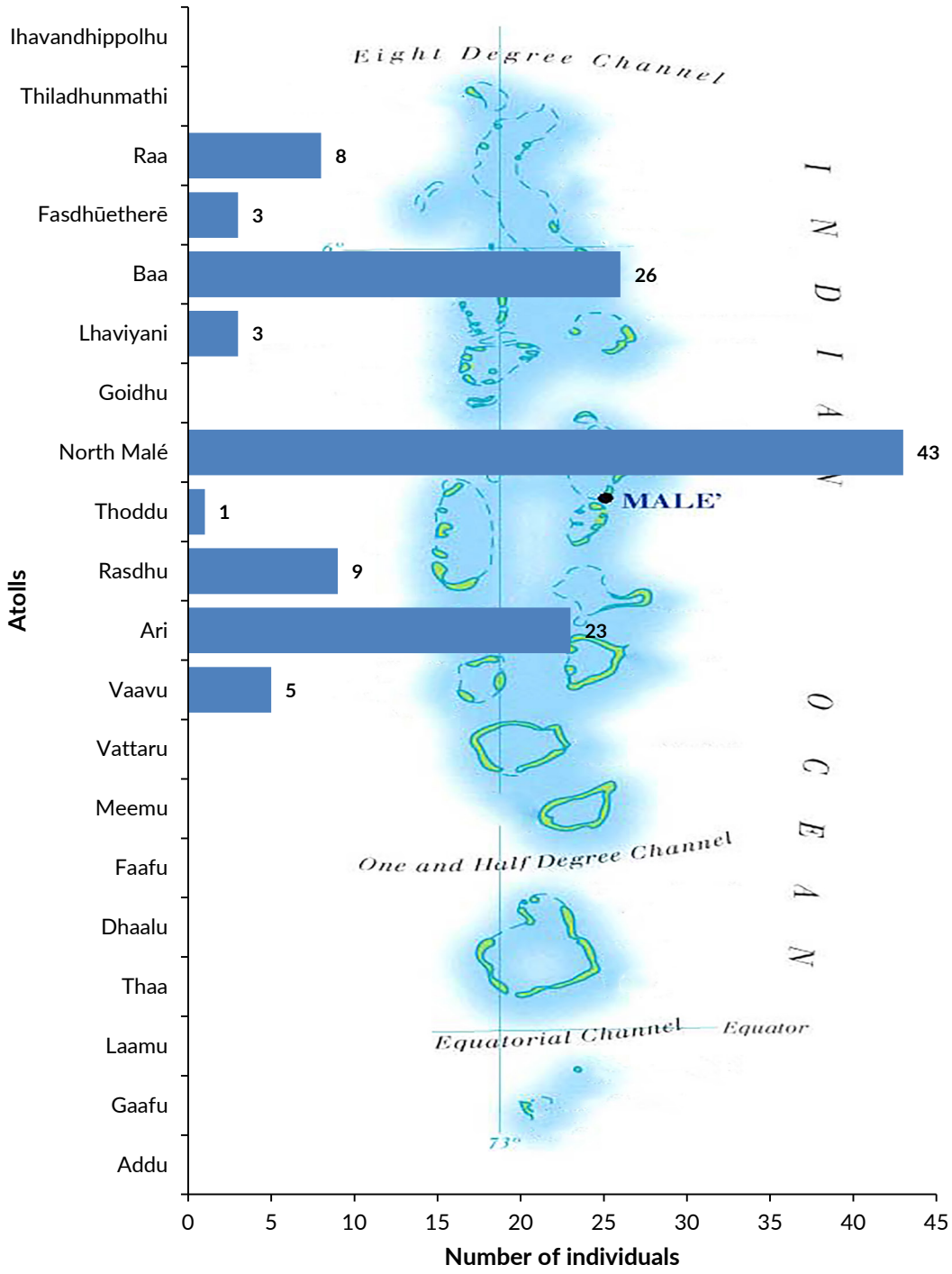

Figure 17: Number of reef manta rays (*Mobula alfredi*) (*n*=75) from within the South Malé Atoll population (*n*=101) which have been recorded in other atolls throughout the Maldives Archipelago. *Note: Some individuals have been sighted in more than one atoll outside South Malé Atoll.*

The high degree of migrations by individuals recorded travelling between the atolls is reflective of the wider population. With relatively small distances (10s km) between the atolls in the central and northern regions of the Maldives, and shallow maximum ocean depths (<300m) between most of these atolls, there are limited barriers to migration. Indeed, several individuals have also been recorded travelling back and forth between other atolls (i.e. Baa Atoll) and NMA multiple times within a single season. However, these results are also likely influenced by the increased survey effort in these central atolls by the MMRP researchers.

Site Fidelity

A large proportion (56%) of the reef manta ray sub-population of NMA (*n*=725) have never been recorded outside of this atoll (Fig. 18), and 74% (*n*=540) have been recorded on more than one occasion within the atoll. Eighty-three individuals have been sighted more than 25 times during the 1987-2018 study period within the atoll, and 23 individuals more than 50 times. Unsurprisingly, given the reduced survey effort and apparent lower residency rates within SMA, there have been less re-sightings of the recorded sub-population (*n*=101); where only 49% (*n*=50) of the individual reef manta rays have been sighted on more than one occasion within the atoll. Furthermore, the maximum sightings for any individual within the atoll is 13, with only nine individuals having been sighted more than five times within the atoll. Indeed, 26% (*n*=26) of the individuals sighted in SMA have been recorded only inside this atoll, while 43% (*n*=43) and 21% (*n*=21) have been recorded within two and three atolls, respectively (Fig. 19).

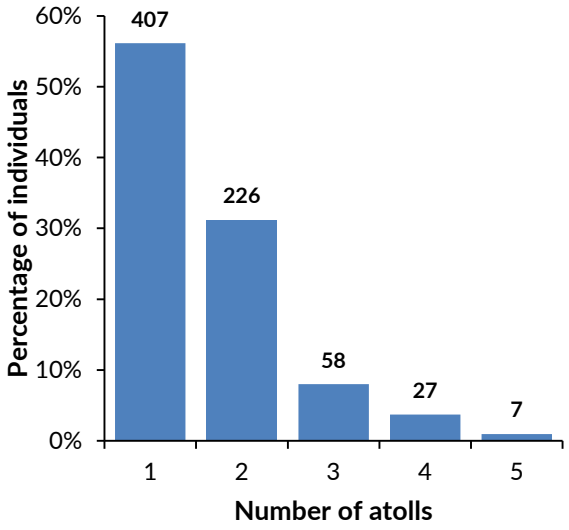

Figure 18: Percentage of the North Malé Atoll reef manta ray (*Mobula alfredi*) population (*n*=725) which have been sighted in one (only North Malé) or more geographical atolls. Actual number of individuals above bars (1987-2018).

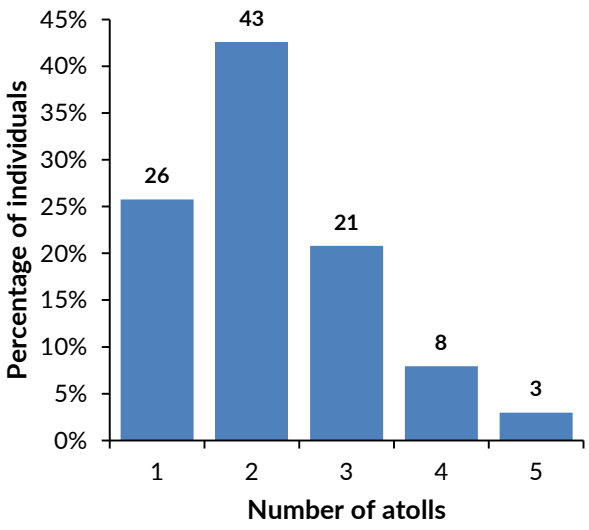

Figure 19: Percentage of the South Malé Atoll reef manta ray (*Mobula alfredi*) population (*n*=101) which have been sighted in one (only South Malé) or more geographical atolls. Actual number of individuals above bars (1987-2018).

Many individuals that exhibit high fidelity to NMA also exhibit patterns of specific habitat use within the atoll, favouring particular sites. For example, MV-MA-0090 (Pickle) is an adult female reef manta ray that has been one of the most sighted individuals in NMA since 2005. To date, Pickle has been recorded a total of 144 times throughout the Maldives, but at only four different survey sites within NMA. Prior to 2018, the vast majority (81%) of Pickle's sightings have occurred at the key manta aggregation area that includes Lankan Beyru (*n*=77) and Sunlight Faru (*n*=13) (Group 1). While the remaining sightings (19%) were recorded within the key aggregation area which includes Rasfari North (*n*=20) and Boduhithi Thila (*n*=1) (Group 3). In 2018, Pickle was the most sighted individual in the Malé Region, with a total of 33 sightings across ten months. During this survey year, Pickle followed the same habitat use pattern, with 61% (*n*=20) of sightings at Lankan Beyru, and 36% (*n*=12) of sightings recorded at Rasfari North (Fig. 20). The most sighted adult male reef manta ray within the Malé Region, MV-MA-0162 (Simple), also exhibits similar habitat use patterns; sighted 93 times since 2006, Simple also visits the same two key aggregation areas; Group 1 and Group 3. Prior to 2018, eighty-six percent of Simple's sightings were recorded at Lankan Beyru (*n*=70). However, in 2018, Simple was sighted almost evenly between the survey sites of Lankan Beyru (*n*=5) and Rasfari North (*n*=7) (Fig. 21).

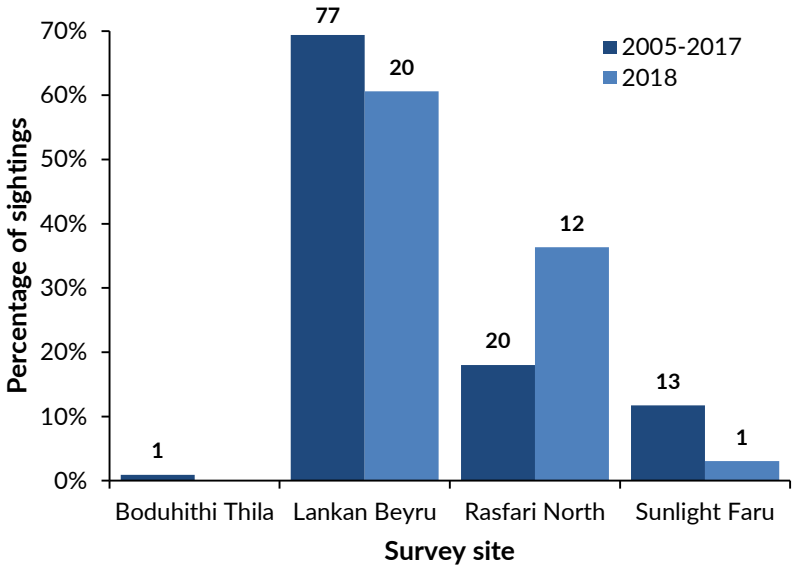

Figure 20: Percentage of the sightings of the reef manta ray (*Mobula alfredi*) MV-MA-0090 (Pickle) at different survey sites within North Malé Atoll. Actual number of sightings above bars.

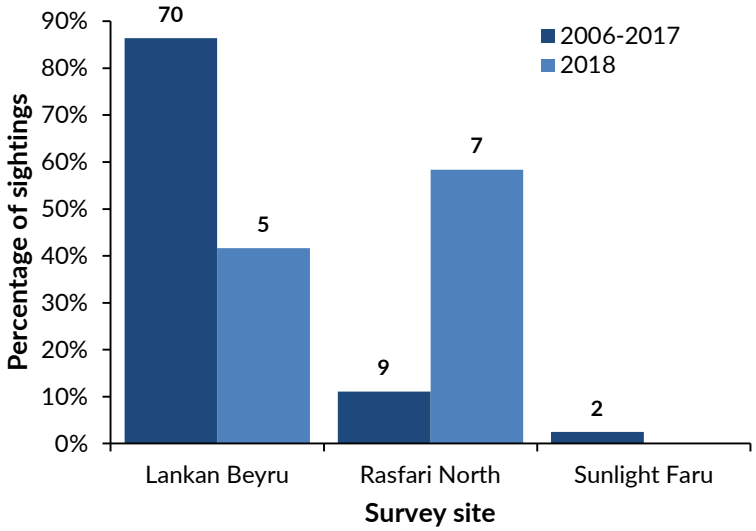

Figure 21: Percentage of the sightings of the reef manta ray (*Mobula alfredi*) MV-MA-0162 (Simple) at different survey sites within North Malé Atoll. Actual number of sightings above bars.

Without utilising more sophisticated tracking methodologies, such a telemetry studies, it is difficult to create a more detailed picture of how individual reef manta rays exhibit site fidelity. However, the increased surveying effort by the MMRP from 2006 onwards does allow some broad preliminary analysis. Throughout 2018, each manta ray was observed on average four times within the Malé Region (Fig. 22), a slight increase compared to 2017 (n=3.4). To account for survey effort, a Residency Index (RI) was calculated for each year based on the ratio between the number of days each individual was sighted and the total number of surveyed days (e.g. an RI of 3% means that on average, each individual was sighted on 3% of the total survey days). The RI for 2018 (1.3%) was slightly higher than that noted in 2017 (1%), and similar to that of all years from 2012 onwards (Fig. 23). The low residency of manta rays in the Malé Region in recent years is likely the result of higher survey effort, as RI is inversely correlated with number of surveys (Fig. 24), and a reflection of more transient behaviour, with manta ray movements likely dictated by more favourable conditions elsewhere. There is also the possibility that the level of development, resulting in increased boat traffic, and increased snorkeller and diver pressures at the manta ray's aggregation sites, has affected the ray's residency. The impacts of increasing noise pollution, reef degradation, and the physical disturbances which all result from these development activities have yet to be evaluated in detail.

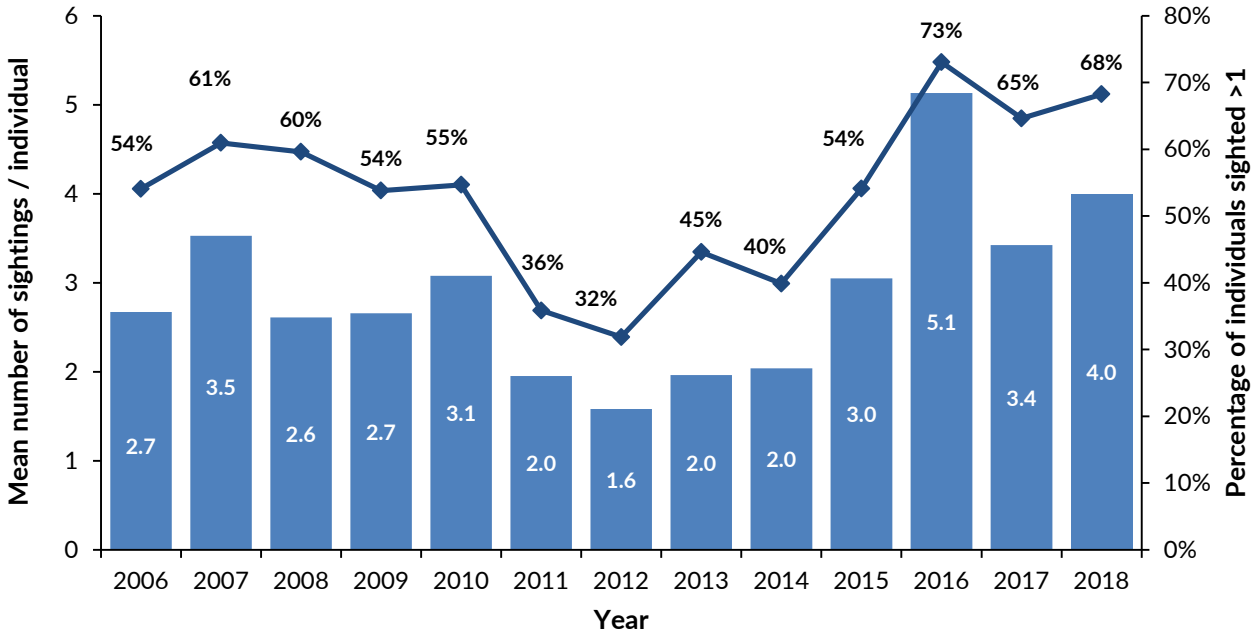

Figure 22: Mean number of sightings per individual reef manta ray (*Mobula alfredi*) in North and South Malé Atolls, and the percentage of individuals sighted on multiple occasions during the same year.

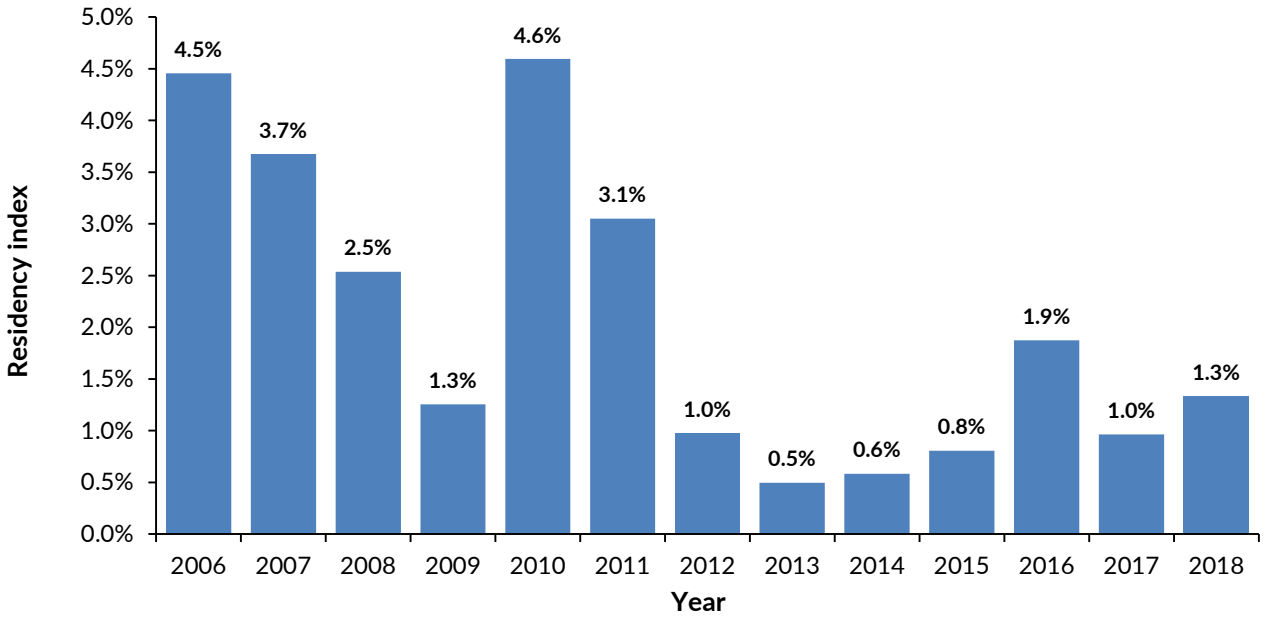

Figure 23: Annual Residency Index (RI) of the reef manta rays (*Mobula alfredi*) in North and South Malé Atolls. RI is calculated as the average of each individuals' residency score (= number of times sighted annually divided by the total number of surveys).

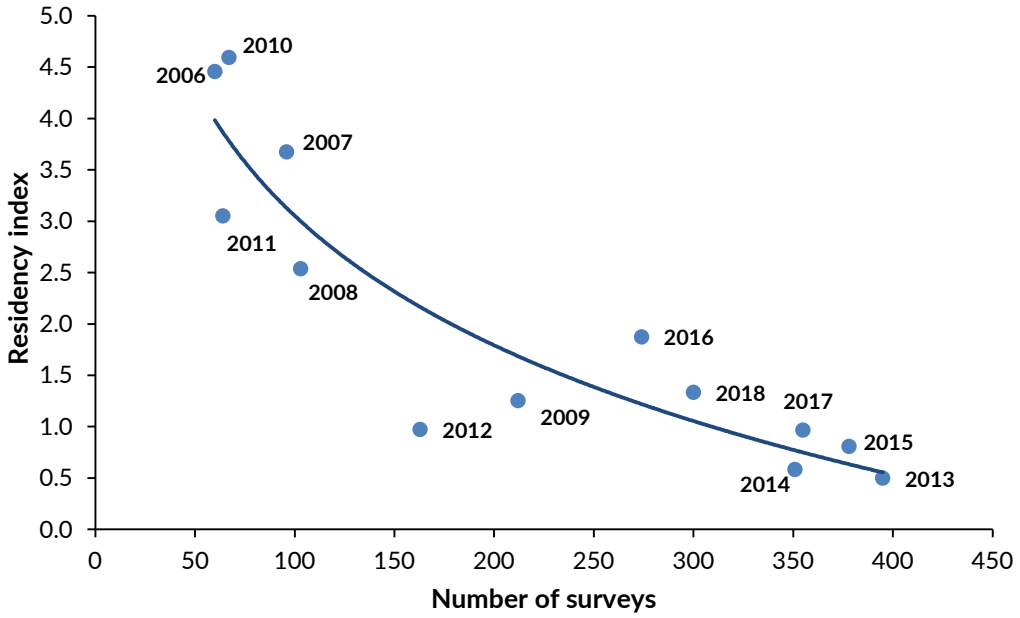

Figure 24: Relationship between the number of surveys conducted and the residency index of reef manta rays (*Mobula alfredi*) recorded within a study year in North and South Malé Atolls (2006-2018).

Courtship & Reproduction

Throughout their range globally, manta ray reproductive activity often peaks at particular times of the year. In the Maldives, courtship behaviour and mating are much more frequently observed during the months of October and November, and again in March and April, when the country's two monsoons (seasons) transition from one to the other. Throughout the day, adult manta rays spend a significant amount of their time cleaning, with female manta rays often spending several hours each day cruising around a favoured cleaning site. Cleaning stations, therefore, often become the focal point for courtship and mating activity, with mature males aggregating at these sites in search of sexually receptive females.

In contrast to 2017 (*n*=35) and 2016 (*n*=40), a low incidence of courtship activity was recorded at cleaning stations during 2018 (*n*=10) (Fig. 25). Interestingly, all courtship activity in 2018 was recorded at Rasfari North and Boduhithi Thila, during the Northeast Monsoon. This is the first time since 2011 that courtship activity was not recorded during the Southwest Monsoon. The reduced courtship activity in 2018 correlates with the lower number of individuals seen at Lankan Beyru and Sunlight Faru; favoured cleaning stations during the Southwest Monsoon.

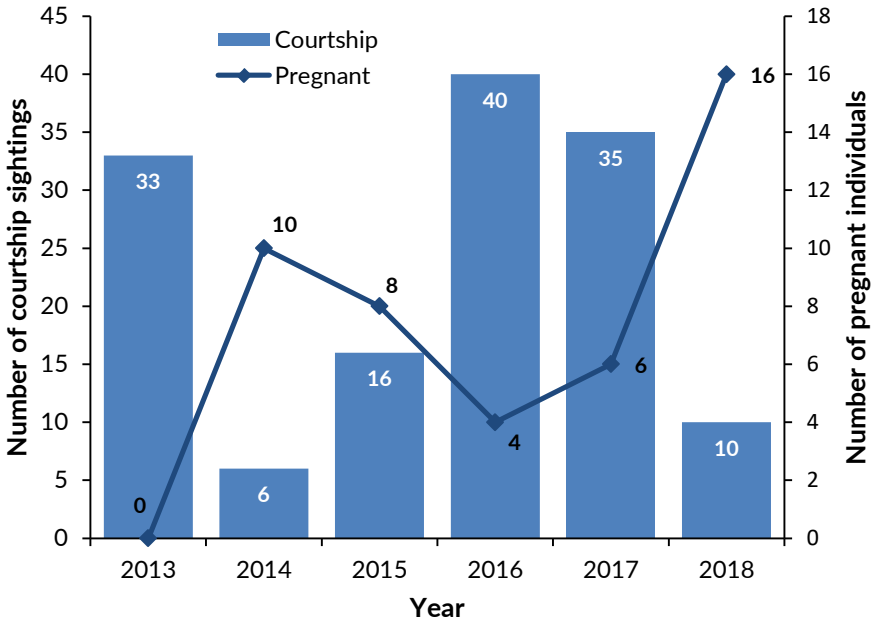

Figure 25: Number of reef manta ray (*Mobula alfredi*) sightings where courtship was the predominant behaviour observed annually in North and South Malé Atolls, and the total number of pregnant females recorded in that same year.

In 2018, 51 adult female manta rays were sighted, and 31% (*n*=16) of these individuals were visibly pregnant (Fig. 26). With a gestation period of one year, manta ray pregnancies become easily visible at about six months into the pregnancy. Of the 16 individuals observed to be pregnant in the Malé Region in 2018, 94% (*n*=15) were already in the later stages of gestation (3rd-4th trimester) when first observed in 2018. It is therefore hypothesised that the increased number of pregnancies recorded in 2018 are a result of the high level of courtship activity documented in 2017, and may be the reason for the low level of courtship activity documented during 2018 (Fig. 25). The high incidence of pregnancies reported in 2018 should not however detract from the overall very slow reproductive rate for this species, which, on average, sees only 14% of the mature females reproducing annually. With such a low fecundity it becomes vital for the survival of these animals to minimise anthropogenic and natural impacts. Effective measurements include the establishment of Marine Protected Areas and the adherence to sustainable tourism activities at key manta ray mating, cleaning and feeding sites.

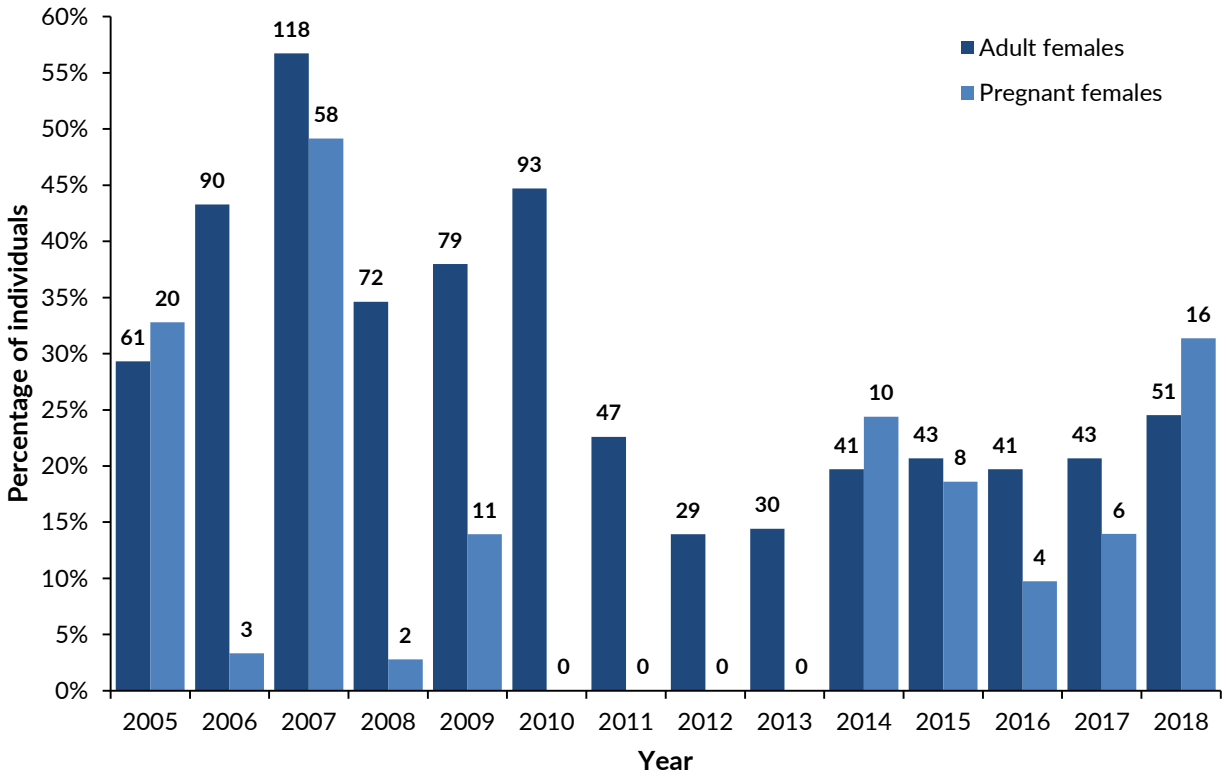

Figure 26: Percentage of adult female reef manta rays (*Mobula alfredi*) sighted annually in North and South Malé Atolls, and the percentage of those females that were recorded pregnant in the same year. Actual number of individuals above bars.

Sub-Lethal Injuries

Of the 783 individual reef manta rays recorded in the Malé Region, 40% (*n*=313) have some form of sub-lethal injury. Within the NMA sub-population of reef manta rays (*n*=725), 2% (*n*=14) were recorded with one or more new sub-lethal injuries in 2018. Overall, 15 separate injuries were recorded, 47% (*n*=7) of which resulted from anthropogenic origins (e.g. fishing line entanglement, boat strikes, etc.), whilst 47% (*n*=7) resulted from natural origins (e.g. predatory bites, diseases, deformities, etc.). The remaining one sub-lethal injury originated from an unknown source (Fig. 27). Within NMA, a higher proportion of these injuries were recorded on adult reef manta rays, which are more exposed to threats (such as sharks and fishing pressures) because they frequent aggregation sites along outer reefs and inside channels. Comparatively, 3% (*n*=3) of the SMA reef manta ray population (*n*=101) were recorded with a new sub-lethal injury in 2018, with a total of three separate injuries recorded. However, injury origins differ slightly; with 67% (*n*=2) of injuries arising from anthropogenic sources and the remaining (*n*=1) originating from an unknown source (Fig. 28). The boat strike injuries in SMA (*n*=2) impacting juvenile manta rays is an increasing concern, especially at Guraidhoo Falhu, where juvenile manta rays often feed in shallow waters.

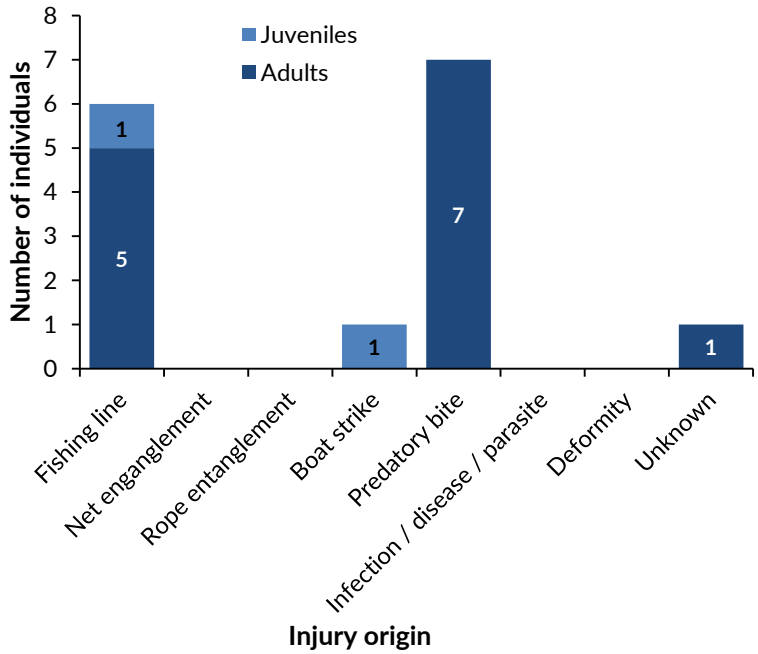

Figure 27: Demographic variations in the number of newly recorded sub-lethal injuries (*n*=15) within the North Malé Atoll reef manta ray (*Mobula alfredi*) population (*n*=725) in 2018, and the likely origin of the injuries.

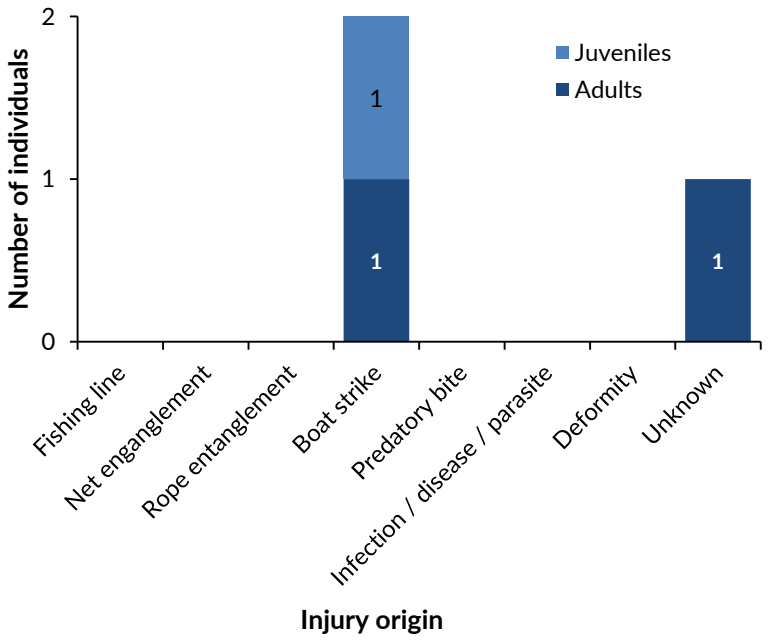

Figure 28: Demographic variations in the number of newly recorded sub-lethal injuries (*n*=3) within the South Malé Atoll reef manta ray (*Mobula alfredi*) population (*n*=101) in 2018, and the likely origin of the injuries.

Of all manta injuries recorded in the NMA sub-population in 2018, the most common body area inflicted by injury (71%) are the manta ray's pectoral fins (Fig. 29); a similar finding to other MMRP atoll study reports. This is most likely because manta rays cannot see well directly behind them, making them vulnerable to attacks from predators (mainly large sharks) within the anterior pectoral fin region. This region of the body is also where entangled fishing line often causes the most damage. The proportion of individuals with injured pectoral fins remains relatively consistent between the sexes, and maturity status, of the population within NMA. However, there was an even split (33%) of the body area inflicted by new injuries seen in the SMA sub-population (Fig. 30).

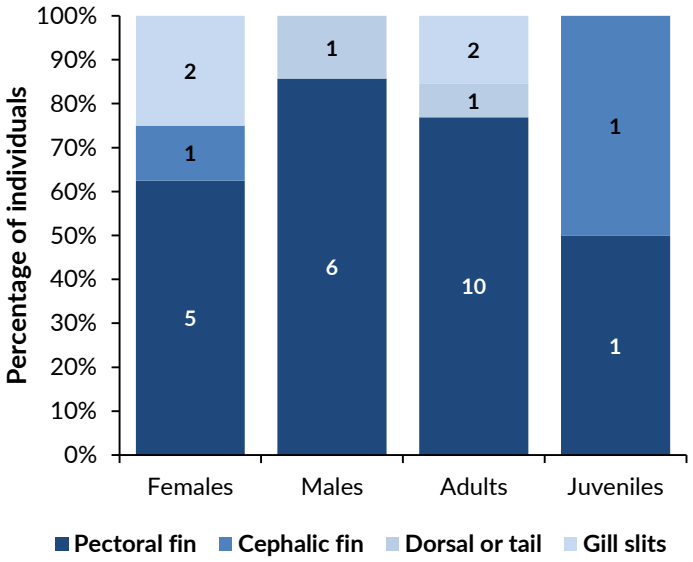

Figure 29: Demographic variations in the location of newly recorded sub-lethal injuries (*n*=15) within the reef manta ray (*Mobula alfredi*) population of North Malé Atoll (*n*=725) in 2018. Actual number of injuries on bars.

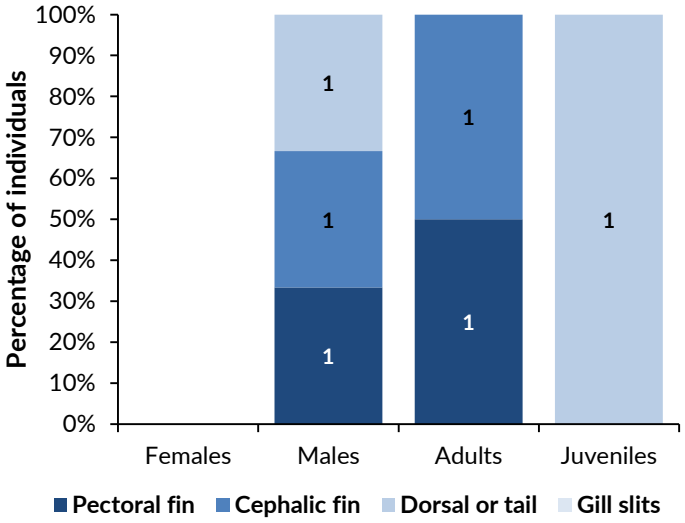

Figure 30: Demographic variations in the location of newly recorded sub-lethal injuries (*n*=3) within the reef manta ray (*Mobula alfredi*) population of South Malé Atoll (*n*=101) in 2018. Actual number of injuries on bars.

ENVIRONMENTAL VARIABLES

Environmental conditions, particularly wind and current strength, have a strong influence on the seasonal abundance of phytoplankton, and therefore zooplankton availability, which in turn is likely to influence manta abundance. Weather data for 2018 and previous years were sourced from the Maldives meteorological department, and have been analysed together with sighting records to determine whether any correlation exist between manta ray sightings and wind speed. In 2018, average annual wind speeds slightly decreased compared to the previous two years (*n*=15.5km/h). However, the average number of manta ray sightings per survey slightly increased (*n*=3.4) compared to 2017 (*n*=2.2) (Fig. 31).

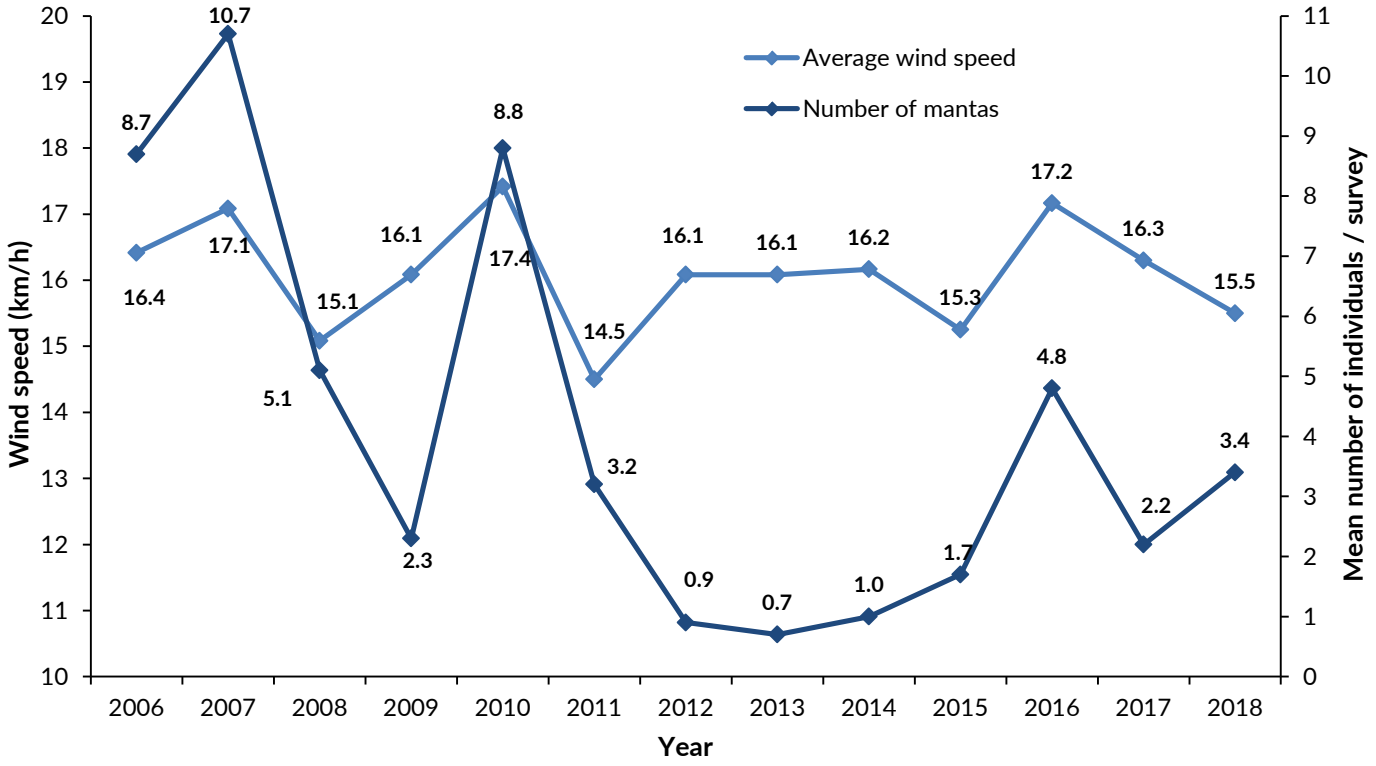

Figure 31: Annual mean wind speed (km/h), and the mean number of reef manta ray (*Mobula alfredi*) sightings per survey in North and South Malé Atolls.

Closer analysis of wind speed and manta ray activity throughout 2018 shows that similar to previous years, wind speeds dropped significantly during November (*n*=11km/h) (Fig. 32 & 33). However, the number of individual reef manta rays sighted per survey in 2018 did not increase during the second half of the Southwest Monsoon as seen in other years (Fig. 32), instead sightings during this time declined until December (Fig. 33). In 2018, the average number of reef manta rays sighted per survey were highest in January (*n*=15.2), which is higher than the average across all previous years 2006-2017 (*n*=4.9), and remained relatively high until decreasing in April (Fig. 33). The increased number of individuals seen per survey throughout the beginning months of 2018 may be explained by the increased average wind speed witnessed in December 2017 (*n*=18km/h) along with a spike in wind speed seen again in February 2018 (*n*=18km/h). In general, sightings of reef manta rays within the Maldives tend to increase one or two months after stronger than average wind speeds, which generate increased primary productivity, which in turn leads to increased localised zooplankton prey for the manta rays.

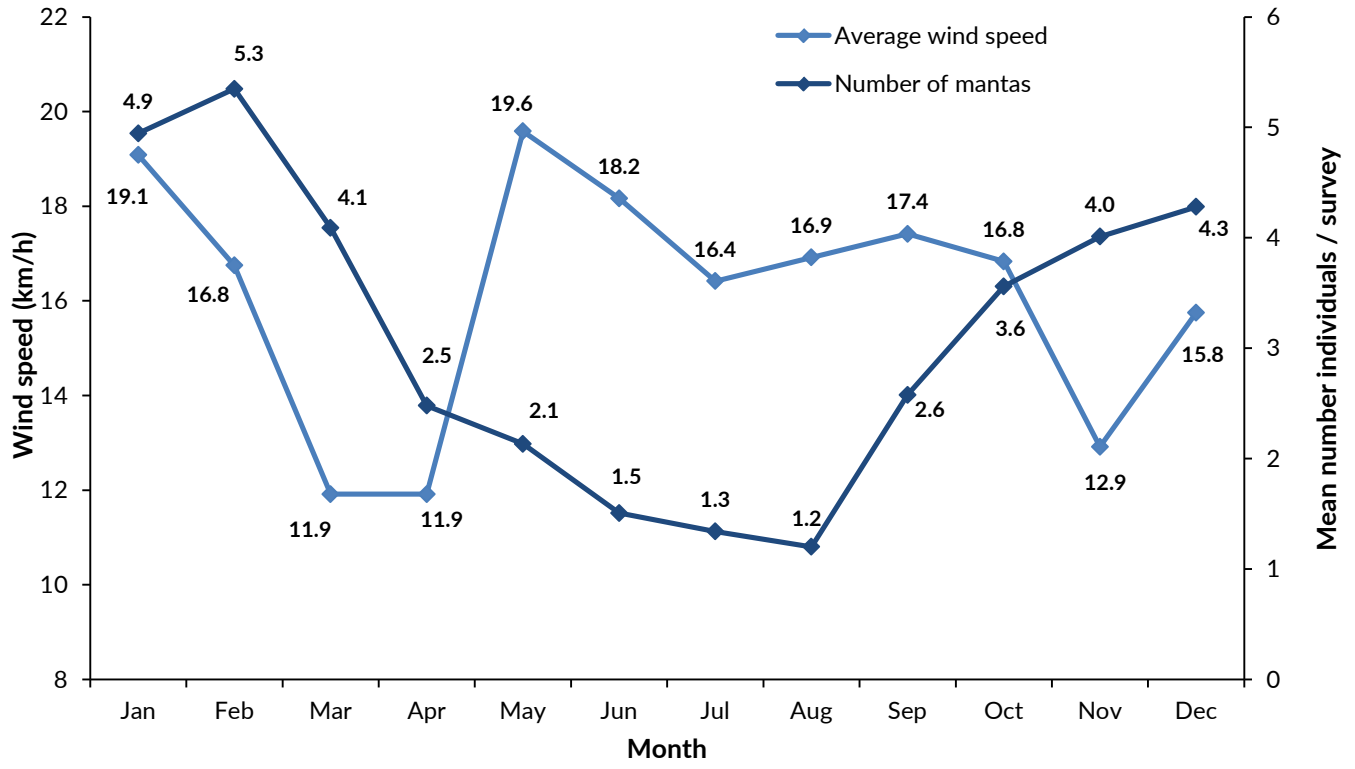

Figure 32: Monthly mean wind speed (km/h), and the mean number of reef manta ray (*Mobula alfredi*) sightings per survey in North and South Malé Atolls (2006-2017).

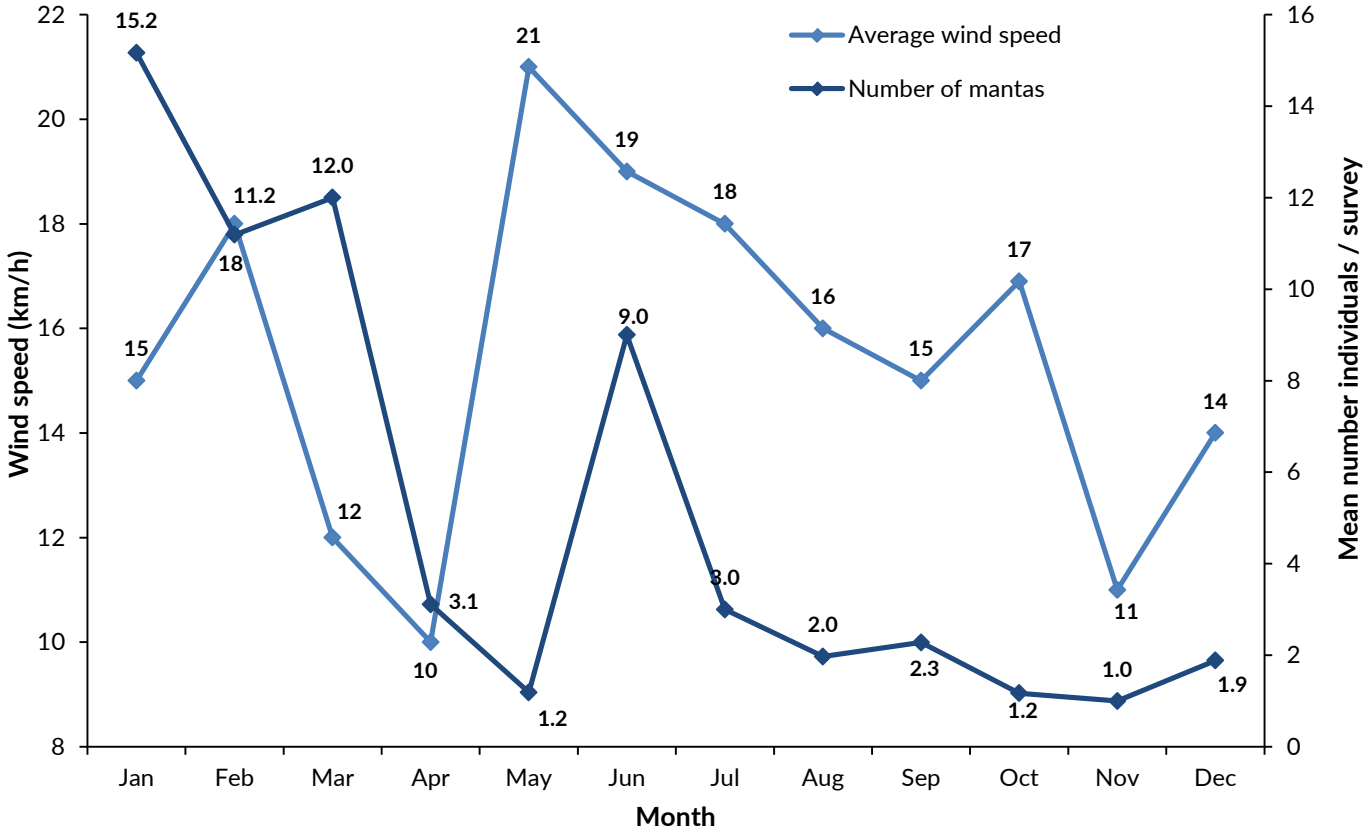

Figure 33: Monthly mean wind speed (km/h), and the mean number of reef manta ray (*Mobula alfredi*) sightings per survey in North and South Malé Atolls during 2018.

Tidal currents bring plankton-rich water in to, and out of, the atoll lagoons via channels along the outer rim of the atoll daily. Therefore, it is expected that tidal currents also influence the manta rays' movements and habitat use. In order to further determine any correlations between current direction and a given behaviour, survey data from 2018 included the variables current direction, current speed, and primary observed behaviour. Of the 300 surveys recorded in 2018, manta rays were present on 82% (*n*=247) of these occasions. On 47% of these surveys when manta rays were present (*n*=117), the current was outgoing, during which time the predominant behaviour observed was cleaning (*n*=91) (Fig. 34). In contrast, on the fewer occasions when feeding behaviour was recorded in 2018 (*n*=19), it was almost equally recorded during incoming and outgoing currents (Fig. 34).

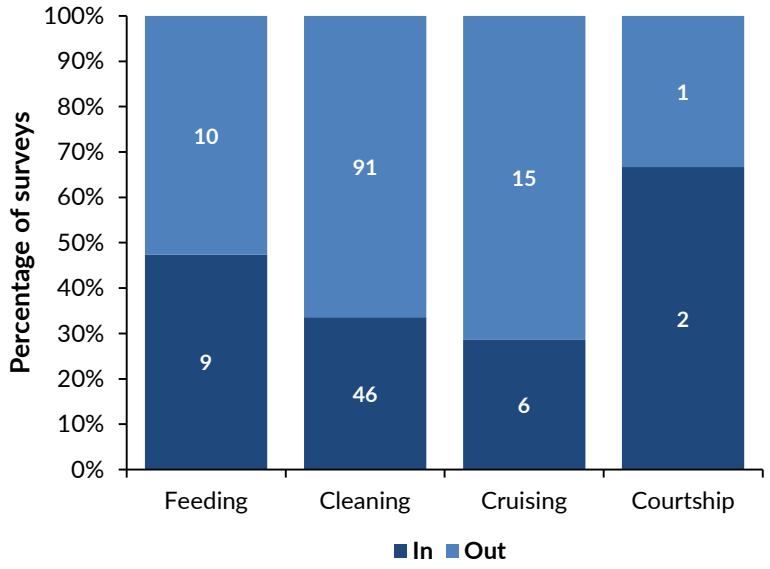

Figure 34: Changes in behavioural activity of reef manta rays (*Mobula alfredi*) in relation to current direction (In, Out) through the channels of North and South Malé Atolls during 2018 surveys (*n*=247).

Overall, the most common behaviour displayed by the reef manta ray population of the Malé Region was cleaning, constituting 77% (*n*=190) of all recorded surveys in 2018 during which manta rays were present (*n*=247). Indeed, of the 1,007 photo-ID sightings of reef manta rays recorded in 2018, 91% (*n*=912) were of individuals cleaning.

MANTA RAY TOURISM & MARINE PROTECTED AREAS

The Malé Region is one of the nation's most popular tourist destinations, with numerous visitors snorkelling and diving during their stay, hoping to see marine megafauna, such as manta rays. During surveys, the MMRP collected data on anthropogenic pressures. The average number of boats recorded per survey has steadily increased over the years, with a high of 2.8 in 2018 (Fig. 35). Similarly, the average number of snorkellers and/or divers per survey has increased since data collection began, with a big jump in numbers recorded between 2017 (*n*=10.9) and 2018 (*n*=16.3) (Fig. 36). The increasing tourist pressure noted at these key manta aggregation sites highlights the importance of these areas to the Maldivian economy, and emphasises the need for proper protection and tourism management. Manta tourism from guests based in local guesthouses, resorts, and on dive liveaboard boats, generates an estimated $15 million USD annually. However, if tourism pressure continues to increase, manta rays will be more heavily subjected to anthropogenic related injuries, such as boat strikes, and it is possible that they will be forced to abandon these disturbed aggregation areas.

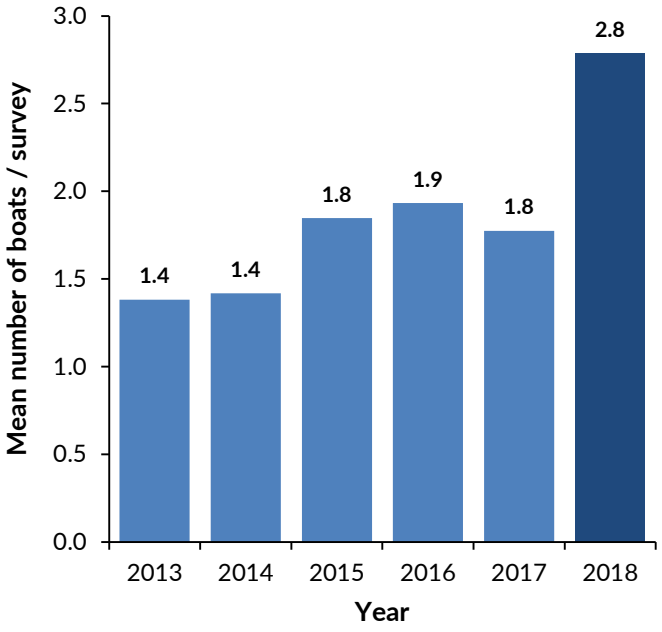

Figure 35: Mean number of tourism vessels per survey (*n*=1,695) in North and South Malé Atolls.

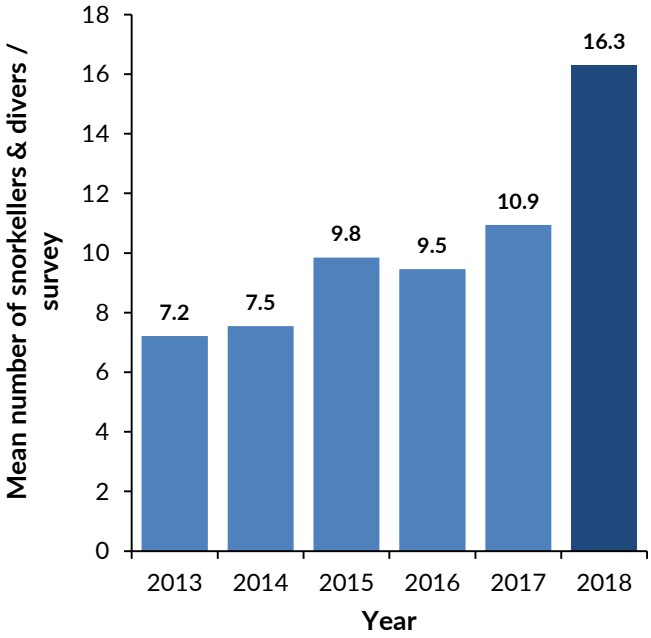

Figure 36: Mean number of snorkellers and divers per survey (*n*=1,695) in North and South Malé Atolls.

To date, the two most popular, and famous destinations for swimming with manta rays in NMA are Rasfari North; a designated Marine Protected Area (MPA), and, Lankan Beyru; which is not afforded protection in any way. During 2018, survey data on anthropogenic pressure was collected for the first time within Rasfari MPA (as well as Boduhithi Thila), allowing for some preliminary analysis (Fig. 37).

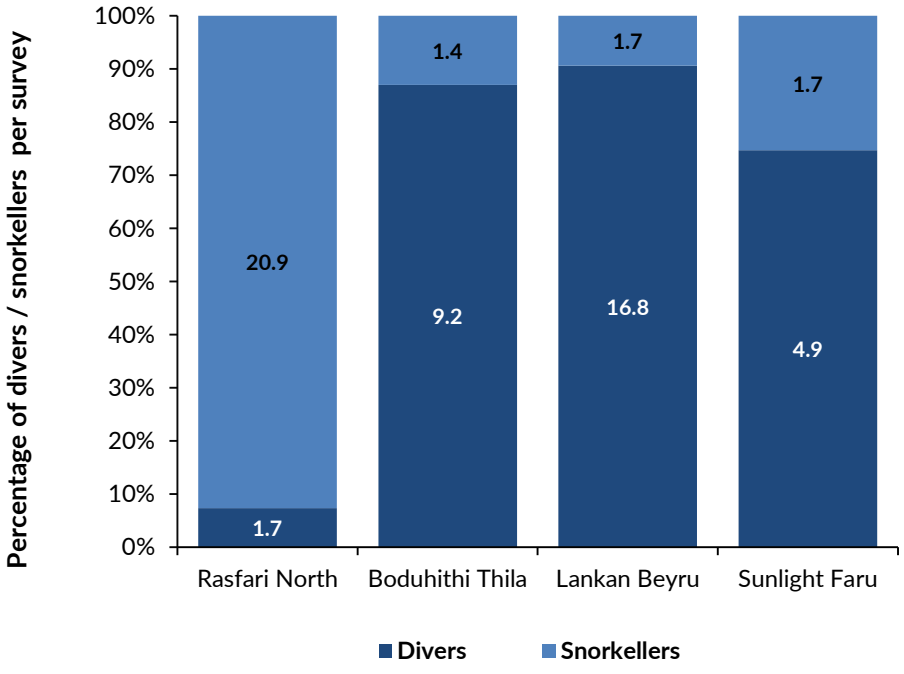

Figure 37: Variation in the mean number of snorkellers and SCUBA divers present per survey (*n*=207) at four key reef manta ray (*Mobula alfredi*) aggregation sites in North Malé Atoll during 2018. Actual numbers within bars.

The MPA of Rasfari is relatively large (25km²), encompassing both the uninhabited island of Rasfari, and all surrounding reef and lagoon areas. However, while protected on paper, there is no management plan for this site, which is an increasing concern. Especially at the northern area of this MPA, where adult manta rays aggregate to feed, clean and mate (at Rasfari North and Boduhithi Thila). Rasfari North is a shallow reef crest (2-5m), which allows for spectacular, up-close encounters with cleaning and courting manta rays for both snorkellers and SCUBA divers, attracting thousands of tourists to the area each year. In 2018, an average of 3.4 boats, 20.9 snorkellers, and 1.7 SCUBA divers were recorded per survey at Rasfari North (Fig. 37). The presence of SCUBA diving activity at this site is of particular concern, due to increased disturbance on top of the manta ray cleaning station by the divers. Rasfari MPA would benefit from being a snorkelling-only zone. Moreover, with no management plan in place to regulate tourism at this site, there are unsustainable levels of pressure on the aggregating rays. Jet skis, speedboats and sea scooters (Sea-bobs) regularly drive over the top of cleaning manta rays, and in some instances motorised vessels are used to "herd" manta rays back in the direction of guests. Tourists also touch and chase the rays on a regular basis. In addition, there is no effort to prevent fishing inside these areas, further threatening the rays as a result of bycatch entanglement.

Due to their close proximity to Malé, and reliability of sightings, Lankan Beyru (and Sunlight Thila) are also among the most visited (and most famous) manta ray aggregation sites in the world, yet some of the least protected. In 2018, an average of 3.4 boats, 1.7 snorkellers, and 16.8 SCUBA divers were recorded per survey at Lankan Beyru (Fig. 37). This high level of diving activity at this site is a major cause for concern because of the importance of this aggregation site to the reef manta ray population. With hundreds of divers visiting this site daily during the 'manta season', no regulations on the number of divers or boats, no site use regulations or enforcement thereof, and constant boat traffic above the cleaning station area, there are likely to be devastating implications for the long-term health of this population if these activities remain unmanaged.

In response to the growing interest in manta ray tourism, and the negative impacts that result from unregulated wildlife tourism, the Manta Trust published its first Best Practice Code of Conduct (CoC) in 2014, with an updated CoC released in late 2017. The Best Practice CoC is aimed at minimising tourism activities' impact on the natural behaviour of manta rays. The 2017 update included the launch and distribution of a 10-step guide for "How to Swim with Manta Rays", complemented by a snorkelling and SCUBA diving briefing video. Together, it is hoped these materials will deliver a pertinent message on sustainable tourism - how to get the most out of your experience with the manta rays while ensuring that interactions do not disturb or negatively impact the animals. The Manta Trust's CoC has been implemented by dozens of operators, both in the Malé Region and throughout the Maldives.

MANAGEMENT CHANGES & INITIATIVES

The Maldives' government have not designated any new MPAs within the Malé Region since 2006. To date, there are eight MPAs within NMA, and two within SMA. Reef manta rays have been sighted at five of these MPAs between the years 1987-2018: Thanburudhoo Thila, Nassimo Thila, and Rasfari in NMA, and at Embudu Falhu and Guraidhoo Kandu in SMA. Although the designation of these sites is important, they are currently only protected on paper. If manta rays are to continue to flourish in the Maldives, it is essential that effective management plans are created and implemented at all manta aggregation sites which are currently within MPAs. Furthermore, many new, and much larger, MPAs are required in the Maldives to protect other key manta aggregation sites. These MPAs are urgently required to help mitigate the rapidly increasing pressures of tourism development, reef fishing, the climate crisis, and habitat destruction. In addition, as tourist numbers continue to grow, the MMRP will continue to disseminate the Manta Trust's Best Practice Code of Conduct (CoC) to various operators in the Malé Region and throughout the Maldives, hopefully with the support of the Maldivian government, to minimise the impact of tourism activities on the natural behaviour of manta rays.

This report was made possible thanks to

EURO DIVERS MALDIVES AT MEERU ISLAND RESORT

As our primary supporter in North Malé Atoll, Euro Divers Maldives has been incredibly supportive of the Manta Trust and MMRP. We hope this partnership continues to prosper for years to come.

MALDIVES GOVERNMENT AUTHORITIES

The Manta Trust is grateful for the opportunities provided by the Ministry of Environment and Energy, the Ministry of Fisheries, Marine Resources and Agriculture, the Environmental Protection Agency, and the Marine Research Centre. All data was collected in accordance with the relevant permit requirements of the aforementioned governing bodies.

The Manta Trust would also like to extend a warm thank you to all the other resorts, guest houses, liveaboards, dive centres and watersports teams as well as the marine biologists and citizen scientists who have supported our research and submitted sightings.

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

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 opportunities that the Manta Trust's MMRP have in the Maldives are unparalleled. Working in an area that is home to the largest aggregation of reef manta rays in the world, our research continues to expand every year. We are humbled by the thought of being able to further pursue our research programmes alongside the Maldives government. 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.

This report was compiled on behalf of the MMRP and the Manta Trust by:

Jessica Haines - BSc (Hons)
Project Manager - North Malé Atoll

Tam Sawers - MSc (Hons)
MMRP Project Leader

Dr. Guy Stevens
Chief Executive & Co-Founder

This document was created by:

Simon Hilbourne - MSc (Hons)
Digital Media & Communications Manager

For further information, please email:

northmale@mantatrust.org **info@mantatrust.org**