

Maldivian manta ray populations: perceptions of local dive communities and implications for conservation



Nicola Bassett
Y3703869

UNIVERSITY *of York*

Environment Department
MSc Marine Environmental Management
Summer Placement Dissertation



Abstract

Manta rays (*Manta alfredi*) have become a major attraction for divers and snorkelers worldwide, however increasing demand for their gill rakers in Asian markets has led to unsustainable fishing pressure and reports of population decline. The Maldives, unlike many other Asian countries, does not have a targeted manta ray fishery and has been the focus of a decade-long study by the Maldivian Manta Ray Project (MMRP). Recent studies indicated considerable fluctuations in regional manta ray abundance, however longer-term observations are required to interpret these apparent variations more fully. Data on manta ray populations prior to 2005 are limited, however the current study extends the use of historical observations, as demonstrated by Sawers (2014), through interviews with experienced divers, to assess how manta ray distribution and abundance may have changed over time. Divers were useful indicators of manta ray distribution, and their responses suggested that 'hotspots' of manta activity had not changed radically over recent years. However, many 'new' sites have emerged, most likely because of an expanding tourism industry and exploration for novel areas. At regularly visited sites, the majority of divers (58%) perceived a decrease in manta rays since the start of their careers, and particularly since 2010. Divers also highlighted specific sites where declines may be more acute, such as Dhonkalo Thila and Lankan Beyru, where it was suggested anthropogenic factors could be responsible. Investigation of diver knowledge and perception of marine conservation in the Maldives exposed considerable dissatisfaction with current management of Marine Protected Areas (MPAs) and criticism of the lack of communication and collaboration between the diving industry and marine biologists. Nevertheless, there was general support for more conservation management initiatives, although this study emphasised the importance of improved stakeholder engagement for successful implementation.

Introduction

Manta rays are large planktivorous elasmobranchs in the family *Mobulidae*, which constitutes 11 species: two within the genus *Manta*, and nine within the genus *Mobula* (Couturier et al. 2011). Until recently, the former has been considered a monospecific genus, with *Manta birostris* having a worldwide distribution, however since 2009, taxonomic revisions have differentiated *M. birostris* (the oceanic manta) from *M. alfredi* (the reef manta) (Marshall et al. 2009). Both species have a circumglobal distribution and are found in tropical, subtropical and temperate waters (Marshall et al. 2009); *M. alfredi* is more commonly sighted around coral reefs and along coastlines, whereas *M. birostris* is considered to be a more oceanic species (Couturier et al. 2011). A third species, *M. cf birostris*, is believed to occur in the Caribbean Sea and Atlantic Ocean, however further taxonomic evidence is required to distinguish this putative species from the two currently-recognised species (Marshall et al. 2009). This relatively late reappraisal of the genus *Manta* has resulted in confusion regarding much of the biological information of *M. alfredi* and *M. birostris*. In particular, many of the population dynamics, ecological and behavioural attributes of *M. alfredi* are uncertain or unknown (Couturier et al. 2011).

Due to their planktivorous diet, manta rays form predictable aggregations and have distribution patterns associated with seasonal food availability (Anderson et al. 2011a; Couturier et al. 2012,). This phenomenon is particularly acute in the waters surrounding the Maldivian archipelago. The Republic of Maldives, located in the northern Indian Ocean, comprises 26 geographically distinct atolls with approximately 1,190 coral reef islands (McClanahan & Muthiga 2014). The Maldives rarely experience extreme weather conditions, however the biannual monsoons strongly influence the region's climate and surrounding waters (Anderson et al. 2011a). The northeast monsoon runs from around December to

March when the current flows are predominantly westward, whereas the southwest monsoon (May to October) typically drives the currents eastward (Anderson et al. 2011a). As these seasonally reversing currents pass over the Maldives ridge, which acts as a barrier to oceanic currents, upwelling causes nutrient-rich waters to become mixed into the upper euphotic zone (Anderson et al. 2011a). This promotes productivity blooms of phytoplankton on the leeward side of atolls, supporting a high zooplankton biomass (Anderson et al. 2011a), which in turn sustains one of the largest single populations of reef manta rays in the world (Stevens and Brooks 2011) making seasonal migrations throughout the archipelago (Anderson et al. 2011a).

Manta ray aggregations have also been characterised by visits to cleaning stations which, together with their predictable feeding behaviour and lack of human avoidance have made them a relatively easy target species for fisheries in certain parts of the world (Couturier et al. 2012; O'Malley et al. 2013). However, rather than demand for their meat, it is the branchial filaments which have become a highly sort-after ingredient in the Asian market (Couturier et al. 2012; O'Malley et al. 2013); a report by the FAO estimated mobulid catches to have increased from 900 to 3,300 tonnes between 2000-2007 (Lack and Sant 2009). Manta ray life-history characteristics, such as late maturity, low fecundity and slow growth, further intensify their vulnerability to fishing-pressure (Couturier et al. 2012) and populations can be easily overfished (Anderson et al. 2011b). These characteristics also reduce the ability of populations to recover once depleted and so manta rays are considered unsustainable as a fisheries resource (Couturier et al. 2012; O'Malley et al. 2013). The Maldives, unlike other countries in Asia, do not have a targeted fishery for these animals. However in 2014, the Maldivian Government demonstrated foresight in recognising the risk that a manta ray fishery could develop and therefore made it illegal to harm, capture or export any ray species (Murray 2014; BABR 2014). In making this decision, the Government acknowledged the

economic importance of live manta rays, especially to the country's tourism industry, where they are estimated to generate over US\$8.1 million annually (Anderson et al. 2011b). The tourism industry in the Maldives has grown dramatically since 1972, with over 1.1 million tourist arrivals in 2013 to the 109 resorts and local guesthouses throughout the country (NBS 2014). Coral reefs and charismatic megafauna make the Maldives an attractive place for diving and snorkelling, with these activities being the primary purpose of visits for 17% of international tourists in 2014 (Ministry of Tourism 2015). Manta rays are now a major tourist attraction and the experience of diving and snorkelling with them has become a highly sought-after activity in many countries (Anderson et al. 2011b; O'Malley et al. 2013). In particular, tourists in the Maldives are willing to pay more for manta excursions than those offering sharks or turtles (O'Malley et al. 2013), and many people visit the country with an expectation of seeing these animals (Anderson et al. 2011b). Manta rays often feature in the marketing strategies and advertisements of tour operators, many of which have recognised the importance of offering well-informed manta excursions, enlisting the help of marine biologists and facilitating research into manta ray biology and ecology (Anderson et al. 2011b).

The Maldivian Manta Ray Project (MMRP) is a research and conservation programme, which has been conducting research on the resident population of reef manta rays in the Maldives since 2005 (Manta Trust 2015a). Using photographic and video monitoring techniques, the project has made over 30,000 sightings and identified over 3,700 individual reef manta rays (MMRP 2015). These data have improved the knowledge on manta ray abundance and behaviour and provided further insight into regional population dynamics and aggregation sites (Manta Trust 2015a). Alongside data collection, the MMRP works closely with tourists, local communities and surrounding resorts to educate and engage them in manta ray research and conservation (Manta Trust 2015a). It has been instrumental in decisions to designate

Marine Protected Area (MPA) status to a unique manta aggregation site (Hanifaru Bay) and research continues to support management plans for the surrounding area (MMRP 2015).

Recent reports from the MMRP have indicated regional fluctuations in manta ray populations (Stevens and Brooks 2011; Stevens et al. 2012). The lowest number of sightings was recorded in 2011 throughout the Baa Atoll study region; significantly fewer sightings were made at the key monitoring site at Hanifaru Bay in particular (Stevens and Brooks 2011). This was attributed to the unseasonable weather patterns observed throughout that year. Wind strength in 2011 was significantly lower than in previous years; a pattern that was repeated across many other Indian Ocean nations (Stevens and Brooks 2011). Without the strong winds, it was suggested that the monsoonal currents were unable to initiate the productivity bloom upon which the zooplankton, and ultimately the manta rays, rely (Stevens and Brooks 2011).

However, to understand these local fluctuations in manta ray populations fully and to establish whether they are a recent phenomenon or part of a continuing cycle, long-term observations of manta ray abundance and distribution are needed. Prior to a study conducted by Sawers (2014), there were few data on manta ray abundance and distribution pre-2005. Sawers (2014) captured the traditional knowledge of local fishers on regional changes in the abundance of charismatic species such as manta rays and whale sharks. The results highlighted the potential of traditional knowledge in identifying 'hotspots' and regional changes to local marine life, and supported a growing acceptance that traditional knowledge is an important factor when implementing conservation and management strategies (Drew 2005; Rosa et al. 2005; Gandiwa 2012).

The current study extends use of historical observations through interviews with divers and marine biologists who have been diving in the Maldives for at least ten years to assess how manta ray distribution and abundance may have changed over time. In addition, it seeks to examine the extent of the dive community's perceptions and knowledge of marine conservation in the Maldives. The study also aims to compare the dive community's perception of changes in the abundance of other charismatic marine species with that of the local fishers reported in earlier research (Sawers 2014).

Methods

Between July and August 2015, semi-structured interviews were conducted with divers and marine biologists operating in the Maldives. Selection of interview candidates was deliberately non-random and only those with at least ten years of diving or working experience in the Maldives were approached. Colleagues at the Manta Trust generated a database of suitable candidates, all of whom were emailed, informing them about the project and asking for their assistance. Additional contacts were acquired by asking interviewees to recommend further divers or marine biologists who fitted the criteria. Where possible, interviews were conducted face-to-face but, due to the distance and inaccessibility of some of the islands, interviews were mainly conducted by telephone or through the Internet voice-call platform Skype. On the rare occasion that an interview could not be arranged with a candidate, the questionnaire was emailed to them, to answer and return at their convenience.

Interview design

The interviews were designed to last between 30 and 45 minutes and were a mixture of 'open' and 'closed' questions, some of which invited interviewees to give reasons for their answers to gauge their opinion and knowledge of certain topics (Appendix 1). Eight questions, highlighted in Table 1, were similar to those posed by Sawers (2014), so comparisons could be made between the responses from the different communities.

The interview comprised four sections: a) interviewee experience and background information, b) historical and current manta ray sightings, c) change in abundance of other

marine animals and d) perception and knowledge of marine conservation efforts in the Maldives.

A map with highlighted sites (Appendix 2) was emailed to the interviewees prior to the interview, and was used to avoid misunderstandings over the location of sites. To eliminate bias, it was stressed that the respondents' answers need not be limited to those sites highlighted.

Data analysis

Microsoft Excel was used for data recording and for descriptive statistics.

Table 1. Questions posed by Sawers (2014) and their counterparts in the current study.

Questions from Sawers (2014)	Questions in the current study
<p><i>“What time of the year are manta rays most commonly observed?”</i></p>	<p><i>“Which months of the year are manta rays most commonly seen in the Maldives in general?”</i></p>
<p><i>“Do you think the number of whale sharks has changed since you first began fishing?” (Yes/No)</i> <i>- “If yes are they more or less common today than they were then?”</i></p> <p><i>“Can you think of any animals that are more common today than they were when you started fishing”</i></p>	<p><i>“Please specify whether or not you have seen a change (increase, decrease, no change) in the numbers of:</i></p> <p><i>Whale sharks</i> <i>Reef sharks</i> <i>Sea turtles</i> <i>Groupers</i> <i>Baitfish</i> <i>Tuna</i> <i>Dolphins</i> <i>Other.</i></p>
<p>[Referring to Hanifaru Bay MPA] <i>“Do you know why the MPA was established?” (Yes/No)</i> <i>- “If yes, what was the reasoning behind designating the Hanifaru Bay MPA?”</i></p> <p><i>“How did the establishment of the MPA affect you?”</i></p> <p><i>“Do you think the establishment of the Biosphere Reserve has been beneficial?” (Yes/No)</i></p> <p><i>“Is the Biosphere Reserve well-managed?”</i></p>	<p><i>“Do you know why the MPA was established in Hanifaru Bay?” (Y/N)</i> <i>- “If yes, what was the reasoning behind the designation?”</i></p> <p><i>“Did the establishment of the Hanifaru Bay MPA affect you?” (Y/N)</i> <i>- How?</i></p> <p><i>“Do you think the establishment of the Hanifaru Bay MPA has been beneficial?” (Y/N)</i> <i>- Why?</i></p> <p><i>“In your opinion, is the Hanifaru MPA well managed?” (Y/N)</i> <i>- Why?</i></p>
<p><i>“How do you feel about the work of scientists and conservationists in the Maldives?”</i></p> <p><i>“In general, how do fishermen feel about manta rays?” i.e. are they seen as a: menace/feared/respected/respected?</i></p>	<p><i>“How do you feel about the work of scientists and conservationists in the Maldives?”</i></p> <p><i>“In general, how do you think the diving industry in the Maldives perceives manta rays?”</i></p>

Results

Interviews with 61 divers and marine biologists were conducted during July and August 2015. Those interviewed had an average of 18 years experience working in the Maldives, with a maximum of 36 years and a minimum of 7 years. The majority of respondents (79%) dived everyday although 15% claimed their diving time had reduced over recent years. Almost half of respondents (n=28) had experience of work both on liveaboards and at resorts; 18 had worked solely at resorts or local islands, and the remaining 15 worked solely on liveaboards.

Manta rays

Manta ray sightings and seasonal patterns

Respondents' views on the principal months for viewing manta rays differed from those reported by Sawers (2014), where the majority of local fishers highlighted June and July when mantas were most likely to be seen. Fewer than half of respondents in the current study (n=26) quoted specific months when they saw manta rays most often; there was no apparent increased likelihood of viewing manta rays in any particular month (fig. 1). The remaining 35 respondents did not specify particular months, suggesting that manta rays can be seen all-year-round in this region. The majority of respondents (72%) also reported that the season when they see manta rays had not changed during their career, some stating that, 'mantas follow the monsoon which influences the currents and plankton densities at certain sites'.

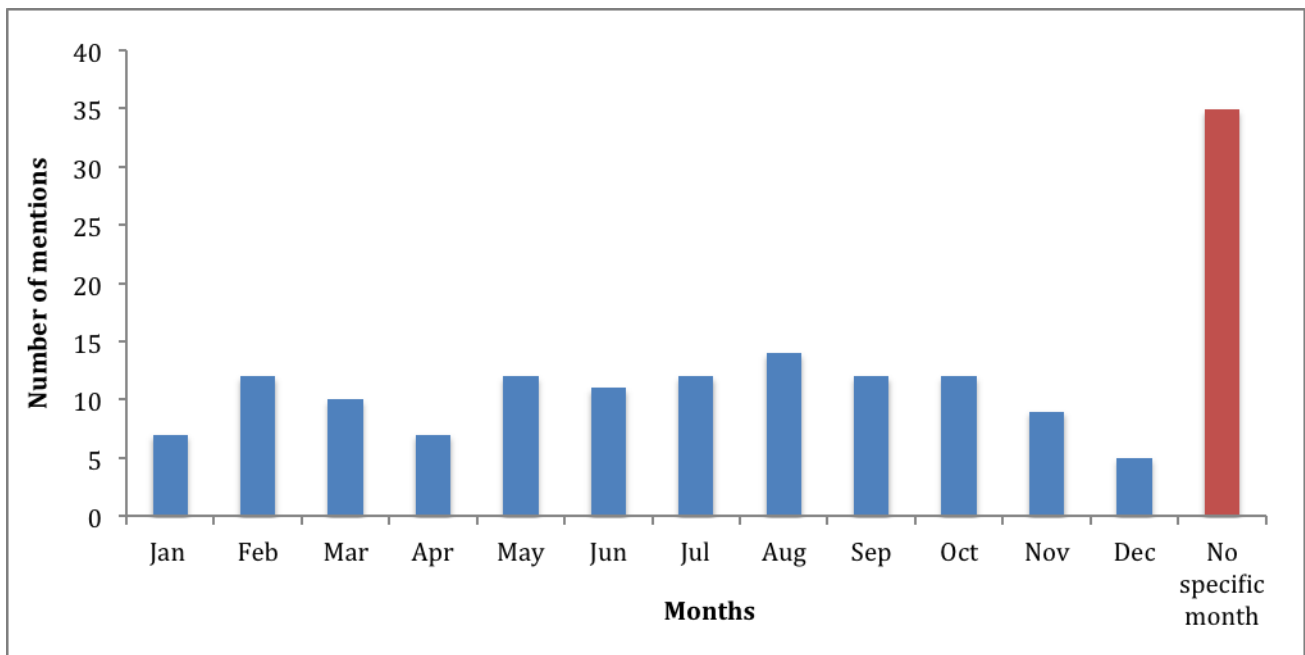


Figure 1. The principle months cited for viewing manta rays

Manta ray hotspots

Respondents were asked to specify the three manta sites they visited most often, a) prior to 2005, and b) over the last five years. From a total of 55 sites mentioned prior to 2005, five emerged as the most popular (Table 2; fig. 2). 31 sites were mentioned only once, however nearly half of respondents referred to Lankan Beyru in North Malé Atoll (n=26). When asked about the manta sites they visit most often now (i.e. during the last five years) similar sites emerged as the most popular (Table 3; fig. 3), however the total number of sites mentioned by all respondents (70) was greater than those prior to 2015; 36 sites were 'new', i.e. not mentioned in the earlier timeframe. Lankan Beyru was again the most popular site visited over the last five years, listed by 18 respondents; a slight decrease from 26 prior to 2005. The area of Moofushi emerged as a popular site in the last five years, replacing Dhonkalo Thila whose popularity decreased five-fold.

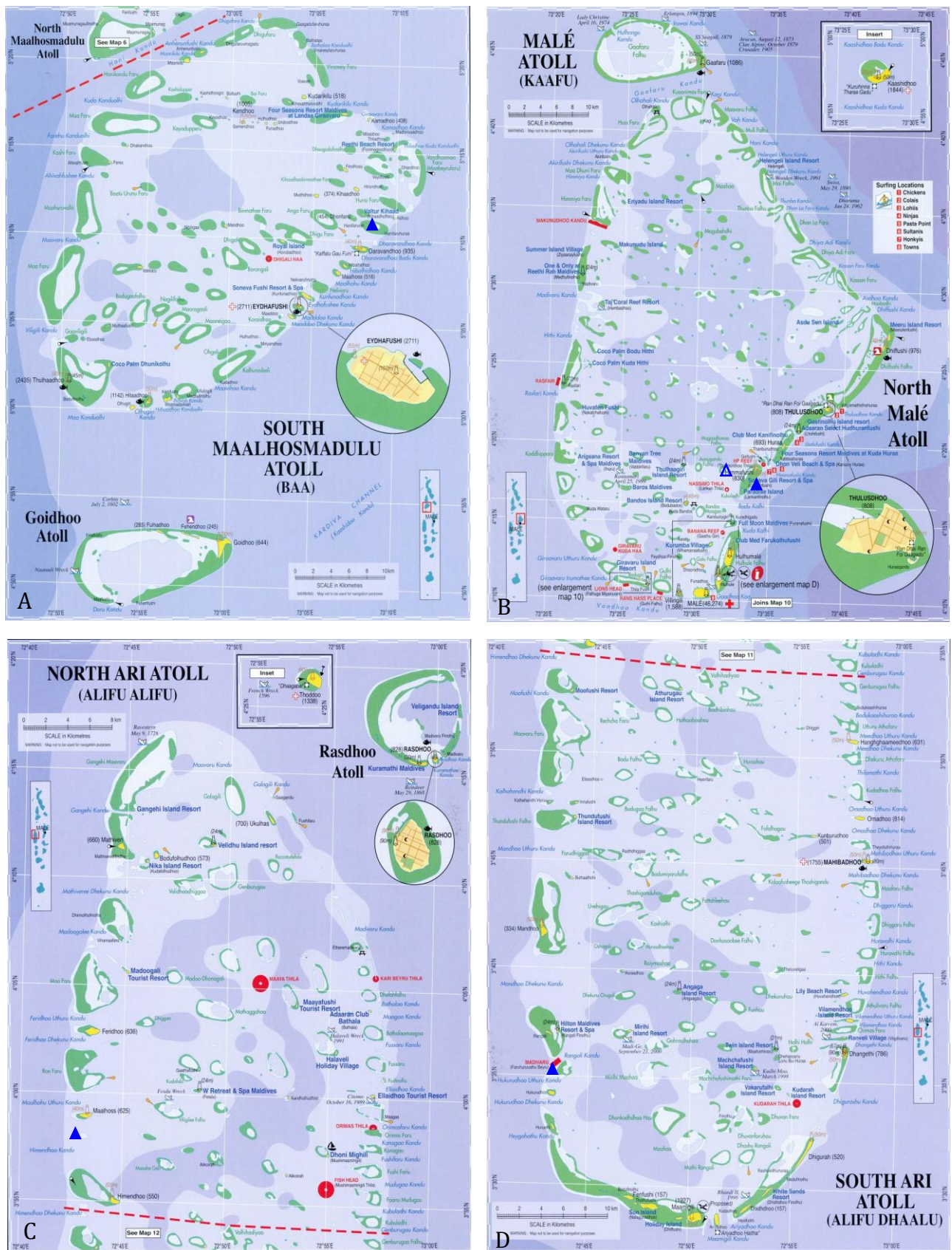


Figure 2. Location of the five most popular manta sites visited by respondents prior to 2005. Each site is highlighted by a triangle: Hanifaru Bay (Baa Atoll, Map A), Lankan Beyru (North Malé Atoll, Map B, filled triangle), Sunlight Faru (North Malé Atoll, Map B, unfilled triangle), Dhonkalo Thila (North Ari Atoll, Map C), Rangali Madivaru (South Ari Atoll, Map D)

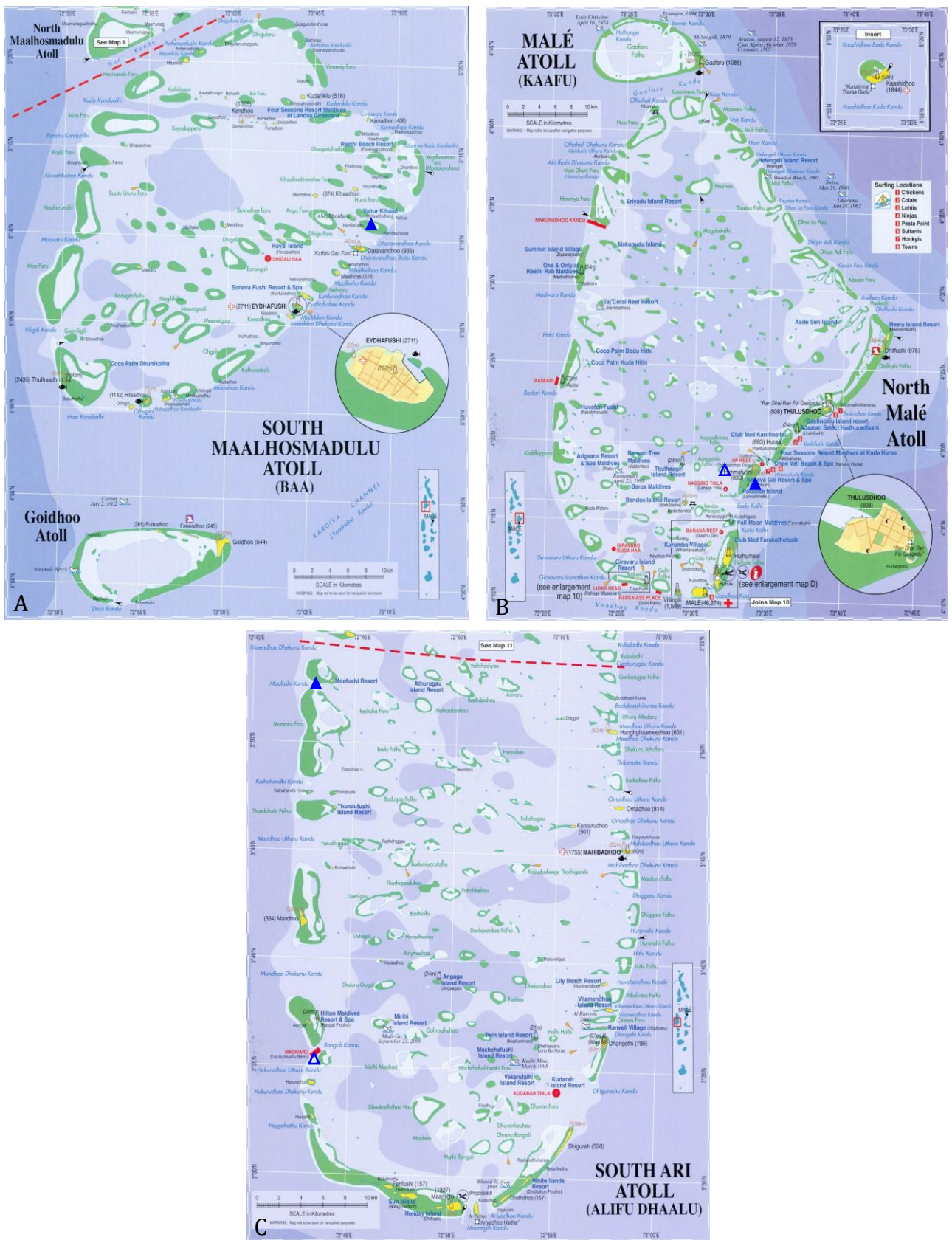


Figure 3. Location of the five most popular manta sites visited by respondents during the last five years. Each site is highlighted by a triangle: Hanifaru Bay (Baa Atoll, Map A), Lankan Beyru (North Malé Atoll, Map B, filled triangle), Sunlight Faru (North Malé Atoll, Map B, unfilled triangle), Moofushi (South Ari Atoll, Map C, filled triangle), Rangali Madivaru (South Ari Atoll, Map C, unfilled triangle).

Table 2. The five most commonly visited sites prior to 2005

Site	No. of respondents who mentioned visiting each site
Lankan Beyru	26
Dhonkalo Thila	17
Rangali Madivaru	17
Sunlight Faru	11
Hanifaru Bay	10

Table 3. The five most commonly visited sites during the last five years

Site	No. of respondents who mentioned visiting each site
Lankan Beyru	18
Dhonkalo Thila	14
Rangali Madivaru	13
Moofushi	12
Hanifaru Bay	10

The largest aggregations of manta rays were witnessed by respondents at cleaning stations in Lankan Beyru and Dhonkalo Thila and at the feeding station Hanifaru Bay (33%, 26% and 53% respectively), particularly during 2007 (figs. 4 and 5).

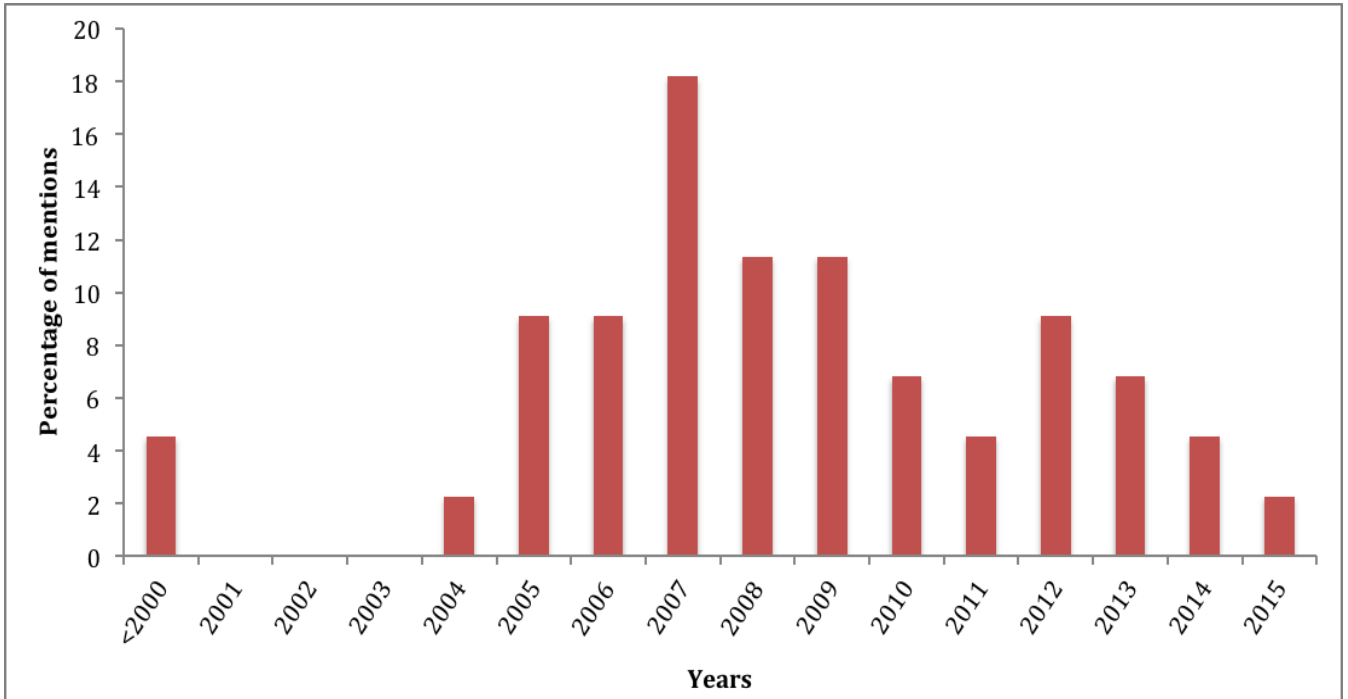


Figure 4. Years when the largest aggregations of manta rays were seen at feeding stations (n=44).

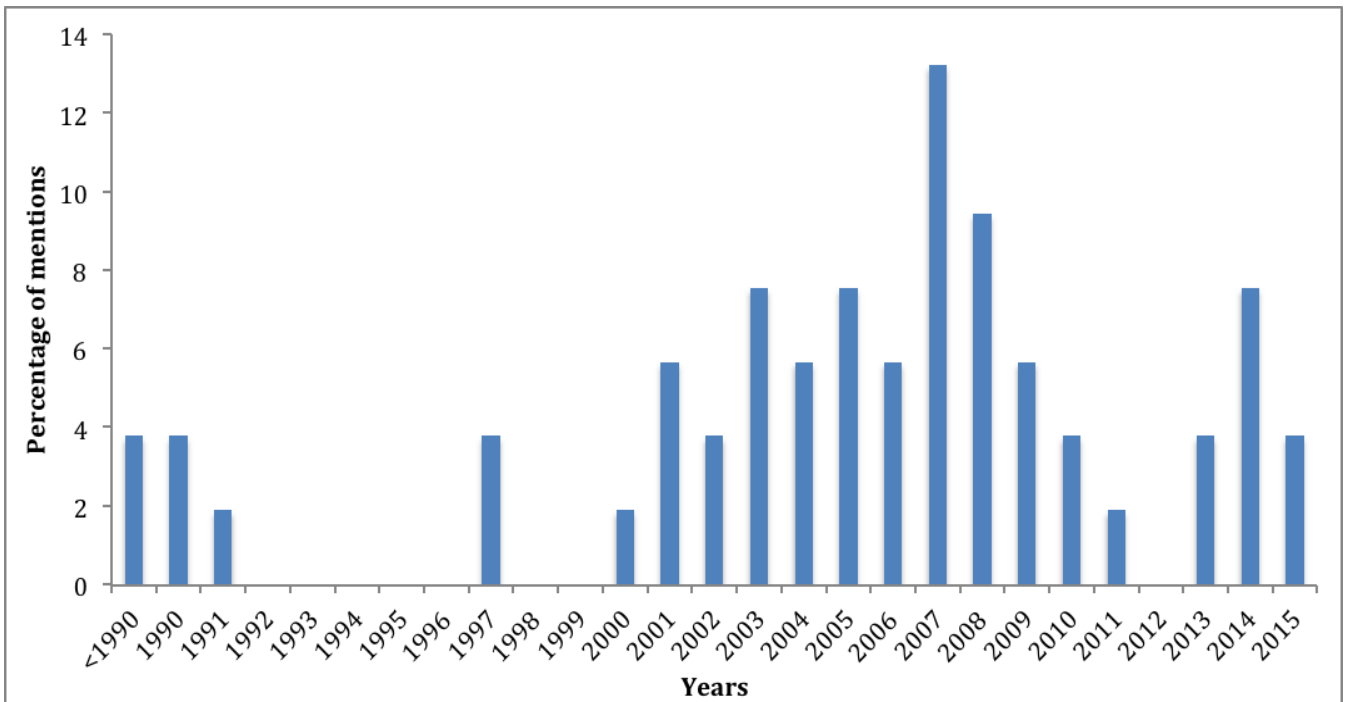


Figure 5. Years when the largest aggregations of manta rays were seen at cleaning stations (n=53).

Changes in manta ray abundance

Over half of respondents (57%) suggested that manta rays were less common at one or more of the three sites they visited most often during the last five years (fig. 6). More specifically, at Lankan Beyru, Rangali Madivaru, Sunlight Faru and Hanifaru Bay, respondents perceived manta rays to be less common than at earlier visits (fig. 7). However, the dive community had very different views on the abundance of manta rays at Moofushi and responses were evenly split between less common, more common and no change (fig. 7). 66% of respondents reported such a decrease in manta rays that they very rarely, or no longer, see them at some sites, most notably Dhonkalo Thila and Lankan Beyru (25% and 15% of respondents respectively). The majority of respondents (19%) identified 2010 as the year when they first noticed an apparent decrease in manta rays; half of those who specified Dhonkalo Thila also cited 2010. In contrast, 16 respondents (the majority with current or past experience of liveaboard work) noted manta rays visiting 15 new sites, notably Moofushi.

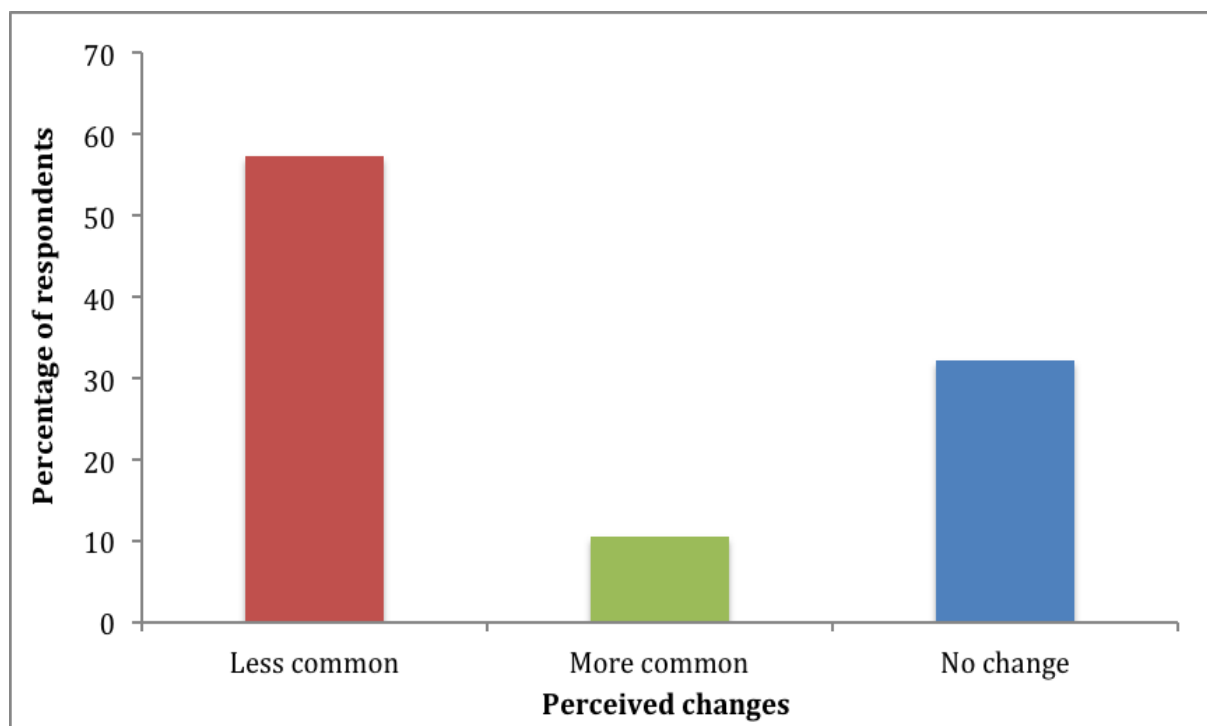


Figure 6. Perceived changes in the abundance of manta rays at sites most commonly visited during the last five years (n=171)

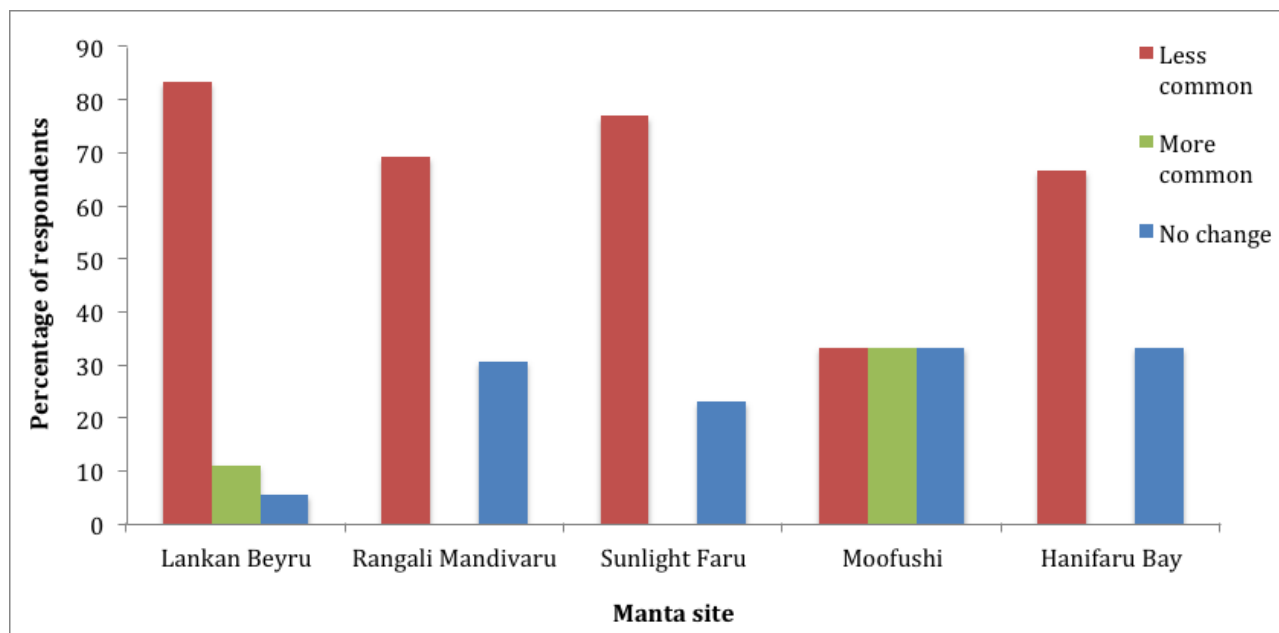


Figure 7. Perceived changes in the abundance of manta rays at the five most commonly mentioned sites respondents visited over the last five years.

Abundance of other marine species

The majority of respondents in the current study (60%) reported a change in whale shark abundance; similar to that of the local fishing community respondents in the earlier study (58%) (Sawers 2014). However all of the fishers who reported a change in the numbers of whale sharks referred to population decline, whereas only 33% of respondents from the diving community agreed; the remaining 27% of divers reporting a change, perceived an increase in abundance. The majority of divers attributed this increase to running tourist or scientifically based excursions focused on whale sharks or to a transfer of workplace to South Ari Atoll where the majority of whale sharks can be found. The remaining respondents in the current study (37%) thought the numbers of whale sharks had not changed.

The perceived changes in abundance of reef shark, baitfish and tuna were broadly similar between the two communities (fig. 8). The majority of fishers and divers (77% and 65% respectively) considered reef sharks to have increased and attributed this to the recent ban on shark fishing and exportation of shark products in 2010; commenting, “there had been a notable increase [in the numbers of sharks] especially over the last two years”. Decreases in the abundance of tuna and baitfish were also recognised by both communities (fig. 8) although 47% of divers saw no change in the numbers of baitfish and a number of respondents commented they are, “extremely seasonal” and “their numbers have been fluctuating for years”. Nearly half of respondents in the current study noticed a decrease in the number of groupers reporting that they, “do not see any large ones anymore” and “the sizes are definitely getting smaller”.

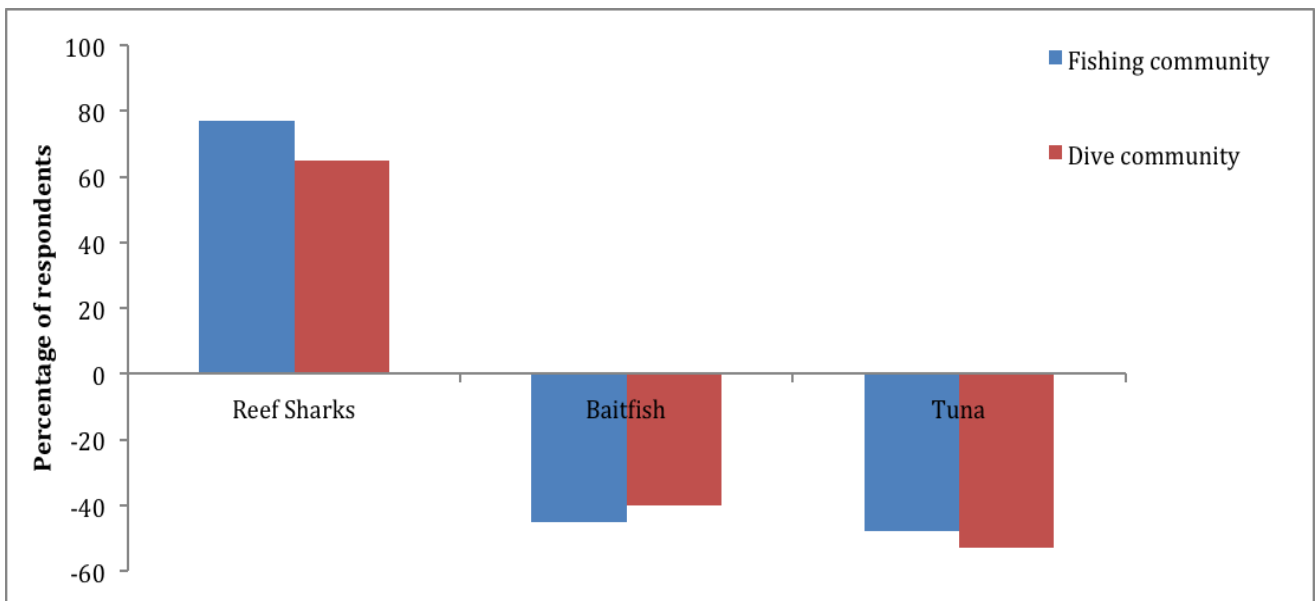


Figure 8. A comparison of perceptions in fishing and dive communities regarding changes in abundance of marine species. The data points below zero indicate the percentage of respondents who perceived a decrease in abundance of marine species. Fishers n=62; dive community n=61.

Perception and knowledge of marine conservation in the Maldives

Most respondents (89%) thought scientists and marine conservationists in the Maldives, “do a good job” and their work is important, although several thought scientists, “can cause problems and can be unnecessary”. Despite this, the majority of respondents (70%) were currently involved, and 10% said they had been involved in the past, with at least one conservation programme. These ranged from PADI’s Project Aware programme, to assisting coral restoration projects and taking identification photos for the Manta Trust or the Maldives Whale Shark Research Programme.

Respondents were also asked, “*Are you satisfied with the level of communication and collaboration between the scientists/conservationists and the tourism industry?*”. Over half replied they were not (56%); some stressed that, “scientists don’t share any information”, “there is no coordination of efforts” highlighting, “there is definitely a wall between stakeholders and the scientists”. When asked how this could be improved, social media was emphasised as a platform through which more information could be shared. The need for “more collaboration between scientists and dive guides” was also highlighted, as was the desire for scientists and conservationists to give more presentations to guests, both on resorts and liveaboards.

Hanifaru Bay

All respondents had heard of the Hanifaru Bay Marine Protected Area (MPA), while 95% had heard of the UNESCO World Biosphere Reserve covering the entirety of Baa Atoll. Regarding Hanifaru Bay, almost all respondents (97%) knew why the area was established as a MPA, the majority citing, “protection of mantas and whale sharks that aggregate there” as the reason for designation. Thirteen respondents recognised the human impact on the area, commenting that protection was put in place, “to decrease the human pressure on the area”, and, “for the safety of people in the water”.

Over half of respondents (59%) stated the establishment of the MPA had not affected them; mainly citing it is “too far away for it to affect us”. Those respondents who had been affected (38%) gave varied reasons stating, “there are now more fees for guests and [tour] operators” and, “you now have to buy permits and pay to enter even if you don’t see mantas”. Two respondents also highlighted that, “liveboards can only [visit] on certain days” ultimately, “restricting the routes [we can take]”. The majority of respondents who had been affected either currently worked on a liveboard or had some liveboard experience (n=18).

However, the majority of respondents (85%) believed the establishment of the MPA had been beneficial stating, “it regulates the numbers of people swimming with the mantas, allowing the mantas more space and less abuse” and had also, “increased the education and awareness of mantas”, although comments were made suggesting, “the [management] regulations need to be tightened”. Nearly a quarter of respondents (23%) thought the MPA was well managed and acknowledged the presence of the Rangers who, “are there to collect the money and enforce the rules” and the management of liveboards and resorts that, “have their specific days on which they can enter the Bay”. 46% declared they did not know if the MPA was well managed, while 17 respondents were too far away from Hanifaru Bay or had never visited so

did not know. 8% of respondents responded negatively, while 23% gave variable answers, reasoning, “the management level was ok” or, “[Hanifaru Bay] is well managed now, but not when it was first established” and also that Hanifaru Bay is “well managed in concept but not in practice”.

Manta ray conservation

Respondents were asked, “*How do you think the diving industry in the Maldives perceives manta rays?*”, and almost all of the responses (n=59) regarded manta rays as, “useful for tourism purposes”; one respondent going so far as to say, “[the diving industry] overlay the manta with the dollar sign”. There were however, references to the intrinsic value of manta rays, with responses such as, “manta rays are adored, people love seeing them” and, “manta rays are respected”. It was therefore unsurprising that 82% of respondents knew that manta rays were a legally-protected species in the Maldives and 93% thought they should be legally protected. However, there were references (n=4) to the fact that there isn’t an established manta fishery in the Maldives, “so why are they protected”, although nine respondents praised the Government’s foresight commenting that, “the protection is good in case a dedicated manta fishery does open up here in the Maldives”.

Only two respondents were unaware of rules or regulations regarding diving or snorkelling with manta rays. The remaining 59 did know of such rules or regulations with eight in particular being highlighted, the most common (n=35) being, “don’t touch the manta rays”. Eight respondents recognised one, “shouldn’t get too close to the manta rays”, whereas another 19 specifically mentioned proximity to cleaning stations, stating one “shouldn’t go on top of, or too close to a manta cleaning station”. 22 respondents commented that the rules or

guidelines they were aware of were, “the guidelines issued by the Manta Trust” or, “the rules my resort issues”. Respondents were therefore asked, “*Do you think there should be Government regulations in place, such as a code of conduct to control interactions with manta rays*”, to which the majority (n=50) were in favour. The remaining 11 had reservations stating “no one will follow the rules, even if they were in place” or commenting that the drive for controlling interactions with manta rays “really needs to come from within the diving industry itself”, with “community-made rules, sanctions and more self-discipline”.

Discussion

Results from the current study contribute to continuing research into the Maldivian population of reef manta rays (*M. alfredi*); in particular, how distribution and abundance may have changed over time. The results also give further insight into societal awareness and attitudes towards marine conservation in the Maldives, which may have implications for future marine management programmes.

The use of traditional knowledge has become increasingly recognised as a source of valuable information (Davis and Wagner 2003) and scientists have traditionally enlisted the help of extractive resource users, such as fishers, to gather ecological information about species encountered by traditional peoples (Drew 2005). This has led to a greater understanding of animal abundance and population trends and has also assisted in the implementation of suitable management programmes for key conservation areas (Drew 2005; Rosa et al. 2005; Gandiwa 2012). The current study enlisted the help of experienced divers, which have been recognised in previous studies for providing broad scale, long-term information on elasmobranch populations (Ward-Paige and Lotze 2011; Ward-Paige et al. 2013). Due to the regularity with which divers visit certain sites, they can become very familiar with the features of local flora and fauna (Ward-Paige and Lotze 2011) and it is therefore suggested they could become sensitive to changes in the location or abundance of particular species. Divers often take well-documented logs of their dives, including date, location and commentary on notable observations (pers. obs.). These logged accounts could therefore provide a valuable reference for temporal population fluctuations. There is a working assumption in the current study that, due to the popularity of manta rays, dive guides, masters and instructors will have a tendency to visit the sites most frequented by manta rays (hotspots) in order to satisfy guests, and to abandon those sites where manta rays are no

longer encountered. However, it became apparent during the course of interviews that some information was withheld, because divers were reluctant to divulge knowledge of key sites to preserve their commercial advantage.

The results highlighted a number of manta sites that were regularly frequented by divers, (Tables 2 and 3; figs 2 and 3.). There was little difference between the most popular sites during the two time periods (pre-2005 and during the last five years); Lankan Beyru, Rangali Madivaru, Sunlight Faru and Hanifaru Bay were mentioned most often. This suggests these sites are still manta ray 'hotspots' since divers would not continue to visit if manta rays were absent. Furthermore, three of the most popular dive sites (Lankan Beyru, Dhonkalo Thila and Hanifaru Bay) were also those where respondents had witnessed the largest aggregations of manta rays. It is reasonable to conclude that the popularity of these sites is due to a high likelihood of seeing large numbers of manta rays. The decreased popularity of one site (Dhonkalo Thila) further supports this assumption; the number of respondents quoting it as a popular site decreased five-fold since 2005. Moreover, nearly a quarter of respondents commented that manta rays have decreased to a point where they no longer, or very rarely, see them anymore. There was however, an increase in the overall number of manta sites (55 to 70) mentioned by respondents over the two time-periods. This may reflect the increased diversity of sites being discovered and frequented by an expanding tourism industry. For example, one site (Moofushi) emerged as a relatively 'new' site for encountering manta rays (Table 3; fig. 3).

There was a consensus that manta rays are less common now, particularly at Lankan Beyru, Rangali Madivaru, Sunlight Faru and Hanifaru Bay, than during earlier visits; the majority of respondents first noted a decline, especially at Dhonkalo Thila, from 2010. Hanifaru Bay, as a designated MPA, has been particularly well studied since 2008 and MMRP reports show that

annual sightings have been significantly lower over the last two years (Stevens and Froman 2014). The MMRP also recorded the lowest number of sightings (n=2085) across the whole of Baa Atoll in 2011 (Stevens and Froman 2014). This was attributed to unseasonable conditions recorded during the southwest monsoon affecting the concentration of zooplankton and therefore manta ray activity (Stevens and Brooks 2011). However, anecdotal evidence from the current study implied that human activity may have caused the manta rays to desert key sites. Respondents suggested that fewer manta rays were seen, “because the cleaning stations are occupied by divers instead”, and there are “too many people crowding [the cleaning station]”. The incessant pressure on popular manta sites, as described by one respondent, can be seen, “from 08.00 in the morning to 17.00 in the afternoon” where “sometimes you can see four mantas with about 50 or 60 divers”.

Several studies have reported direct and indirect negative impacts from diving and snorkelling activities on coral reef ecosystems, for example unintentional contact from fins or equipment (Tratalos and Austin 2001; Barker and Roberts 2004). Despite MMRP data on boat and tourist pressure (Stevens and Froman 2014), little is known about the impacts of disturbance on the behaviour of manta rays at cleaning and feeding stations. Some studies have suggested that improperly managed marine megafauna tourism may have a negative affect (Graham 2007; Quiros 2007). The current study reinforces the need for more research, and a project is currently underway to gain a better understanding of human-manta interactions (Annie Murray pers. comm.).

Changes in abundance of other marine animals

Sawers (2014) speculated that a perceived increase in the numbers of reef sharks by local fishers may be associated with their wish to reinstate limited shark fishing. Although not directly comparable due to spatial differences, the fishers' observations were corroborated by results in the current study, where over half (65%) of divers also perceived an increase. This perception was attributed to the shark fishing and export ban (implemented in 2010) and suggested that conservation efforts to recover dwindling populations were having a positive effect. In contrast, whale sharks have been declining throughout Baa Atoll over the last seven years (Stevens and Froman 2014); a trend also noted by local fishers (Sawers 2014). A third of respondents (33%) in the current study reported a decrease in whale shark numbers since the start of their career whilst a further 27% perceived an increase; this was attributed to either a change of workplace or to increased excursions focused on whale sharks specifically. It has been suggested that whale shark sightings could be linked to environmental changes (Sequeira et al. 2014) or to migration and subsequent exploitation elsewhere (Bradshaw et al. 2008; Sawers 2014).

Perception and knowledge of marine conservation

Respondents seemed very knowledgeable about appropriate behaviour when diving or snorkelling with manta rays. There was also a high level of awareness of the establishment of the Hanifaru Bay MPA and the Baa Atoll UNESCO World Biosphere Reserve. Many referred to compliance, either with guidelines issued by their operator, or with the Best Practice Code of Conduct issued by the Manta Trust. This scientific, evidence-based approach provides tourists and operators with advice for interacting with manta rays both at cleaning stations

and during feeding events whilst snorkelling or diving (Manta Trust 2015b). These include recommendations on vessel activity and personal behaviour in the water; refraining from chasing or touching the manta rays was a practice most frequently recognised by respondents. The Manta Trust also recommends a 3m diver or snorkeler approach limit; most respondents were aware of this but referred to a range of 2m to 5m. Whilst the use of best practice guidelines has been effective elsewhere, for example minimising the negative effect of humans on whale sharks (Mau 2008; Pierce et al. 2010), those issued by the Manta Trust are local recommendations for tourism operators and there are no regulations covering the region as a whole. There was wide support amongst respondents for enforcement of a legal code of conduct to facilitate more effective control of interactions with manta rays.

In contrast to local fishers (Sawers 2014), the majority of respondents in the current study regarded the establishment of the Hanifaru Bay MPA as beneficial. They highlighted benefits from reducing the numbers of tourists in the Bay at any one time, and increased awareness of manta rays. However, strong opinions were expressed regarding management practices. Whilst there was general recognition of improvements, including reduced over-crowding from well-defined 'user days' alternating between resorts and liveboards, these restrictions presented difficulties for liveboards in scheduling itineraries and route planning. Liveboards cater primarily for divers, and many of the respondents were unhappy about the prohibition introduced in 2012. 38% of respondents stated the designation of Hanifaru Bay MPA had adversely affected them, the majority of whom had some kind of liveboard experience.

The interviewees also expressed the need for more interaction between scientists and the diving industry. There was considerable dissatisfaction with the current level of communication and collaboration between these two sectors; respondents stressed the

importance of working together to increase awareness of the marine environment. Enhanced awareness of scientific research, and the outcome of projects, would limit misunderstanding and strengthen the relationship between the two groups. Greater use of social media was frequently mentioned as an outlet through which information could be shared and viewed easily. Recent studies have emphasised the value of social media, such as Facebook, in encouraging development of wider ocean literacy (Fauville et al. 2015). If posts, particularly videos or pictures, trigger an interest by being shared and discussed, it can encourage individuals to explore the ideas further, by reading more about the subject (Fauville et al. 2015).

Conclusions

Use of historical knowledge has provided further insight into the distribution and changing abundance of the Maldivian population of manta rays. Accounts from divers across the region have indicated a general decrease in manta ray abundance and specified certain sites where decline may be more acute. Concerns were expressed regarding the impact of increasing numbers of divers or snorkelers at cleaning and feeding stations on manta ray behaviour, including contributing to population decline at sites such as Dhonkalo Thila. Opinions varied on management practices at key sites, however, it was generally recognised that greater cohesion and improved communication is needed between the diving industry and marine biologists for successful implementation of future conservation management strategies in the Maldives.

Disclaimer

I confirm that I have conformed to the University of York's regulations on academic integrity. The word count provided does not include text within figures, tables or their corresponding legends; the appendices, direct quotes or any questions relating to my study written in italicised text.

Acknowledgments

I am extremely grateful to have been afforded the opportunity to conduct this research project in the Maldives. I wish to thank Guy Stevens, Niv Froman, Annie Murray and Tam Sawers for this incredible opportunity, and for their continued support and guidance during the research process. To the Four Seasons at Landaa Giraavaru for hosting me during my time in the Maldives and to the respondents who completed the interviews, enabling this research to take place.

Word count: 4996

References

- Anderson R. C., Adam M. S., Goes J. I. (2011a) From monsoons to mantas: Seasonal distribution of *Manta alfredi* in the Maldives. *Fisheries Oceanography*. 20(2), 104–113
- Anderson R. C., Adam M. S., Kitchen-Wheeler A-M., Stevens G. (2011b) Extent and economic value of manta ray watching in Maldives. *Tourism in Marine Environments*. 7(1), 15–27
- BABR (2014) *Rays included in the protected species list*. Baa Atoll Biosphere Reserve. URL: <http://www.broffice.gov.mv/en/index.php/news-events/166-rays-included-in-the-protected-species-list> [Accessed: 12th September 2015]
- Barker N. H. L., Roberts C. M. (2004) Scuba diver behaviour and the management of diving impacts on coral reefs. *Biological Conservation*. 120:481–489
- Bradshaw C. J. A., Fitzpatrick B. M., Steinberg C. C., Brook B. W., Meekan M. G. (2008) Decline in whale shark size and abundance at Ningaloo Reef over the past decade: The world's largest fish is getting smaller. *Biological Conservation*. 141:1894–1905
- Couturier L. I. E., Jaine F. R. A., Townsend K. A., Weeks S. J., Richardson A. J., Bennett M. B. (2011) Distribution, site affinity and regional movements of the manta ray, *Manta alfredi* (Krefft, 1868), along the east coast of Australia. *Marine and Freshwater Research*. 62:628–637
- Couturier L. I. E., Marshall A. D., Jaine F. R. A., Kashiwagi T., Pierce S. J., Townsend K. A., Weeks S. J., Bennett M. B., Richardson A. J. (2012) Biology, ecology and conservation of the Mobulidae. *Journal of Fish Biology*. 80:1075–1119
- Davis A, Wagner J. R. (2003) Who Knows? On the importance of identifying 'expert' when researching local ecological knowledge. *Human Ecology*. 31(3)463–489
- Drew J. A. (2005) Use of traditional ecological knowledge in marine conservation. *Conservation Biology*. 19:1286–1293
- Fauville G., Dupont S., von Thun S., Lundin J. (2015) Can Facebook be used to increase scientific literacy? A case study of the Monterey Bay Aquarium Research Institute Facebook page and ocean literacy. *Computers and Education*. 82:60–73
- Gandiwa E. (2012) Local knowledge and perceptions of animal population abundances by communities adjacent to the northern Gonarezhou National Park, Zimbabwe. *Tropical Conservation Science*. 5(3)255–269
- Graham R. T. (2007) Whale sharks of the Western Caribbean: an overview of current research and conservation efforts and future needs for effective management of the species. *Gulf and Caribbean Research*. 19(2)149–159
- Lack M., Sant G. (2009) *Trends in Global Shark Catch and Recent Developments in Management*. TRAFFIC international
- Manta Trust (2015a) *The Maldivian manta ray project*. URL: <http://www.mantatrust.org/in-the-field/maldives/> [Accessed: 12th September 2015]

- Manta Trust (2015b) *Swimming with mantas*. URL: <http://www.mantatrust.org/conservation/swimming-with-mantas/> [Accessed: 17th September 2015]
- Marshall A. D., Compagno L. J. V., Bennett M. B. (2009) Redescription of the genus *Manta* with resurrection of I (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). *Zootaxa*. 28(2301)1–28
- Mau R. (2008) Managing for Conservation and Recreation: The Ningaloo Whale Shark Experience. *Journal of Ecotourism*. 7:213-225
- McClanahan T. R., Muthiga N. A. (2014) Community change and evidence for variable warm-water temperature adaptation of corals in Northern Malé Atoll, Maldives. *Marine Pollution Bulletin*. 80:107–113
- Ministry of Tourism (2015) *Maldives Visitor Survey 2014*. Available at: <http://www.tourism.gov.mv/latest-documents-en/maldives-visitor-survey-june-2014/> [Accessed: 12th September 2015]
- MMRP (2015) *Maldivian Manta Ray Project volunteer handbook*.
- Murray A. (2014) *The Maldives announces all ray species now added to the Maldives Protected Species List*. Press release: <http://www.mantatrust.org/wp-content/uploads/2012/03/Maldives-Protection-for-all-Ray-Species-Manta-Trust-Maldivian-Manta-Ray-Project-Save-Our-Seas-Foundation-5th-June-2014.pdf> [Accessed: 17th September 2015]
- NBS (2014) *Tourist arrivals and tourist bed-nights 2011-2013*. National Bureau of Statistics. Available at: <http://www.planning.gov.mv/yearbook2014/yearbook/Tourism/10.5.pdf> [Accessed: 12th September 2015]
- O'Malley M. P., Lee-Brooks K., Medd H. B. (2013) The global economic impact of manta Ray watching tourism. *PLoS One*. 8(5)1-11
- Pierce S. J., Méndez-Jiménez A., Collins K., Rosero-Caicedo M., Monadjem A. (2010) Developing a Code of Conduct for whale shark interactions in Mozambique. *Aquatic Conservation: Marine and Freshwater Ecosystems*. 20(7)782–788
- Quiros A. L. (2007) Tourist compliance to a Code of Conduct and the resulting effects on whale shark (*Rhincodon typus*) behavior in Donsol, Philippines. *Fisheries Research* 84:102–108
- Rosa I. M., Alves R. R., Bonifácio K. M., Mourão J. S., Osório F. M., Oliveira T. P., Nottingham M. C. (2005) Fishers' knowledge and seahorse conservation in Brazil. *Journal of Ethnobiology and Ethnomedicine*. 1:1-12
- Sawers T. (2014) The value of traditional knowledge in manta ray conservation in the Maldives. Master's thesis, The University of York, England
- Sequeira A. M. M., Mellin C., Fordham D. A., Meekan M. G., Bradshaw C. J. A. (2014) Predicting current and future global distributions of whale sharks. *Global Change Biology*. 20(3)778–789

- Stevens G., Brooks K. (2011) *Maldivian Manta Ray Project 2011 Season Summary*. A short report for the Ministry of Environment, Maldives; EPA and AEC Project
- Stevens G., Froman N. (2014) *Maldivian Manta Ray Project 2014 Season Summary*. A short report for the Ministry of Environment, Maldives; EPA and AEC Project
- Stevens G., Lee-Brooks K., Sciambi D. (2012) *Maldivian Manta Ray Project 2012 Season Summary*. A short report for the Ministry of Environment and Fisheries, Maldives; EPA and MRC
- Tratalos J. A., Austin T. J. (2001) Impacts of recreational SCUBA diving on coral communities of the Caribbean island of Grand Cayman. *Biological Conservation*. 102:67–75
- Ward-Paige C. A, Davis B., Worm B. (2013) Global population trends and human use patterns of Manta and Mobula rays. *PLoS One*. 8(9)1-9
- Ward-Paige C. A., Lotze H. K. (2011) Assessing the value of recreational divers for censusing elasmobranchs. *PLoS One*. 6(10)1-11

Appendix 1 – interview questions, preceded by an introduction to the project

Introduction:

My name is Nicola and I would like to thank you for agreeing to assist me with my survey. I am studying for a Masters' Degree at the University of York, in England and have chosen to focus my research on Manta Rays in the Maldives; in particular the historical status of these animals, their movements and population dynamics prior to 2005.

So, since 2005, researchers and conservationists have been gathering information on the manta rays that live here. However, in order for us to fully understand and interpret this information we need to know more about manta ray occurrences in the past (or prior to 2005), as well as other large animals such as whale sharks. Which is why we want to talk to you.

At the outset it is very important for you to understand that everything we discuss today will be completely confidential and all information will be anonymous.

I will begin by asking you about your diving experience, in particular those dive sites you visit the most and more general questions about manta ray sightings in the Maldives. I will then move onto questions regarding specific dive sights: when and where you see manta rays. If you do not understand anything or want to ask any questions during the interview, please stop me at any time.

It is crucial that you answer each question as accurately as possible. If you are not sure of the answer to a question, please state this as your answer.

Right, let us begin:

Background

- 1- When did you start diving in the Maldives?
- 2- How often do you dive/snorkel?
- 3- Have there been any long periods of inactivity since you started diving? (Y/N)
 - a. When?
- 4- Are you based on a Resort or Liveaboard? Both?
- 5- Have you changed working location since you started diving in the Maldives?
 - If yes:
 - a) When?
 - b) Where did you move from and to (Atoll)?
- 6- Which Atoll do you and have you dived the most?
- 7- Please take a look at the map of the **manta sites**, can you name the three sites you dived or snorkelled at most often between **1990 and 2005**. If a site is not included in the list I have given you, please state the name of the site and Atoll.

	Top dive/snorkel sites
1	
2	
3	

- 8- Using the same map, what are the top three sites you dive/snorkel **most often now** – after 2010? Again, please mention any that are not included in the list.

	Top dive sites
1	
2	
3	

Manta ray sightings

The following questions concern your manta ray sightings throughout the Maldives, and at specific sites.

Across the Maldives

- 9- Which months of the year are the manta rays most commonly seen in the Maldives in general?

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
-----	-----	-------	-------	-----	------	------	-----	------	-----	-----	-----

10-Has this season changed since you started diving in the Maldives? (Y/N)

a. How?

E.g.

1. *They arrive later*
2. *They arrive earlier*
3. *They are here for a shorter time period*
4. *They are here for a longer time period*

Peak abundance – cleaning and feeding stations

11-These questions relate specifically to manta ray abundance at **cleaning stations**, which are marked on the map legend you have in front of you.

- a. At which site have you seen the largest numbers of manta rays? The site does not have to be restricted to those listed on the map
- b. Can you remember which **year** you saw them?

	Dive sites	Year
1		

12- These questions relate to manta ray abundance at **feeding stations**, three are marked on the map legend you have in front of you.

- a. At which site have you seen the largest numbers of manta rays? The sites does not have to be restricted to those listed on the map
- b. Can you remember which **year** you saw them?

	Dive sites	Year
1		

Sightings and fluctuations – specific dive sites

The following questions relate to manta ray populations on a more local scale. So for this, I will be using the three dive/snorkel sites you mentioned you visit most frequently, at the beginning of this interview.

13-You mentioned you dived/snorkelled at, [*the 3 sites they list*], **before 2005**, what months of the year were manta rays most commonly seen at each of them?

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
-----	-----	-------	-------	-----	------	------	-----	------	-----	-----	-----

	Dive/snorkel site visited prior to 2005	Time of year
1		
2		
3		

14- At the dive sites you mentioned you **dive at now** [*list the 3 dive sites*], what time of the year do you see manta rays most commonly seen at each of them?

Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
-----	-----	-------	-------	-----	------	------	-----	------	-----	-----	-----

	Dive site visit now	Time of year
1		
2		
3		

15- At [*indicate their top 3 dive sites*], how often do you see manta rays on your dives during the manta season at this site?

E.g.

- a. *Every time I visit the site*
- b. *Almost every time I visit the site*
- c. *Occasionally*
- d. *Rarely*
- e. *Never*

	Dive site visit now	Frequency of mantas sightings
1		
2		
3		

16- Do you think the numbers of manta rays has changed since you began diving at (*name each of their top 3 dive sites visit now*)? (Y/N)

- a. Are they more or less common today than they were when you first started diving in the Maldives?

	Dive site visit now (since 2005)	Frequency of mantas sightings (more/less common)
1		
2		
3		

Changes in manta sightings

These questions relate to changes in manta sightings at dive sites

17- Are there any dive sites that you used to/still dive at, but no longer see manta rays at anymore? (Y/N)

If yes:

- a. Which sites are they?
- b. When did you first start diving there?
- c. When did you first notice manta rays had stopped visiting the site(s)

Which sites?	First started diving there	Manta stopped visiting (yr)

18- Are there any sites where you now see manta rays, whereas before they weren't there? (Y/N)

If yes:

- a. Which sites are they?
- b. When did you first start diving there?
- c. When did you first notice the manta rays start visiting the site(s)?

Which sites?	First started diving there	Manta start visiting (yr)

Other marine animals

I will now move onto questions regarding other marine animals in the Maldives, and whether you have seen a change in their numbers since you started diving in the Maldives.

19- Please specify whether, or not, you have seen a change (increase, decrease or no change) in the numbers of:

Marine animal	Change in numbers? <i>Increase, decrease or no change</i>
a) Whale shark	
b) Reef shark	
c) Sea turtles	
d) Groupers	
e) Baitfish	
f) Tunas	
g) Dolphins	
Other. Please specify	

Perception of conservation efforts in the Maldives

I'm now going to move onto questions regarding conservation efforts in the Maldives.

Hanifaru Bay and the Biosphere Reserve

20- Have you heard of the UNESCO World Biosphere reserve covering the entirety of Baa Atoll? (Y/N)

21- Have you heard of the Hanifaru Bay MPA (Y/N)

22- Do you know why the MPA was established in Hanifaru Bay? (Y/N)
a. If yes, what was the reasoning behind the designation?

23- Did the establishment of the Hanifaru Bay MPA effect you? (Y/N)
a. How?

24- Do you think the establishment of the Hanifaru Bay MPA has been beneficial? (Y/N)
a. Why?

25- In your opinion, is the Hanifaru MPA well managed? (Y/N)
a. Why?

All MPAs in the Maldives

26- Are you aware of any other MPAs in the Maldives? (Y/N)
a. Can you name three?

27- In your opinion, are they well managed? (Y/N)
a. Why?

28- How do you feel about the level of management of MPAs in the Maldives? (*e.g. is there too much, too little, would you like greater/less management*)
a. Why?

Work of scientists and conservationists

29- How do you feel about the work of scientists and conservationists in the Maldives? (*e.g. important/too strict/they cause problems/it's unnecessary*)

30- Are you aware of any rules and regulations about diving or snorkelling with manta rays? (Y/N)
a. What are they?

31- Do you think there should be Government regulations in place, such as a code of conduct to control interactions with manta rays (*e.g. vessel speed on approach, rules about touching mantas, max. numbers of tourists per dive-guide etc.*) (Y/N)

- 32- Are you actively involved/or do you participate in any conservation program? (Y/N)
- a. If **yes**, which one?
 - b. If **no** would you be interested in becoming involved in such programs?
- 33- Are you satisfied with the level of communication and collaboration between conservationists/scientists and the tourism industry?
- a. If not, how would you like to see it improved?

Final questions

- 34- In general, how do you think the diving industry in the Maldives perceives manta rays?
- E.g. Are they...*
- 1- *Seen as a menace*
 - 2- *Feared*
 - 3- *Respected*
 - 4- *Adored*
 - 5- *Useful for tourism purposes*
 - 6- *Other. Please specify*
- 35- Are manta rays a legally protected species in the Maldives? (Y/N)
- 36- Do you think manta rays should be protected? (Y/N)
- 37- Having completed this survey, can you recommend anybody else I could talk to?
- 38- Is there anything you would like to ask or tell me?

Appendix 2 – Map of selected manta sites for interviewee reference (split over two pages for appendix)



FAAFU ATOLL
North Nilandhe



Dheburideethere Kandu

Vattaru Kandu



MEEMU ATOLL
Mulaku

DHAALU ATOLL
South Nilandhe



Kudahuvadhoo Kandu



THAA ATOLL
Kolhumadulu

Veymandoo Kandu



LAAMU ATOLL
Hadhdhunmathee

ONE AND HALF DEGREE CHANNEL
(Huvadhoo Kandu)



GAAFU ALIFU ATOLL
North Huvadhoo

GAAFU DHAALU ATOLL
South Huvadhoo

SOUTH EQUATORIAL CHANNEL
(Addoo Kandu)

GNAVIYANI ATOLL
Foammulah



Seenu Atoll
Addu

16

Dive sites key

Haa Alifu Atoll

1- Aquarium

Lhaviyani Atoll

2- Fushifaru Kandu (Fushifaru Thila)

3- Dhanifaru (Vaavaru)

Baa Atoll

4- Hanifaru Bay

5- Dharavandhoo Thila

6- Dhigu Thila (Anga Faru)

7- Nelivaru Thila (Nelivaru Haa)

North Malé Atoll

8- Boduhithi Thila (Rasfari North)

9- Sunlight Faru (Thulhaagiri)

10- Lankan Beyru (Manta Point)

South Malé Atoll

11- Sand Dune (Banana Reef / Guraidhoo Falhu)

Ari Atoll

12- Dhonkalo Thila (Table Thila)

13- Kalhahandi Huraa (Panettone)

14- Huravalhi Fahlu (Lilly Beach)

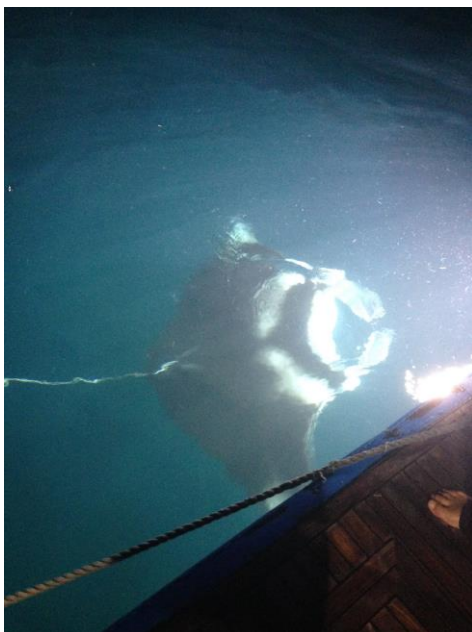
15- Rangali Madivaru (Manta Point)

Addu Atoll

16- Mudakan (Manta Point / Maa Kandu)

Extra – curricular activities

- The majority of my interviews were conducted in the evening, allowing me to be a part of the Manta Trust research team, assisting with the daily in-water data collection. I went out on the research boat and looked for manta rays at the daily monitoring sites – well-known manta cleaning and feeding stations. When manta rays were sighted, I would work alongside the other researchers to free-dive under the manta rays taking identification photos. I also collected environmental data and monitored the tourism levels at each site. Once back at the office I would edit my photos and assist with the identification of individual manta rays.
- I assisted a number of private ‘Manta Scientist for a Day’ guests trips, which involved introducing guests to the workings of the Manta Trust and answering any questions they had; informing them on regulations regarding manta ray interactions and their conduct in the water; taking guests to the daily monitoring sites, demonstrating how to take ID-photos and leading them on snorkelling trips to view cleaning and feeding manta rays
- Four Seasons staff were offered the opportunity to take part in a ‘Manta Safari’, and have the experience of swimming with manta rays. I co-led the half-day excursion, which was attended by 18 staff. I was on hand to answer any manta-related questions they had whilst travelling round the various manta ray sights and informed them on the regulations regarding swimming with the manta rays. Once located, I was responsible for guiding groups of staff, of various swimming abilities, to view the manta rays.
- I was also given the incredible opportunity to join a private liveaboard trip, which was travelling south from Baa Atoll to Fesdhoo Lagoon in Ari Atoll, in order to collect material for a National Geographic article - a follow-up story on the Hanifaru Bay Marine Protected Area by Thomas Peschak.



At Fesdhoo Lagoon, manta rays came up to feed at back of the boat due to the dense plankton at the surface of the water, attracted to the light!

Nicola Bassett – Placement blog

Maldives 2015

When I think back to the grey November day in York, when I was sitting with my supervisor discussing what I would like to do for my summer placement, little did I know what I was to experience a full 8 months later. At the time I was introduced to Guy Stevens, the founder of the Manta Trust and we discussed a project looking at the historical abundances of manta rays in the Maldives. Of course, I jumped at the chance and at the beginning of July I was stuffing my bags with suncream and Haribo (for the addicts out in the Maldives) itching to get out to see these beautiful animals as soon as possible.

My project involved interviewing divers and marine biologists from around the Maldives who could give further insight into the historical populations of mantas, as little is known about manta ray abundance and distribution prior to 2005, when the Manta Trust started collecting data. It was primarily a desk-based research project with the majority of interviews being conducted over Skype, however, due to respondent availability these were often scheduled during the evenings, allowing me to become part of the Manta Trust research team and assist with their daily data collection.

My first day on the research boat had arrived, and with it the opportunity to have my first manta encounter! I trailed around after the other volunteers trying to remember what was needed for the full day on the research Dhoni and where everything was kept – towels, food and drinks – check; cameras with fresh batteries - check, fins and snorkels – check! Once everything was loaded, the Dhoni made its leisurely way to Hanifaru Bay, which I had heard so much about. Everyone I have spoken to about manta rays in the Maldives have said it is THE place to see mantas, and not just one or two, there was talk that over one hundred can aggregate in this small bay! As you can imagine I was full of anticipation and excitement at the thought of seeing this number of mantas in one place.



The research Dhoni on a wonderfully calm day!

I soon realised however, that manta rays can be extremely 'picky' about when and where they choose to feed and to get cleaned. High tide, I was told, can affect when we see mantas, especially in Hanifaru Bay where the nutrient-rich waters laden with zooplankton are funnelled into the Bay during each high tide. Here the mantas take advantage of the natural glut of food and spend a couple of hours gorging on the plankton which is swept into the Bay. On my first day however, there was not a manta ray in sight, despite our desperate attempts to search for them, snorkelling up and down the Bay. The story was much the same at other manta sites such as Dharavandhoo, where I amused myself for 45 minutes watching the territorial damselfish darting in between their coral blocks, but what I really wanted to see was a manta ray emerging from the deep.



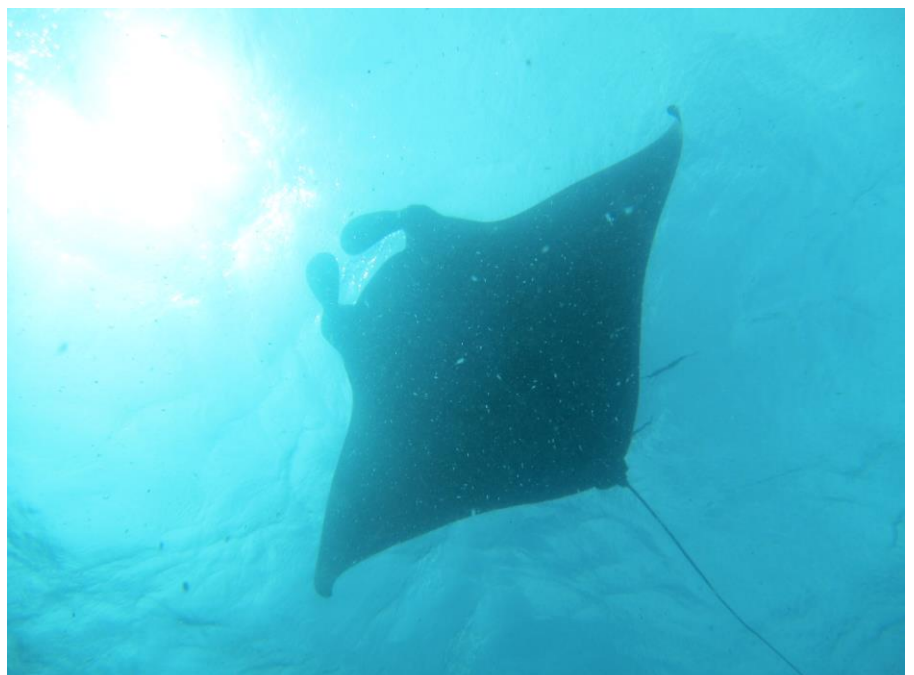
Turtle mid-barrel roll

Towards the end of the day, and back at Hanifaru, my patience was rewarded with the tell-tale splashes and wingtips breaking the surface. This meant mantas! Scrabbling to get my fins and mask, I jumped in, took a deep breath and swam head first down towards them. Camera at the ready to take the infamous ID shot of the manta's belly, I couldn't suppress a smile and a small squeal of excitement, which immediately scuppered all plans of taking perfect ID shot. Heading to the surface coughing and spluttering I couldn't believe what I had seen: not one, but ten mantas barrel-rolling and chain feeding, making the most of the abundance of plankton that was hanging at the surface. I was in awe of their size and how they moved so balletically, turning effortlessly with their wingtips grazing the surface of the water. I was mesmerised by one manta in particular whose signature move seemed to be the 'backward roll', or 'barrel roll' feeding technique. She (I later learned it was Turtle) elegantly flung

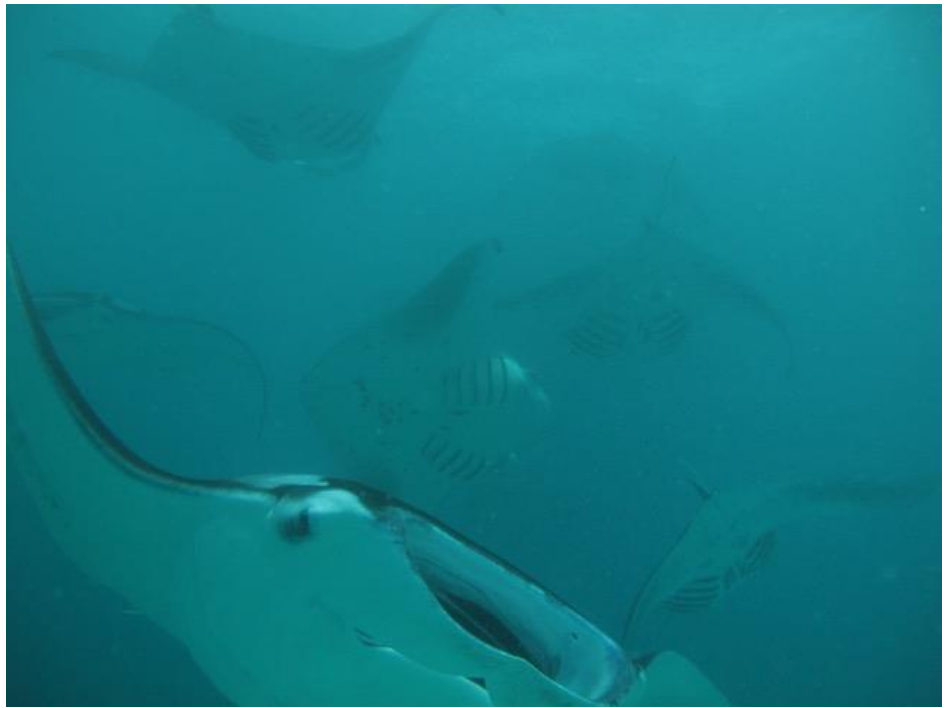
herself backwards to complete a loop in the water column, targeting a condensed patch of plankton. I composed myself and tried again, diving down to get underneath the long chain on mantas, which were swimming so gracefully, apparently unperturbed by this overexcited human getting in their way!

The following days didn't bring many opportunities to refine my free-diving or photography skills, as the mantas were nowhere to be seen; the timing of high-tide was not in our favour and we were still days away from the new moon. The latter bringing with it larger-than-normal tides, which again influences the plankton densities in Hanifaru Bay leading to a higher chance of seeing mantas aggregating in large numbers.

In the few days leading up to the July new moon however, we could really sense the weather was changing: the wind-speed started to increase, which also brought the storms the wet monsoon is notorious for. One storm in particular took us by surprise and we quickly decamped onto the nearby liveaboard that Guy and his guests had arrived in a few days before. The sky, which until now had been an endless crown of blue above our heads, had turned a menacing shade of purple; localised rain clouds over the separate islands started to gather together in one mass and erupted overhead. We sat inside waiting for the storm to pass, all looking silently out at Hanifaru Bay hoping that the mantas would arrive and clock watching as high-tide ticked slowly closer. Eventually the rain subsided and, as if a switch had been flicked, the clouds vanished and were replaced by the bright sunshine once again. It was suddenly go go go! Batteries and SD cards were hastily put back into cameras, masks and fins were grabbed and rash vests found as we made our way to Hanifaru as quickly as the Dhoni would allow us. Standing on the roof of the boat and looking into the Bay, it seemed that luck was on our side as we could see mantas barrel rolling at the surface, a good sign that there was plenty of plankton and probably more mantas feeding deeper out of our sight.



As I jumped in, determined to stay calm and collected, and actually get some passable ID shots, I was not prepared for the sight that greeted me. The huge dark mass swimming below me actually turned out to be around 30 mantas, whereas straight ahead of me at the surface there were about twenty mantas chain feeding and barrel rolling. I



I didn't know where to look; we were surrounded by them. I thought seeing 50 mantas was amazing, but more kept arriving - determined to get their share of the plankton concentrated so conveniently in one place. There were suddenly mantas everywhere I looked! Every now and again a familiar face would pop up to the surface: Niv, Guy, James, Lirar, all with huge smiles on their faces, not believing what was unfolding beneath us. "Definitely more than one hundred" Guy assured us. I could not believe it. This is what I had heard about and had been daydreaming about for the past 8 months - what would it be like to swim amongst so many mantas? Now it was actually happening. It was definitely an 'is this real' moment; I had to keep pinching myself to make sure I wouldn't suddenly wake up in York! We stayed in the water for hours, free-diving down under the wall of mantas, determined to get as many ID shots of different mantas as possible. I felt my confidence and ability to get the all important ID shot improve within just that afternoon - there is nothing like two or three mantas swimming overhead, blocking your way to the surface to improve you breathe hold!

All too soon the mantas decided it was time to leave and suddenly, as quickly as they arrived, they disappeared silently out of the Bay. I clambered back into the research boat, gabbling excitedly and laughing with everyone about what we had just witnessed. I felt incredibly lucky to have seen this spectacle: I had seen over one hundred mantas in one afternoon and only 10 days into my two-month placement out here! What else could possibly happen in the next 8 weeks, I wondered? Whatever it is, bring it on!