

University of York
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Investigating tourism at Hanifaru Bay marine protected area, Maldives.



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Abstract

Hanifaru Bay in the Republic of Maldives is gaining an international reputation as one of the best places in the world to experience swimming with manta rays (*Manta alfredi*) and whale sharks (*Rhincodon typus*). Its importance has been recognised by the Maldivian government and the site has recently been designated as a marine protected area (MPA) with legislation in place to govern the manner in which it should be used. However, despite its legal status there is no onsite government presence to monitor the intensity of site use or to enforce regulations in place. Here results are presented from two months of observation of tourist activity at Hanifaru. During July and August 2010, 430 boats and 4327 people were observed to use the site, this represents an increase of 232.6% in the number of people using the site per day compared to the same period last year. Compliance to legislation governing site capacity was regularly observed to be ignored leading to instances of severe overcrowding both by boats and in the water leading to significant levels of harassment to the animals. Moreover, a number of the regulations in place were found to be ill-suited to the unique nature of the site and, if complied with, might risk the safety of all users of the site. Whilst the MPA designation of Hanifaru provides an excellent foundation for ongoing management, this study emphasises the urgent need for relevant regulations and onsite enforcement to be implemented in order to ensure the future of the site.

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1. Introduction

The Republic of Maldives is a remote archipelago situated in the Indian Ocean some 700km southwest of Sri Lanka (Figure 1.1). The country is comprised of 1192 small sandy islands, arranged into 26 coral atolls spanning a distance of 800km from North to South between 7°N and 0.5°S. The economy of the country is dominated by two key industries, tourism and fishing, both of which rely extensively on the rich marine biodiversity of the archipelago. The country has a total reef area of over 3,500km² supporting over 1,110 species of fish and 250 species of coral in addition to globally significant populations of reef manta rays (*Manta alfredi*) and whale sharks (*Rhincodon typus*) (Emerton *et al.*, 2009).

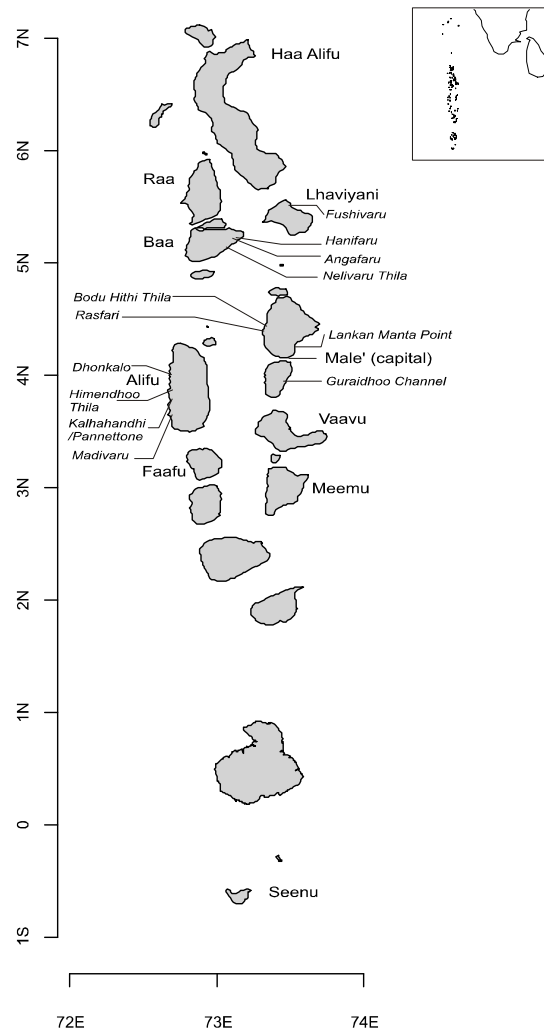


Figure 1.1: The location of the Maldives in the Indian Ocean. Source: Anderson *et al.*, in press a

Overall tourism directly contributes over 27% to GDP, however the total impact of tourism on the national economy is far greater than this (Ministry of Tourism, Arts and Culture, 2009; Emerton *et al.*, 2009); accounting for both direct and indirect contributions (secondary and supporting sectors) the contribution of tourism to GDP is estimated to be close to 67% (Emerton *et al.*, 2009). At the end of 2008 there were 94 exclusive island resorts, 143 registered liveaboard ‘safari’ vessels and a small number of hotels and guesthouses providing for the 683,012 tourists who visited the Maldives that year (Ministry of Tourism, Arts and Culture, 2009).

The favourable location, outstanding natural beauty and rich marine biodiversity are all major factors that attract tourists to the Maldives. Around 15% of all visitors to the Maldives come specifically to dive and although diving is not the overriding reason for selection of the Maldives as a holiday destination for the remaining 85% of visitors, many still participate in diving and snorkelling trips whilst in the Maldives (Ministry of Tourism and Civil Aviation, 2007; Anderson *et al.*, in press a). In recognition of the importance of the marine environment, the Maldivian government has made policy decisions and commitments to improve the stewardship of the natural environment. Such commitments include; the suspension of the whale shark fishery in 1995; the production of a National Biodiversity Strategy (Jameel *et al.*, 2002) under the government’s commitments to the Convention on Biological Diversity; a commitment to protection of the environment in the new Constitution of the Republic of Maldives (Ministry of Legal Reform, Information and Arts, 2008, Article 22); the development of the Atoll Ecosystem Conservation (AEC) project (AEC, 2010); and most recently the designation of three new Marine Protected Areas (MPAs) in June 2009 (AEC, 2010).

The populations of manta rays and whale sharks in the Maldives are a major attraction to both divers and snorkelers with both species seen all year round in the country (Anderson and Ahmed, 1993; Anderson *et al.*, in press a; Anderson *et al.*, in press b). A recent study identified a total of 91 manta ray dive sites in the Maldives and the direct revenue from tourism at these sites is estimated to be worth around US\$8.1 million per year (Anderson *et al.*, in press a).

Hanifaru Bay in Baa Atoll is one such site, here, manta rays along with whale sharks gather seasonally to feed in high numbers. Long-term studies at the site by the Maldivian Manta Ray Project (MMRP) have highlighted the unique nature of the bay and its capacity to attract

large numbers of manta rays and numerous whale sharks to feed during the Southwest Monsoon. This in turn has led to a significant amount of attention in the global media including National Geographic Magazine (Barcott, 2009) and the BBC Natural World series (BBC, 2009). As such, concerns have been raised about tourism levels and boat and tourist conduct at the site (Neves and Stevens, 2009).

The six resorts within Baa Atoll, recognising the importance of this site for manta rays and whale sharks as well as the tourism industry and local communities, all signed a Memorandum of Understanding (MoU) in 2009 (Appendix 1) in order to manage site use and prevent harm to the site, its megafauna and the visitors who use it. The significance of this site also led to its protection as a MPA under Maldivian law in June 2009 (Directive No. 133-EE/2009/19) with a number of elements of the MoU adopted as part of this new law (Appendix 2). The site is also intended as a core zone of the UNESCO World Biosphere Reserve proposed for Baa Atoll. Furthermore, the Maldivian government also set out regulatory guidelines for whale shark interactions within the country's waters in June 2009 (Appendix 3) and the MMRP have set out guidelines for safe use of the bay (Appendix 4).

Current knowledge of manta rays is limited and as recently as last year the genus *Manta* was redescribed with new evidence confirming that the species *Manta birostris* was, in fact, two distinct species *Manta birostris* and *Manta alfredi* (Marshall *et al.*, 2009). *M. birostris* is the larger of the two species with a maximum disc width of over 7m, it has a wider geographic range occurring in tropical, sub-tropical and temperate waters and is more migratory in its nature commonly sighted along productive coastlines with regular upwellings, oceanic island groups and offshore pinnacles and seamounts; *M. alfredi* is a smaller species with a maximum disc width of approximately 5.5m, this species is more commonly sighted inshore, around coral reefs, tropical island groups, atolls and bays as well as along productive coastlines, this species is more resident to tropical waters with smaller home ranges (Marshall *et al.*, 2009).

Both *M. birostris* and *M. alfredi* are observed in Maldivian waters (Stevens, G., personal communication), however it is the more resident *M. alfredi* around which the lucrative tourist industry in the Maldives is based and that is found feeding at Hanifaru in large numbers. Work by the MMRP indicates that the population of this species in Maldivian waters numbers around 6,000 individuals with unique identities of more than 1,800 mantas already collected (Stevens, G., unpublished data)

Although not directly protected in Maldivian waters, there is no targeted fishery for this species as exists in other countries (Marshall *et al.*, 2006), there is however an export ban on all ray products which serves to protect manta rays in Maldivian waters since the rays are not consumed locally. Fisheries for manta rays have caused dramatic declines in abundance (Marshall *et al.*, 2006) and as such *Manta birostris* is listed as ‘near threatened’ on the IUCN Red List (IUCN, 2009), however, this listing was based on data available prior to the redescription of the species and therefore needs urgent reassessment based upon the different life histories of the two species.

Whale sharks have long been known to occur in the Maldives and historically were hunted in Maldivian waters including in Hanifaru Bay (Anderson and Ahmed, 1993; Stevens, G., personal communication). Occurring throughout the world’s tropical oceans (Compagno, 2001) studies have shown the species to be highly migratory (Eckert and Stewart, 2001; Eckert *et al.*, 2002; Graham *et al.*, 2006; Wilson, 2006; Rowat and Gore, 2007; Hsu *et al.*, 2007; Gifford *et al.*, 2007; Brunnschweiler *et al.*, 2009). The species is also known to aggregate seasonally in a number of locations usually in response to a regular food source (Colman, 1997; Heyman *et al.*, 2001; Graham and Roberts, 2007; Rowat and Gore, 2007; Meekan *et al.*, 2009). These aggregations are usually characterised by a predominance of juvenile male sharks (Meekan *et al.*, 2006; Graham and Roberts, 2007; Brooks *et al.*, in review; Pierce, S., personal communication) and the whale sharks found in the Maldives are no different; predominantly immature males with an average size of $5.98 \pm 1.46\text{m}$ (Riley *et al.*, 2010). Whale sharks can be seen all year round in the country as they migrate locally to where the food is most abundant with some of the same individuals frequenting different sites at different times of the year (Anderson and Ahmed, 1993; Riley *et al.*, 2010).

Whale sharks have also been targeted in fisheries (Fowler, 2000) and as such the whale shark is listed as ‘vulnerable’ on the IUCN Red List with a decreasing population (IUCN, 2009). It has been protected in Maldivian waters since 1995 following reported declines in local abundance by fishermen (Anderson and Ahmed, 1993).

Whilst tourism activities based around biodiversity, especially manta rays and whale sharks have the potential to generate important financial benefits for countries and local communities (Davis *et al.*, 1997; Graham and Roberts, 2007; Quiros, 2007; Rowat and Engelhardt, 2007; Jones *et al.*, 2009), the priorities of such activities often conflict with those of biodiversity conservation (Sorice *et al.*, 2003). Studies of whale sharks in Belize and the

Philippines suggest that tourism might have negative implications for these animals; high numbers of tourists and inappropriate tourist behaviours during inwater encounters have shown to have negative short term impacts which could have implications on long term survival, as animals divert their energies from feeding to avoidance behaviour (Graham and Roberts, 2007; Quiros, 2007).

Work carried out by the MMRP at Hanifaru Bay in 2009 (Neves, 2009; Neves and Stevens, 2009) offered the first formal assessment of the anthropogenic impacts at Hanifaru Bay. Concerns raised by these studies included inadequate conduct by boats and tourists while using the bay, most specifically by liveaboard 'safari' boats who are less familiar with the site, overcrowding and a lack of laws and management of the site especially in the face of its growing popularity.

The aim of this study is to extend the work of Neves and Stevens (2009). It will assess the levels of tourism at Hanifaru MPA as well as the impacts that this tourism is having on the megafauna who use this site and will address the issue of compliance to the laws set out for the protection of this site. At present, despite the legislation in place for the protection of this site, there is no government presence onsite to ensure that regulations are adhered to. It is hoped that this study will help to inform decisions about the future management of Hanifaru with regard to both the conservation of the site and its ability to continue to generate revenue for the country and local communities.

2. Methods

2.1. Survey area

Hanifaru Bay (latitude 5°10'N, longitude 78°08'E) is situated in Baa Atoll in the northwest of the Republic of Maldives (Figure 2.1). The bay lies at the end of a 1600m long channel that borders an uninhabited island and shallow lagoon surrounded by reefs. Water in the channel and the bay reaches depths of no more than 20m with the end of the bay shallowing to 7-8m before sloping steeply up into the sandy shallows and reef.

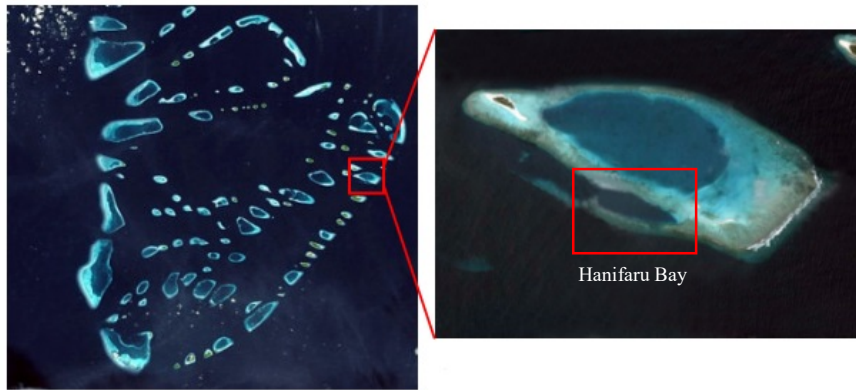


Figure 2.1: Map of Hanifaru Bay and its relative position in Baa Atoll. Source: MMRP.

The Maldivian climate is influenced by two monsoonal seasons, the Northeast Monsoon which runs from December through to March and the Southwest Monsoon which runs from May to October. The channel and bay are positioned such that during the Southwest Monsoon a unique phenomenon occurs when the incoming lunar tide and prevailing monsoonal current are opposed to one another (Figure 2.2). This creates a back-eddie at the channel mouth forcing the plankton rich water brought into the atoll by the tide down into the bay area. Any water flowing out of the bay is picked up again by the incoming tide and so a cycle begins concentrating plankton into the bay. The small area in which this concentration of plankton occurs is no longer than 200m and only 150m meters at its widest, tapering to form the end of the bay. These concentrations of plankton attract large numbers of planktivorous manta rays and whale sharks; over 200 manta rays have been observed in the bay during the course of a single feeding event (Stevens, G., unpublished data). Continuing research by the MMRP is helping to refine the prediction of manta and whale shark feeding events. Numerous factors have been observed to have an influence on the scale and duration

of feeding events, however, trends are appearing and strong tidal exchanges appear to intensify the size of feeding events with the greatest intensity of feeding seen around the high tide time (Stevens, G., personal communication).

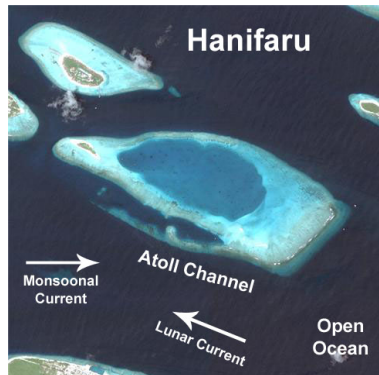


Figure 2.2: Map of Hanifaru Bay showing the juxtaposition of the lunar and monsoonal currents during the Southwest Monsoon. Source: MMRP

The predictability of the occurrence of these megafauna at Hanifaru coupled with the ease of accessibility to the bay offers unique opportunities for tourism as well as the study of the manta rays and whale sharks which frequent the bay. Furthermore it allows for the study of tourism within the bay and the interactions between these animals and humans.

2.2. Data collection

Surveys were carried out between the 1st July and 31st August 2010 on as many days as possible where conditions allowed. Surveys were conducted from an independent research vessel between the hours of 09:00 and 18:00 with survey sessions varying in duration depending on the weather, manta ray abundance and other commitments of the research vessel.

Each vessel that entered the bay was logged and the operator identified. The time of arrival and departure was noted along with the number of tourists and guides onboard and the activity they participated in. In addition notes were made on the speed and conduct of the vessel upon entry and exit and its conduct during time spent in the bay; further details were collected on if, where and how the boat anchored.

In the water the behaviour of the tourists and guides from each vessel was observed, wherever possible, for a 10 minute period for each group. Notes were taken on the behaviour of the people and any reactions of the manta rays or whale sharks to this behaviour.

In addition to the main focus of this research the monitoring team also collected identification photographs of any manta rays and whale sharks observed in the bay each day in order that comparisons could be drawn between site use and megafauna abundance.

Finally, interviews were conducted with a number of the operators to assess how well the regulations had been communicated to the users of the bay.

2.3. Data analysis

Data analysis was carried out to look at both overall levels of tourism and compliance to legislation set out to govern the site. Analysis of compliance was based on a comparison of observed behaviours of both boats and people to the laws governing the full MPA area as shown in Figure 2.3 and the recommendations and guidelines set out by the government, in the MoU and by the MMRP (Appendix 1, 2, 3 & 4). Data on site use was also compared to data collected in 2009 over the same period (Neves, 2009). Comparisons to both laws and regulations and inter-annual comparisons have been made over three key areas; site use; boat conduct; and tourist conduct and megafauna reactions.

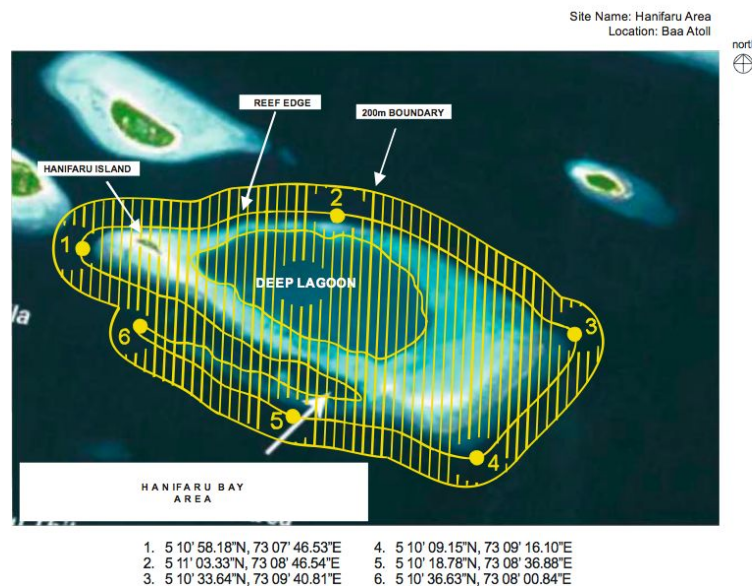


Figure 2.3: Map to show the boundaries of Hanifaru MPA. This encompasses the area 200m from the outer reef edge and excludes the land area of Hanifaru Island.

Source: Government Directive No. 133-EE/2009/19

2.3.1. Site use

Using the data gathered on the vessels that visited the bay, the numbers of people (both tourists and guides) on each vessel, along with data on arrival and departure time it was possible to analyse how many boats and people used the site each day, which operators used the bay, for what purposes the bay was used and to see if the regulations regarding the capacity of the bay were adhered to.

For the purposes of this study a boat was counted each time it used the bay within one day; for example, if a boat left the MPA area and then returned it would be counted for a second time. Boats which only entered the bay to assess the conditions without allowing divers or snorkelers to enter the water (cruising) were considered separately for this part of the analysis since they did not fully utilise the bay. The research vessel was included in all analyses which considered numbers of people or boats using the bay since the boat often had tourists, journalists or film crews in addition to the research team. The research vessel was not included in analyses of bay users and trip purpose as its presence was consistent across the two months and considering research as an additional use of the bay biased the results of the analysis. This methodology is consistent with analysis carried out by Neves (2009) and therefore aids comparison between the two studies.

Analysis of compliance to regulatory measures governing the use of the bay was also considered. The rules applicable to use of the site and its capacity are set out in Table 2.1 below.

Table 2.1: Regulations governing site use at Hanifaru MPA

Regulation	Set out by
The number of vessels that can be engaged within the MPA is limited to 5	Government Directive No. 133-EE/2009/19 (Appendix 2)
The number of swimmers or divers entering the sea is limited to a maximum of 80 persons	Government Directive No. 133-EE/2009/19 (Appendix 2)

Comparisons of average daily boat numbers, operators and activities were made between data collected in 2009 and 2010, in order that any changes in the intensity of use of the site, types of operators using the site and activities tourists participated in was made between the two years. Historical data documenting site use from 2007-2009 was also analysed to look at trends in use of the bay over time.

2.3.2. Boat conduct

The regulations and recommendations applicable to the conduct of vessels using the bay are set out in Table 2.2. As can be seen in the table the government regulations have been supplemented by additional recommendations made by the MMRP and outlined in the MoU signed by the resorts in Baa Atoll. The unique nature and small size of Hanifaru Bay requires that additional measures are taken in addition to the standard regulations to prevent harm to the animals and guests using the site.

Additional observations were also made of any dangerous behaviours such as collisions or near collisions between vessels and collisions or near collisions between vessels and people.

All boats observed entering and leaving the bay, (including vessels only cruising), were assessed by the regulations and recommendations. Only vessels using the bay were assessed against the regulations on anchoring and dropping off or picking up divers and snorkelers. In instances where the manta rays were utilising an area further out of the channel where anchoring or swimmers returning to the anchored vessel was not possible these encounters were not judged against these recommendations.

Levels of misconduct were also assessed against the different types of users to see if particular operators were more prone to breaking the laws and codes of conduct governing the site.

Table 2.2: Regulations and recommendations governing boat conduct at Hanifaru MPA

Regulation/Recommendation	Set out by
The speed limit within the protected area should not exceed 10 nautical miles	Government Directive No. 133-EE/2009/19 (Appendix 2)
Boats should enter the bay with extreme care at a slow speed (to avoid collisions with swimmers or animals)	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines (Appendix 1 & 4)
Boats should enter the bay by the routes marked in red (Figure 2.4) and avoid manoeuvring over the bay (this keeps boats a safe distance from the swimmers and animals)	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines (Appendix 1 & 4)
Boats should not pick up divers or snorkelers over the bay, they should swim back to the boat (this keeps boats a safe distance from the swimmers and animals)	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines (Appendix 1 & 4)
Anchoring except in an emergency situation which is life threatening or leading to the destruction of the vessel	Government Directive No. 133-EE/2009/19 (Appendix 2)
Boats should anchor at the eastern end of the bay on the sandy shelf. Boats should not anchor in the bay, on the cleaning station or in deeper water (due to the size of the bay boats need to anchor in order that they remain a safe distance from the swimmers and animals, boats should not anchor in deep water as animals may become entangled in anchor lines)	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines (Appendix 1 & 4)
No vessel should come closer than 10 metres to reach the whale shark (for the purposes of this study this regulation has also been extended to manta rays)	Government Directive No. 133-EE/2009/19 (Appendix 2)

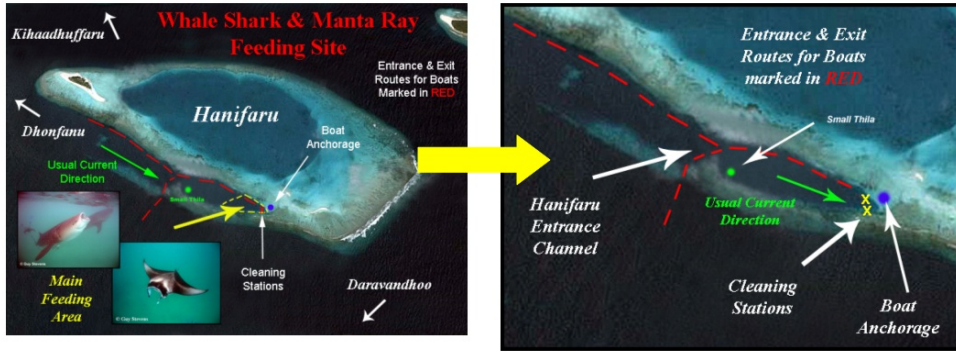


Figure 2.4: Map to show regulations and recommendations by which boats must abide; entry and exit routes indicated by red dashed lines; main feeding area which should not be manoeuvred over shown in yellow; boat anchorage shown in blue. Source: MMRP Guidelines for Hanifaru Bay

2.3.3. Tourist conduct and animal reactions

The regulations and recommendations applicable to inwater encounters in the bay are set out in Table 2.3 and all inwater users of the bay were assessed by their compliance to these regulations.

Table 2.3: Regulations and recommendations governing inwater conduct at Hanifaru MPA

Regulation/Recommendation	Set out by
No person entering the water is allowed to disturb or tamper with whale sharks or manta rays	Government Directive No. 133-EE/2009/19 (Appendix 2)
It is not allowed to TOUCH, RIDE or SWIM AFTER any animal	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines (Appendix 1 & 4)
Divers and snorkelers should keep a suggested distance of 3 to 4m from the animals	Baa Atoll MoU - Maldivian Manta Ray Project Guidelines- Government Whale Shark Interaction Guidelines (Appendix 1,3 & 4)
The normal movements of the animals should not be restricted	Maldivian Manta Ray Project Guidelines (Appendix 4)

3. Results

3.1. Site use

3.1.1. Site use

Over the study period a total of 52 days (234 hours and 13 minutes) were spent observing the site; 25 days (86 hours and 1 minute) in July and 27 days (148 hours and 12 minutes) in August. The higher number of survey hours in August are representative of the higher abundance of megafauna and levels of tourism at the site compared to those seen in July. During the survey a total of 430 boats, 3569 tourists and 4327 people including guides, were observed using the site. A maximum of 29 boats and 335 people were observed in a single day on 18th August (Figure 3.1a). Site use in August was significantly higher than in July, with 328 (73.6%) of the 430 observed boats recorded in August and an average of 12.98 ± 1.51 S.E. boats per day compared to an average of 4.08 ± 0.45 S.E. in July (Mann-Whitney; $U=140$, $n=52$, $p<0.05$). These trends are also reflected in the number of guests with an average of 32.4 ± 4.3 S.E. people using the bay per day in July compared to 139.8 ± 18.0 S.E. people per day (Mann-Whitney; $U=142.5$, $n=52$, $p<0.05$). In addition a further 50 boats in July and 100 boats in August were observed cruising the bay to check for the presence of mantas or whale sharks (Figure 3.1b).

Figure 3.1 illustrates daily use of Hanifaru Bay by both vessels and people (tourists and guides) alongside manta ray and whale shark abundance. As was also noted by Neves (2009), site use by both boats (Spearman's rank correlation; $\rho=0.758$, $p<0.05$) and people (Spearman's rank correlation; $\rho=0.75$, $p<0.05$) were significantly positively correlated with the abundance of megafauna. Abundance of manta rays shown in this graph is based on estimates by an experienced observer, due to time constraints processing individual identifications; abundance of whale sharks is based on identified individuals.

a.



b.

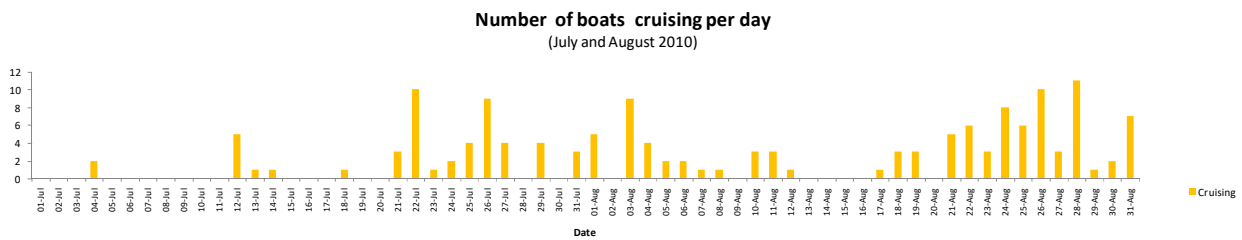


Figure 3.1: Site use at Hanifaru Bay during July and August 2010

In terms of users of the bay there are two key types, the resorts within Baa Atoll and liveaboard ‘safari’ vessels from outside of the area. Figure 3.2 illustrates site use by operator. In both months ‘safari’ boats make up a significant proportion of boats using the bay, 30.4% in July and 50.3% in August, with resort boats accounting for the remaining 69.6% of boats in July and 49% of boats in August with the remaining 0.7% attributed to unknown vessels. Of the resorts Four Seasons account for the majority of site use amongst the resorts accounting for 36.7% of use in July and 19.5% in August.

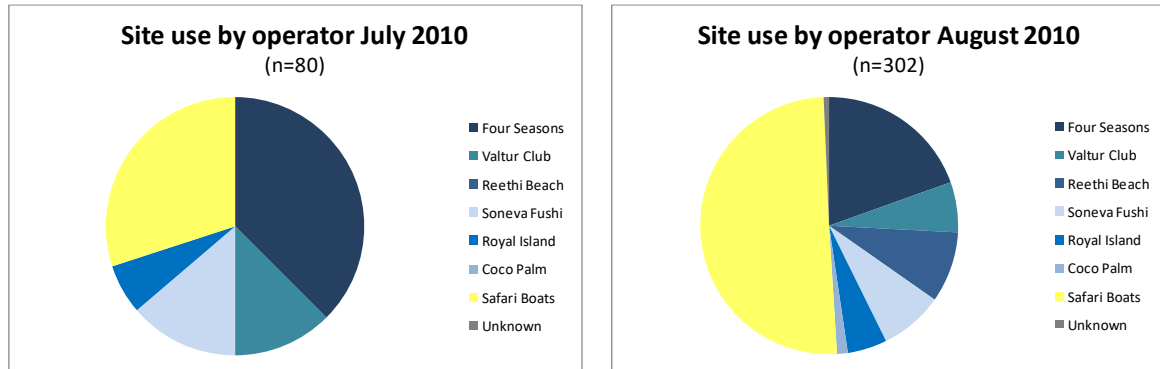


Figure 3.2: Site use by operator in July and August 2010

A total of 35 different safari boats were observed during the course of this study, 13 of which had been seen in 2009 and 22 of which had never used Hanifaru Bay before. In July an average of 1.1 ± 0.3 S.E. safari boats were observed in the bay each day; this increased significantly in August to 4.9 ± 0.5 S.E. per day in August (Mann-Whitney; $U=61$, $n=52$, $p<0.05$).

In terms of activities observed at the bay these were split into 3 broad categories, diving, snorkelling and multiple activities where the people from a particular boat would partake in both snorkelling and diving or multiple dives (Figure 3.3).

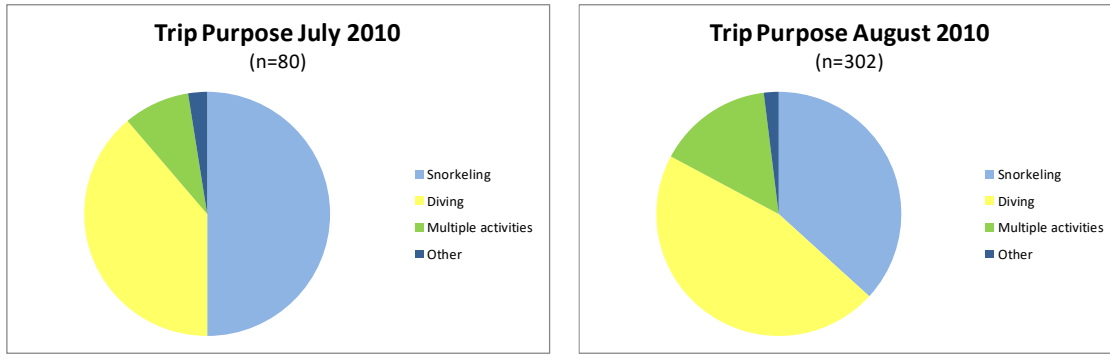


Figure 3.3: Purpose of trips to Hanifaru Bay in July and August 2010

In July the majority, 50%, of trips to Hanifaru were snorkelling trips, however, in August the proportion of snorkelling trips observed in the bay decreased to 36.8%. Conversely the number of diving and multiple use trips increased from 38.8% and 8.8%, respectively in July to 46% and 15.2% in August. When broken down by user type it is clear to see that the types of activity engaged in by each user type was also different, with liveaboard ‘safari’ boats partaking in more diving than resort boats (Figure 3.4). This suggests that the dominance of safari boats seen in August increased diving pressure at the site during this month.

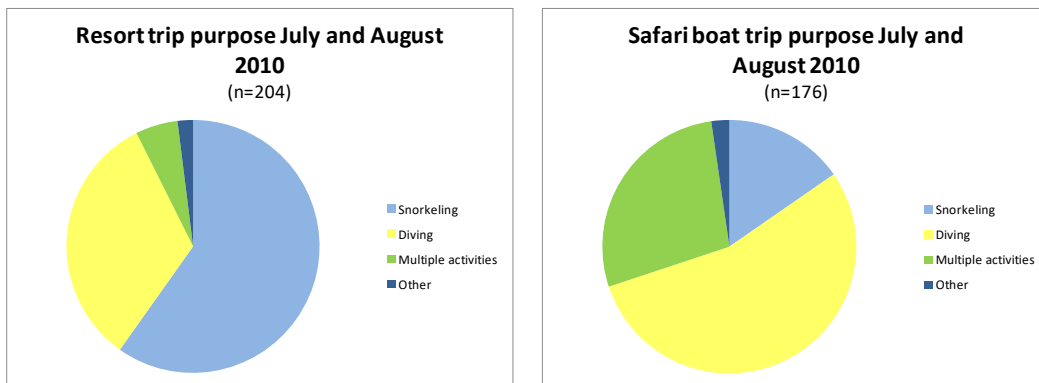


Figure 3.4: Differences in purpose of trips between resort boats and liveaboard ‘safari’ vessels in July and August 2010

Data collected on time spent by each boat in the bay also supported observations of differences in site use by the two user groups. Resort boats most often arrived at the site,

completed one dive or snorkel and then left spending an average of 66.6 ± 2.5 S.E. minutes ($n=179$) at the site, whilst 'safari' boats would spend significantly more time in the bay, often staying on anchor in the bay for several hours doing multiple dives and snorkels spending an average of 85.9 ± 4.2 S.E. minutes ($n=118$) (Mann-Whitney; $U=7020.5$, $n=297$, $p<0.05$).

3.1.2. Compliance to regulations

In July 2010 regulations regarding the maximum vessel capacity of the bay were exceeded on 2 days out of the 25 days surveyed. In August, on 17 of the 27 survey days the vessel capacity of the bay was exceeded. Duration of non-compliance ranged between 15 minutes and 6 hours and 45 minutes with an average duration of just over 3 hours (186 ± 31.3 S.E. minutes). The maximum number of boats observed within the bay simultaneously was 13 (18th August, 2010). Figure 3.5 shows the maximum boat numbers observed simultaneously per day across the full survey period.

In terms of violations of the regulations regarding the numbers of people present at Hanifaru each day a similar pattern (Figure 3.6) was observed with capacity of the bay never observed to be more than 80 people in July but violated on 12 occasions in August. The average duration of non-compliance was generally lower than that observed for boats at slightly over 2 hours (132.5 ± 28.3 S.E. minutes per day) with durations between 15 minutes and 6 hours and 15 minutes observed. The maximum number of people seen at any one time was 187 on the 24th August 2010.

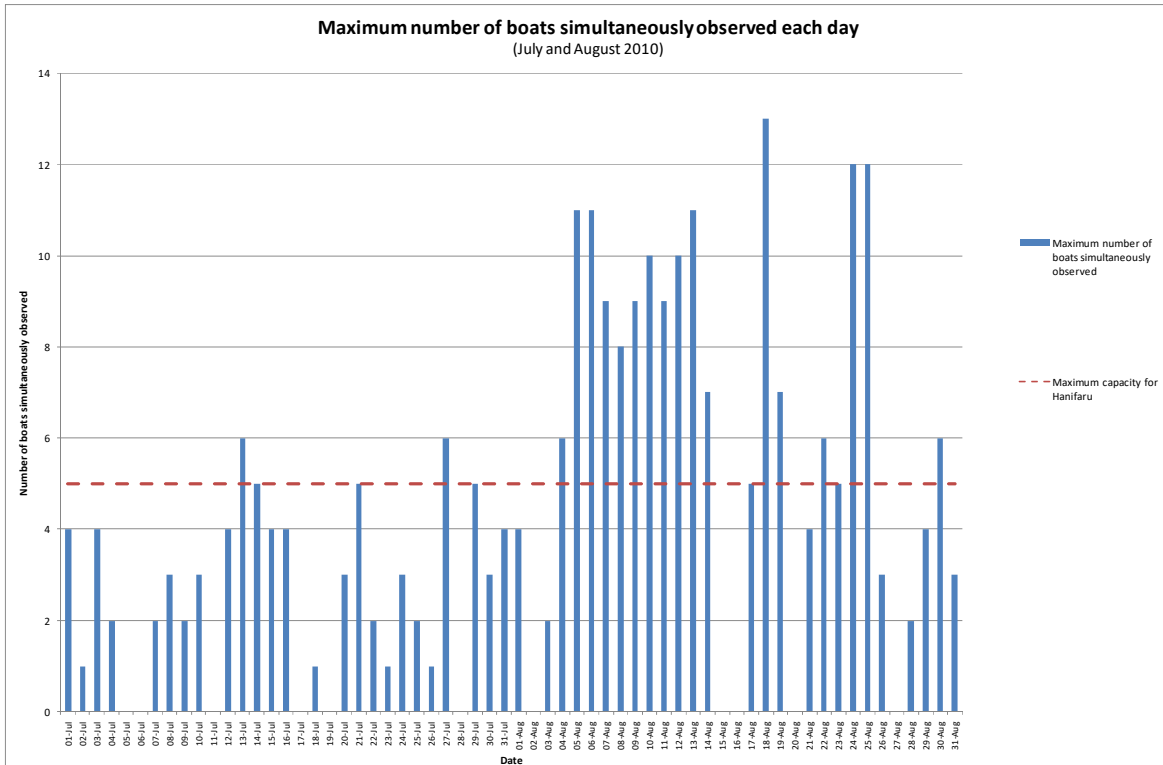


Figure 3.5: Maximum number of boats observed simultaneously each day (July and August 2010)

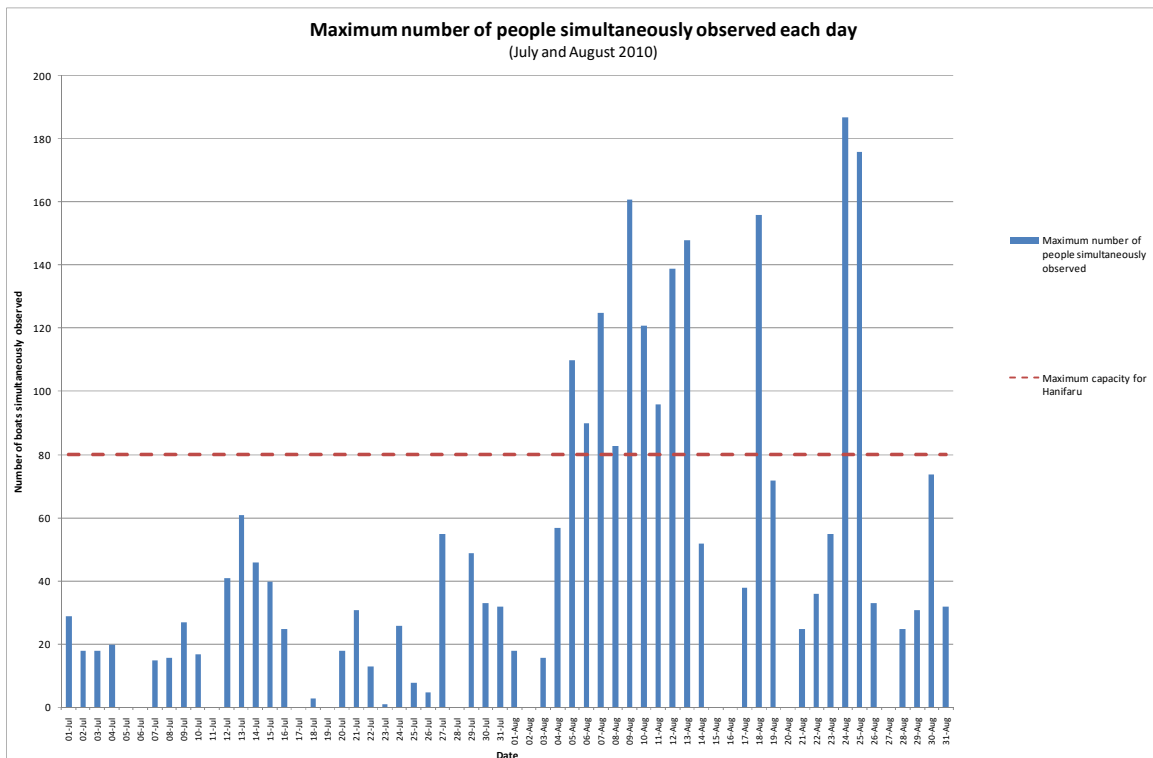


Figure 3.6: Maximum number of people observed simultaneously each day (July and August 2010)

3.1.3. Site use over time

Between 2009 and 2010 there was a dramatic increase in the overall levels of site use at Hanifaru. Over 47 survey days in July and August 2009, a total of 231 boats and 1176 snorkelers and divers were observed at Hanifaru Bay (Neves, 2009; Neves and Stevens, 2009). In 52 days over the same period in 2010, a total of 430 boats and 4237 people were observed using the bay. With the data standardised to take into account the additional survey days in 2010 this represents a 68.3% increase in the number of boats and a 232.6% increase in the number of people using the bay daily between the two years.

Changes were also observed between the types of user and the purpose of trips to the bay between 2009 and 2010. Liveaboard 'safari' boats represented 6% and 23% of all boats using the site in July and August of 2009 (Neves, 2009), where as in 2010 they represented 30.4% and 50.3% of boats using the bay. Diving also increased in relative importance between the 2 years accounting for 26% and 33% of all trips in July and August 2009 (Neves, 2009) and 38.8% and 46% of all trips in 2010 (not including trips where diving was a part of multiple use of the site).

The maximum numbers of boats and tourist observed in a single day was also higher in 2010 at 29 boats and 335 people observed on 18th August 2010 compared to 12 boats observed on the 24th July 2009 and 120 people observed on 20th August, 2009 (Neves, 2009).

Data from 2007 onwards collected by the MMRP and Neves (2009) was compared to data collected in 2010 to evaluate changes in site use over time (Figure 3.7). Data was predominantly collected from May to November each year, reflecting the seasonal nature of the site, and standardised to represent the average number of boats and tourists observed each day. Data collection prior to July 2009 was not carried out with such precision however across all years there is an obvious trend of tourism peaking in the months from July to October corresponding to the presence of whale sharks and mantas. Data collected in 2010, especially August, show that tourism is substantially higher than in previous years, supporting the concerns raised by Neves and Stevens (2009).

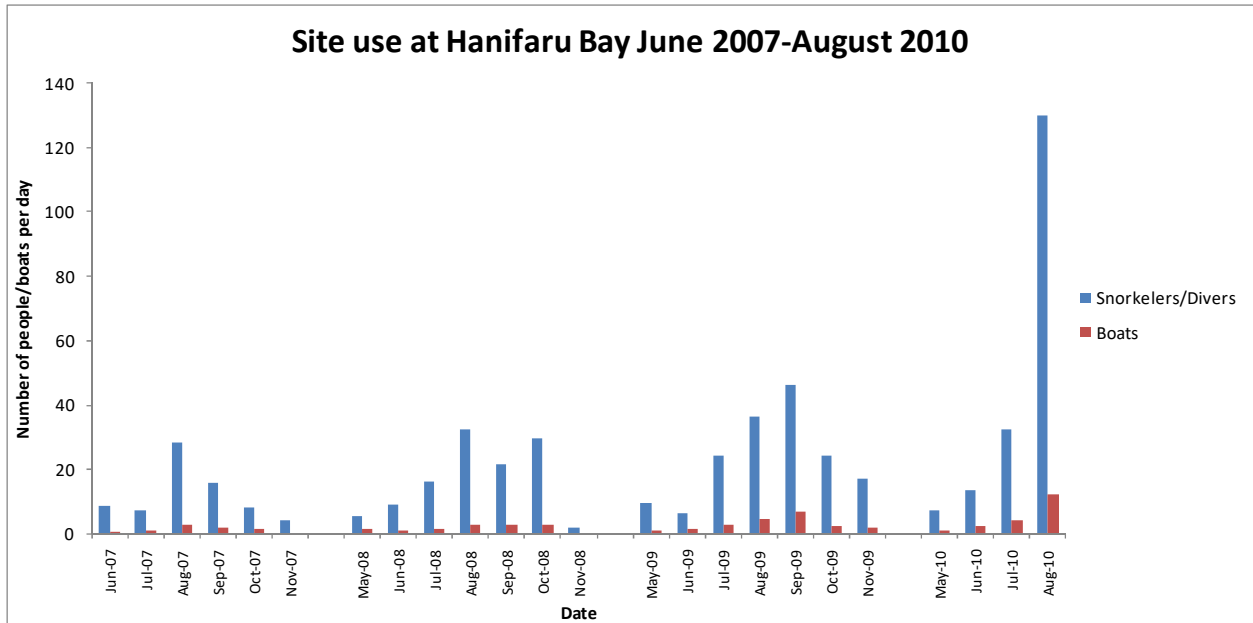


Figure 3.7: Site use from June 2007 to August 2010.

3.2. Boat conduct

The heavy levels of site use seen in 2010 (described in section 3.1.1.) highlight the importance of the regulations and guidelines in place pertaining to boat use in Hanifaru MPA. Although in general good levels of compliance were observed during this study non-compliant behaviour was observed in all areas outlined in Table 2.2 potentially jeopardising the safety of site users and animals.

Figure 3.8 and 3.9 show the levels of inadequate conduct occurring on entrance to and exiting of the bay; observations on speed, conduct (use of the correct entry and exit routes avoiding the main feeding area) and dropping off and picking up of snorkelers and divers within the main feeding area are considered in this analysis. Proportions of non-compliant behaviour are shown across all users of the MPA and broken down by user groups.

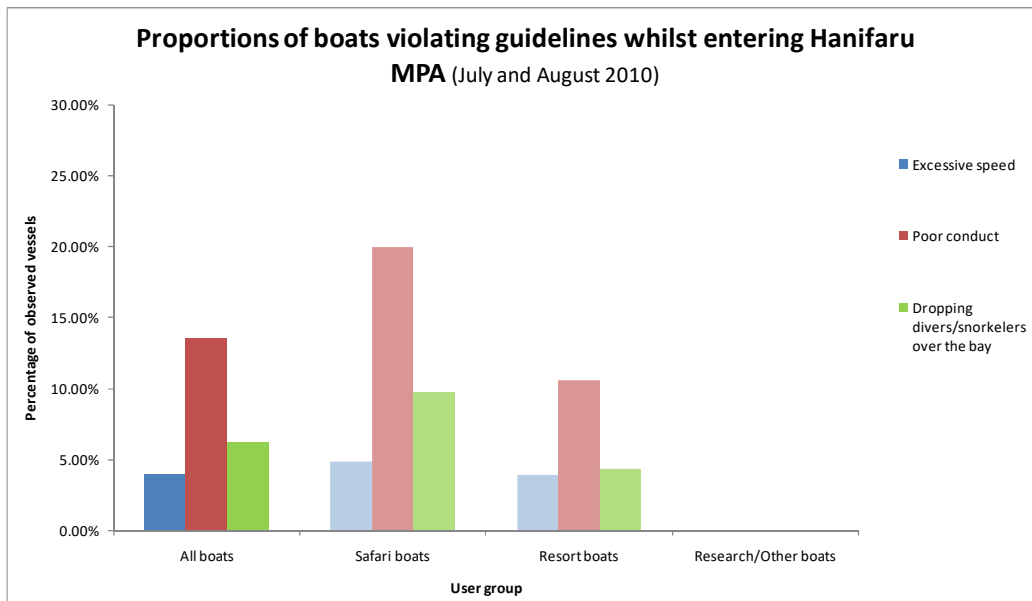


Figure 3.8: Proportion of boats violating guidelines whilst entering Hanifaru Bay

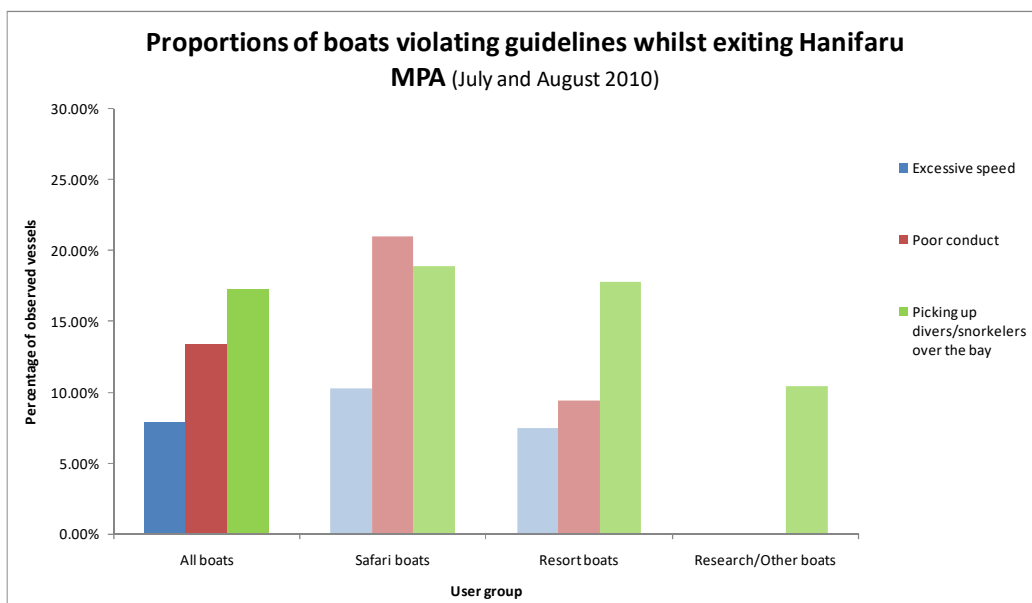


Figure 3.9: Proportion of boats violating guidelines whilst exiting Hanifaru Bay

Overall good levels of compliance were observed with in excess of 80% of all vessels complying with each regulation. In all categories ‘safari’ vessels showed a greater proportion of non-compliant behaviour than other vessels, this most likely reflects the number of vessels seen which had no previous experience within the bay.

Most concerning of these behaviours is the proportions of boats showing poor conduct when entering (13.5%) or exiting (13.4%) the bay and the proportion of boats which pick up divers or snorkelers over the bay (17.3%). Such use of boats in the main feeding area of the bay risks the safety of other users and animals.

Whilst the law related to anchoring in Hanifaru states there should be no anchoring in the bay (this law applies in all Maldivian MPAs) the MoU and MMRP guidelines advise otherwise. Anchoring in Hanifaru is important since the currents that draw in the plankton rich water also cause boats to drift down the channel and over the bay; this means if boats do not anchor they would need to regularly reposition therefore using their engines close to people and animals. This analysis only considers boats which used the bay (not vessels which cruised) and boats which had encounters in the main feeding area (where the anchoring area is close to the area snorkelers and divers are using), however, recommendations and guidelines pertaining to anchoring were still violated. Figure 3.10 shows the proportions of boats anchoring incorrectly or not at all.

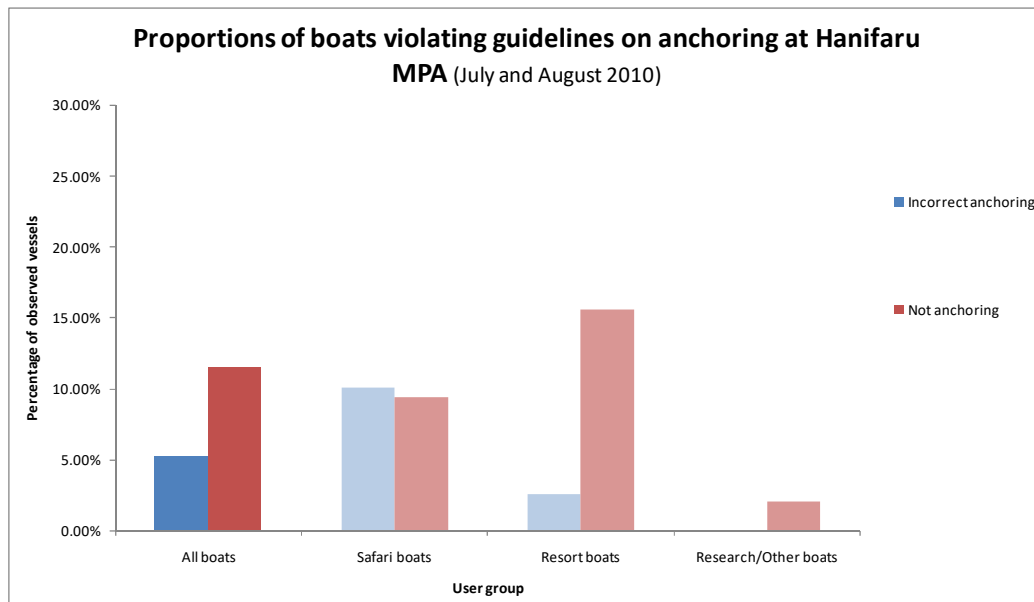


Figure 3.10: Proportions of boats violating guidelines on anchoring at Hanifaru Bay

Overall 5.3% of boats seen over the duration of the survey did not anchor correctly when using the bay with a further 11.5% not anchoring at all. On a number of occasions poor anchoring or not anchoring was observed when the bay was already overcrowded with boats, therefore making the task of anchoring very difficult.

Incorrect anchoring can present problems for the manta rays and whale sharks in Hanifaru. Anchoring in deep water, for example, causes anchor lines to become an obstruction for animals, in one instance during the course of this study a whale shark was observed entangled in the anchor line of a vessel, temporarily distressing the animal and causing it to stop feeding. Other instances of non compliant behaviour are shown in Figure 3.11.

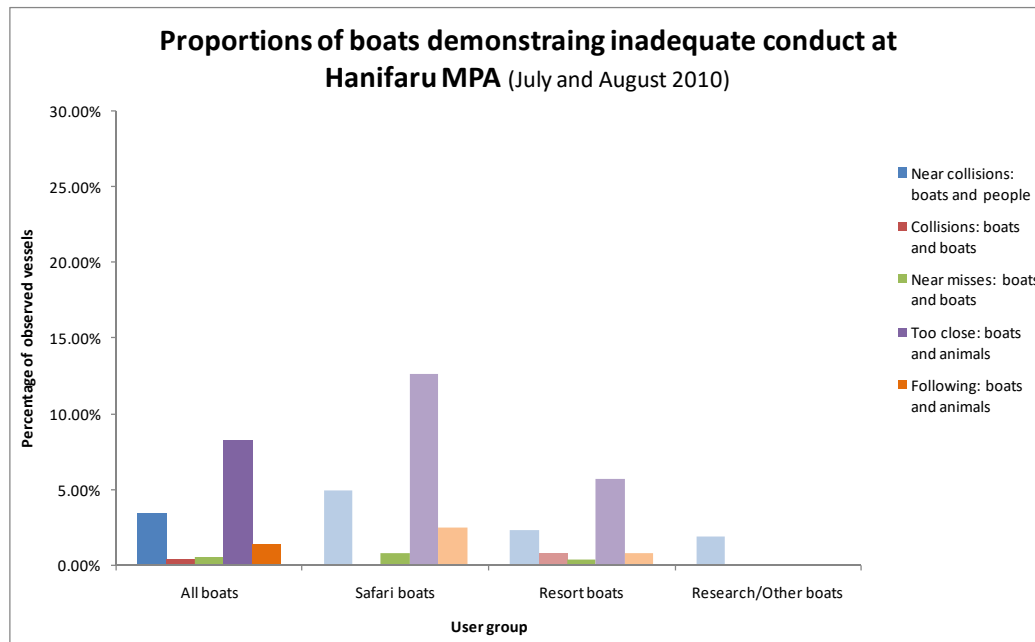


Figure 3.11: Proportions of boats displaying inadequate conduct at Hanifaru Bay

The most concerning of these other non-compliant behaviours is the proportion of boats seen driving too close to animals (closer than 10m as outlined in the law), a behaviour demonstrated by 8.2% of all users in the bay. ‘Safari’ boats were far greater offenders in this category with 12.7% of all ‘safari’ boats observed during the survey driving too close to animals (often when picking up divers over the bay) whilst resort boats came too close to animals in 5.3% of cases. Also concerning is the number of instances of boats following animals; on 8 occasions boats were observed directly following animals in order that their passengers could either observe or photograph them from the surface (3 occasions) or could jump directly into the path of a whale shark or manta rays (5 occasions).

Although no divers or snorkelers were hit by boats during the course of this study several near misses were observed, with boats drifting over snorkelers whilst picking up or dropping divers in over the bay (7 occasions); with divers or, of greater concern, free divers being

passed directly overhead by boats (7 occasions); or by boats which were not anchored drifting into stationary boats while collecting guests, forcing the guests between the two vessels (4 occasions). Observations of boats colliding with one another (2 occasions) were both made when boats were on anchor and in both instances where boats were anchored in too high a number and therefore too close together.

In most categories, as also observed in entry and exit misconduct, the greater proportion of incorrect behaviour observed was from safari boats, this is also true of behaviour observed in 2009 (Neves, 2009). Further investigation into why this might be revealed that although legislation had been brought in by the Maldivian government there had been a lack of communication of this to users of the bay. Despite the law being passed in June 2009, discussions with a number of safari vessel crews and divemasters revealed that they had not been informed of any laws pertaining to Hanifaru Bay. Whilst the resort boats and some safari boats had used Hanifaru regularly in the past, with the resort boats operating under the MoU, 22 (62.9%) of the safari boats seen during the 2 month study had not previously visited the site and therefore would have had very limited, if any knowledge of how to behave whilst using the bay.

3.3. Tourist conduct and animal reactions

Inwater observations were made on 25 days in July and 25 days in August. Minor instances of misconduct involving a single person were only recorded on 10 days throughout the survey, however due to the volume of tourism at the site and the small sampling time spent with each group it is possible that these occasions were occurring with a greater frequency. The misconduct observed in these cases included intentional touching of the animals, chasing the animals and accidental collisions and resulted in varying degrees of reaction from no reaction at all, to flinching and continuing with swimming or feeding, to stopping feeding and swimming away from where the incident occurred. There was variability seen between the reactions with the same behaviours from tourists in the water causing a variety of responses from the animals.

On 5 days throughout the survey where feeding intensity was not at a high level mantas were noted to obviously stop feeding as a reaction to exhaust bubbles from diver's regulators. Such a reaction has serious implications for the future management of the site in the light of the rising dominance of diving at this location.

On 7 days during the course of the survey, on days where there was a high abundance of megafauna and a large number of tourists, major instances of misconduct were observed. Often the worst tourist behaviours occurred when whale sharks were present in the bay. Disruptive behaviours included touching, chasing and overcrowding. These major episodes are described in Table 3.1. Figures 3.12 – 3.14 show some of the behaviours observed

Table 3.1: Major instances of misconduct

Date	Megafauna abundance	Maximum people/boats	Tourist behaviours observed	Megafauna reactions observed
5 th August	Mantas: 150 Whale sharks: 1	People:95 Boats:10	Mantas observed being ridden, touched and chased. Whale shark was observed being touched and very overcrowded	Ridden manta swam away very fast, some other mantas occasionally flinched, most did not react. Shark did not react continued to feed (dense prey abundance)
10 th August	Mantas: 40-50 Whale sharks: 1	People:87 Boats:7	4 boats (50 people) drove directly to shark when it arrived in the bay. Whale shark was observed being touched and very overcrowded	None Continued feeding (dense prey abundance)
12 th August	Mantas: 250 Whale sharks: 2	People:139 Boats:10	Several mantas observed being touched. Whale shark was observed being deliberately touched and accidentally kicked and very overcrowded (87 snorkelers observed simultaneously), photographers strobes twice seen caught in shark's gills, one snorkeler observed holding on.	None Continued feeding (dense prey abundance)
13 th August	Mantas: 120 Whale sharks: 1	People:52 Boats:7	Whale shark was overcrowded with people moving too close, one tourist dragged along caught on dorsal fin	None Continued feeding (dense prey abundance)
18 th August	Mantas: 50 Whale sharks: 4	People:156 Boats:13	Good behaviour until people arrived in large numbers at which point whale shark was crowded and touched on several occasions. Divers diving at less than 1m depth to be close to shark.	None Continued feeding (dense prey abundance)
23 rd August	Mantas: 50 Whale sharks: 1	People:55 Boats:5	When shark first arrived (not high abundance of food) it was overcrowded by 20 snorkelers from one boat	Shark sank to bottom to move away from snorkelers and left the bay for 30 mins; later returned and stayed all day
24 th August	Mantas: 40 Whale sharks: 0	People:187 Boats:12	Film crew and photography groups too close to mantas with cameras. High volume of divers compared to mantas.	The high numbers of divers were observed on several occasions to break up co-operative cyclone feeding by the mantas



Figure 3.12: Tourists observed touching whale shark

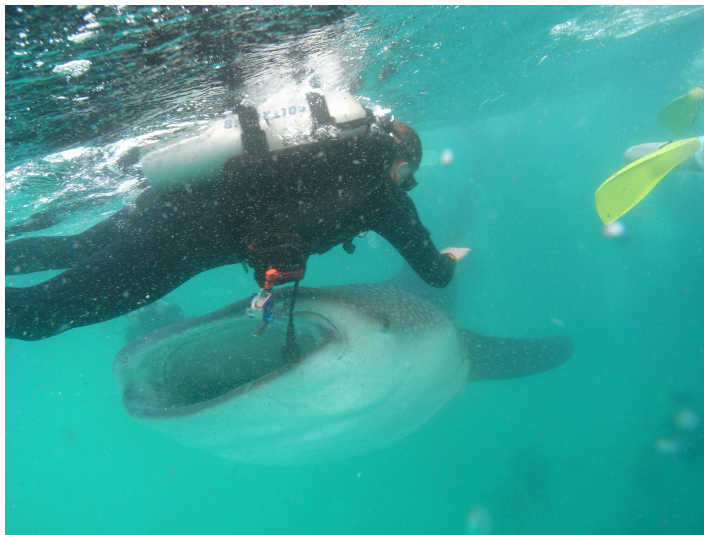


Figure 3.13: Diver obstructs the normal movements of a whale shark



Figure 3.14: Overcrowding of whale shark

Observations of behaviour and reactions in this study suggest that the reactions of megafauna to this disruption often seemed to depend on the intensity of feeding occurring. At times where manta rays or whale sharks were intensively feeding they often did not react to tourists even in situations of extreme provocation, however, if food abundance was lower they reacted more extremely often stopping feeding or leaving the area temporarily. This difference is important to note and should not be construed as the tourists in the bay not having an impact on manta ray or whale sharks utilising the bay. Longer term studies will reveal whether or not these animals continue to use the bay in the face of continued tourism and further work needs to be done to look at prey abundance and animal reactions.

4. Discussion

Despite Hanifaru Bay's recent designation as a MPA with legislation in place to govern its use, at present this site is little more than a paper park. The regulations pertaining to its use have been poorly communicated to those who use or who might potentially visit the site and the site lacks any official government presence, with no enforcement or penalties to ensure that users comply with regulations. Moreover, certain regulations especially those pertaining to boat conduct, speed and anchoring in the bay do not account for the unique nature of the site and if obeyed would make use of the bay more dangerous for both people and megafauna. This study presents a worrying picture of rapid growth in tourism in the face of this lack of appropriate management, suggesting that the Maldivian government needs to take further measures to ensure the ongoing conservation of this important biological site and economic resource.

4.1 Site use

Site use at Hanifaru is growing year on year, however the growth seen in 2010 was exceptional with boat numbers in July and August 68.3% higher and number of users 232.6% higher than over the same period in 2009. In addition the type of operators frequenting the site also changed with a far greater proportion of liveaboard 'safari' vessels seen in both July (30.4% of boats in 2010 cf. 6% in 2009) and August (50.3% of boats in 2010 cf. 23% in 2009) (Neves, 2009). These changes have in turn led to a greater popularity of diving in the bay in 2010 with diving representing 39.5% of all trips to the bay.

The regulations in place to govern site use with regards to the number of boats and people that can use the site are currently set at a sensible level for the site. The bay has enough space for the safe anchorage of 5 vessels and for use by up to 80 people. It was on days where numbers exceeded these that issues began to arise with anchoring boats, collisions between boats on anchor, and overcrowding of animals. In addition to safety implications, numbers of boats and people also has effects on visitor satisfaction with overcrowding having been shown to decrease visitor satisfaction at other locations, such effects could also likely be seen at Hanifaru (Davies *et al.*, 1997; Cohun, 2005; Caitlin and Jones, 2010).

Although the regulations are suitable for the site the key issue is the lack of management of these regulations; at present there is no authoritative body on site to enforce the regulations and as such operators were observed to consistently break the rules. In order to better manage boats using Hanifaru, a permit system has been suggested by the MMRP where vessels can purchase the right to use the site on a given date at a given time in advance of the season. Given the knowledge already in place with regards to patterns of megafauna abundance, premium prices could be charged for days and times where expected abundance is greater. Charges from these permits could be used in the ongoing management of the MPA. In other countries limited entry to the industry is also used as a management tool for site use and should be considered in the case of Hanifaru (Davies *et al.*, 1997; Mau, 2008).

4.2. Boat conduct

The regulations in place to govern boat conduct in the bay are inadequate and show a lack of understanding of the unique nature of the site. A 10 nautical mile speed restriction does not show an appreciation of the size and unique nature of the site and the animals which frequent it, a collision at this speed could prove extremely dangerous if not fatal to animals or indeed snorkelers or divers in the water. In addition, not anchoring, as also suggested by the legislation in place, is a dangerous option in a site which has a strong prevailing current and a limited area for inwater activity of both people and animals. Mooring buoys have been suggested for use in Hanifaru, however these constant inwater obstructions pose a threat to manta rays who have been known to get permanently entangled in lines resulting in death (Stevens, G., personal communication). The seabed topography at the eastern end of the lagoon provides safe and easy anchorage and anchor lines only present a temporary and minor obstruction to animals in the bay.

Overall boat conduct in the bay, measured against the more practical measures suggested for boat conduct in the MoU and MMRP guidelines, was fairly good with 80% or more of all boats complying with regulations. Boat compliance to codes of conduct seemed to be affected by site use with excessive numbers of boats and people providing barriers to proper conduct; for example at times where site use is higher anchoring becomes more difficult and often impossible.

Communication of the regulations was found to be absent for the 2010 season with large numbers of new boats visiting the site who did not know of the official government regulations in place. All users or potential users should be informed of the regulations in order that there is no misunderstanding of what is required.

4.3. Tourist conduct and animal reactions

With tourist interactions with animals in the wild increasing, managers are under increasing pressure to satisfy the conflicting values of recreational use while protecting the animals involved (Sorice *et al.* 2003). While it is often assumed that ecotourism based on wildlife is inherently sustainable only a few attempts have been made to verify this, furthermore ecotourism has the potential to cause significant damage since it often occurs in fragile environments and opens up previously undiscovered destinations to the mass market (Roe *et al.*, 1997), such has been the case in Hanifaru.

Whilst a number of minor incidents were observed the real concern that emerged from this study was the deterioration of behaviour when there were large numbers of people and megafauna using the site simultaneously. This urgently reinforces the need for onsite enforcement of regulations especially those pertaining to numbers of boats and people.

Observations made in this study also suggest that diving might have negative impacts causing manta rays to stop feeding to avoid regulator exhaust bubbles. In addition, when diving and snorkelling occur simultaneously animals at the site are restricted in their movements with people using the water immediately above and below them. One solution to this could be to restrict diving at the site especially since it might prove of short term detriment to the animals using the site. Diving is not needed to ensure an excellent encounter with the feeding animals, which are usually close to the water's surface. Diving is also much more time consuming (therefore reducing the turnover of tourists who can visit the site), it is harder to police, and divers are generally much less able to swim to and from the anchored vessels than snorkelers, therefore increasing safety and disturbance concerns. A diving ban would also create a refuge for the manta rays and whale sharks.

Observations in this study indicate that the behaviour of animals at this site is influenced by interactions with people. Although no major reactions were observed during the 2 months of this survey a number of the more minor reactions show short term changes in behaviour from feeding to avoidance and therefore may have implications for long-term survival (Colman, 1997; Sorice, 2003; Quiros, 2007). More casual observations made in this study also suggested that in times where food abundance is higher, reactions to provocation are lessened or occasionally the animals were observed to stop reacting altogether despite highly invasive behaviours directed at them. This field would benefit from further study. The dangers of not understanding such a phenomenon could easily lead to the misinterpretation of animal behaviour and disturbance.

Briefing tourists plays an essential role and is a mandatory requirement of signatories of the MoU, this should be extended to all users of the bay. Medio *et al.* (1997) demonstrated the effectiveness of briefings in improving diver behaviour.

Further research is required in order to establish if tourism at Hanifaru negatively effects the longer term movements and return rates of manta rays and whale sharks to Hanifaru.

4.4. Future management

Hanifaru Bay is a unique site offering visitors an unrivalled experience and it continues to attract high profile attention with further documentaries, newspaper and magazine articles planned for the near future. As such there is unlikely to be a decline in tourists who wish to experience the site.

In the light of the findings of this study it is essential that Hanifaru Bay is actively managed. The findings of this study suggest that two key issues need to be addressed by the government, firstly the relevance of the legislation in place given the unique nature of Hanifaru Bay and secondly, the onsite enforcement of the legislation in place. However, effective management, especially onsite monitoring, comes at a price and funding opportunities to cover the costs of such management need careful consideration. Government agencies responsible for conservation in the Maldives state that they face persistent shortfalls in funding and at present the budget for environmental protection in the Maldives accounts for less than 1% of government spending and has done for the last 6 years (Emerton *et al.*, 2009).

At present, funding sources for biodiversity conservation in the Maldives are government financial support and overseas donor funding (Emerton *et al.*, 2009). Self generated revenue from the sustainable use of biodiversity from non-extractive uses is low, with few attempts made to identify cases where charges and fees could and should be levied for biodiversity goods and services, despite the fact that these activities often generate high economic values (Emerton *et al.*, 2009).

A study of willingness to pay (WTP) in MPAs that attracted divers and snorkelers suggests an overwhelming approval to pay for entry to such sites (Peters and Hawkins, 2009). Furthermore, a WTP study conducted in Baa Atoll found that 85% of overseas visitors are willing each to contribute US\$35 per visit to marine and coastal conservation; with current visitor numbers of around 45,000 people per year this represents potential revenue of over US\$1.5 million (Emerton *et al.*, 2009). Given the high visitor numbers observed at Hanifaru and therefore the high demand for the site the government should consider this unexploited financial resource in funding management activities for the site.

With regards to changes in regulations, these should be made in close consultation with those who use the site most frequently especially the MMRP who observe the site and those who use it on a daily basis. Moreover it is vital that any further regulations pertaining to use of the site should not compromise the ongoing biological and ecological studies of the MMRP who provide not only important insights to the species that frequent the site, but also continue to inform knowledge on what influences the feeding events for which Hanifaru is so renowned and who are vital in monitoring tourism at the site to ensure it does not have long-term detrimental effects for manta rays and whale sharks.

Any measures brought into place, especially those relating to the management of site capacity, need to be actioned urgently since operators using the site will be taking bookings and planning promotions well in advance of the season (Davies *et al.*, 1997) and will need to make the relevant changes to their scheduling and promotional activities.

As a small site, with clearly defined entry and exit routes, which therefore is easily manageable on a practical basis, Hanifaru has the opportunity to become a model upon which MPA management in the Maldives can be based in terms of funding, management and enforcement. An adaptive approach to management is vital in order that ongoing research can continue to inform management and that all measures required to conserve the future of this site can be taken.

5. Conclusions and recommendations

Hanifaru Bay is a unique site, crucial for manta rays and whale sharks in the Maldives. The Maldivian government has taken vital measures to ensure its protection, however, its designation as a MPA is only the first step in ensuring its ongoing conservation. Further research and consistent monitoring and enforcement are required if the site is to be preserved for future conservation and tourism uses. As such it is recommended that the following steps are taken:

- Existing regulations need urgent adaptation to account for the unique nature of Hanifaru Bay.
- Options such as limited entry to the tourism industry at Hanifaru or a permit system need to be developed urgently in order that site access at Hanifaru can be allocated between all potential users in a systematic way.
- Onsite enforcement of regulations need to be urgently addressed; in particular the regulations pertaining to levels of site use since other regulations become harder to enforce once levels of people reach a certain amount.
- Penalties for the infringement of regulations at Hanifaru need to be introduced in order to incentivise operators to stay within the law.
- Clear and timely communication of regulations to all the operators using or potentially using the site is vital.
- Communication of regulations to tourists using the site is vital through the use of briefings.
- The continuation of diving at the site needs careful consideration.
- Self-funding opportunities need to be urgently considered.
- Monitoring of both the tourism effects and manta rays and whale sharks need to be continued to not only further the understanding of these species but to ensure that tourism levels are not having any long term detrimental effects.

References

- AEC (2010). Atoll ecosystem conservation project website. [Online] Available from:
<http://www.biodiversity.mv/aec/> [Accessed 2nd September, 2010].
- Anderson, R.C. and Ahmed, H. (1993). *The shark fisheries in the Maldives*. Rome: FAO and Malé: Ministry of Fisheries and Agriculture.
- Anderson, R.C., Adam, M.S., Kitchen-Wheeler, A-M. and Stevens, G. (in press a). Extent and economic value of manta ray watching in Maldives. *Tourism in Marine Environments*.
- Anderson, R.C., Adam, M.S. and Goes, J.I. (in press b). Seasonal distribution of manta rays (*Manta birostris*) in the Maldives. *Fisheries Oceanography*.
- Barcott, B. (2009). Feeding frenzy. *National Geographic Magazine*. July Issue 2009.
- BBC (2009). Andrea – Queen of Mantas. *BBC Natural World 2009-2010 series*.
- Brooks, K., Rowat, D., Pierce, S., Jouannet, D. and Vely, M. (in review). Seeing spots.... photo I.D. a regional tool for whale shark identification. *WIO Journal of Marine Science*.
- Brunnschweiler, J.M., Baensch, H., Pierce, S.J. and Sims, D.W. (2009). Deep-diving behaviour of a whale shark *Rhincodon typus* during long-distance movement in the western Indian Ocean. *Journal of Fish Biology*. 74 (3), 706-714.
- Caitlin, J. and Jones, R. (2010). Whale shark tourism at Ningaloo marine park: A longitudinal study of wildlife tourism. *Tourism Management*. 31 (3), 386-394.

- Cohun K. (2005) *Managing the Gladden Spit Marine Reserve: An Analysis of the Whale Sharks Dive Tourism Industry in Placencia, Belize*. MSc thesis, Duke University, USA. [Online] Available from: <http://dukespace.lib.duke.edu/dspace/bitstream/10161/224/1/Cohun%20MP%202005.pdf> [Accessed 15th September, 2010]
- Colman, J.G. (1997). A review of the biology and ecology of the whale shark. *Journal of Fish Biology*. 51 (6), 1219-1234.
- Compagno, L.J.V. (2001). *Sharks of the world. An annotated and illustrated catalogue of shark species known to date, Vol. 2. Bullhead, carpet and mackerel sharks (Heterodontiformes, Lamniformes and Orectolobiformes)*. FAO species catalogue for fisheries purposes. No 1. FAO, Rome. [Online] Available from: <http://www.fao.org/docrep/009/x9293e/x9293e00.HTM> [Accessed 22nd March, 2010].
- Davis, D., Banks, S., Birtles, A., Valentine, P. and Cuthill, M. (1997). Whale sharks in Ningaloo marine park: managing tourism in an Australian marine protected area. *Tourism Management*. 18 (5), 259-271.
- Eckert, S.A., Dolar, L.L., Kooyman, G.L., Perrin, W. and Rahman, R.A. (2002). Movements of whale sharks (*Rhincodon typus*) in South-east Asian waters as determined by satellite telemetry. *Journal of Zoology*. 257, 111-115.
- Eckert, S.A. and Stewart, B.S. (2001). Telemetry and satellite tracking of whale sharks, *Rhincodon typus*, in the Sea of Cortez, Mexico, and the north Pacific Ocean. *Environmental Biology of Fishes*. 60 (1-3), 299-308.
- Emerton, L., Baig, S. and Saleem, M. (2009). *Valuing biodiversity: the economic case for biodiversity conservation in the Maldives*. AEC project, Ministry of Housing Transport and Environment, Government of Maldives and UNDP Maldives.
- Fowler, S.L. (2000). *Whale shark Rhincodon typus Policy research and scoping study*. WWF, WildAid and the Shark Trust Nature Conservation Bureau, UK.

- Gifford, A., Compagno, L.J.V., Levine, M. and Antoniou, A. (2007). Satellite tracking of whale sharks using tethered tags. *Fisheries Research*. 84 (1), 17-24.
- Graham, R.T., Roberts, C.M. and Smart, J.C.R. (2006). Diving behaviour of whale sharks in response to a predictable food pulse. *Journal of the Royal Society Interface*. 3, 109-116.
- Graham, R.T. And Roberts, C.M. (2007). Assessing the size, growth rate and structure of a seasonal population of whale sharks (*Rhincodon typus* Smith 1828) using conventional tagging and photo identification. *Fisheries Research*. 84 (1), 71-80.
- Heyman, W.D., Graham, R.T., Kjerfve, B. And Johnannes, R.E. (2001). Whale sharks *Rhincodon typus* aggregate to feed on fish spawn in Belize. *Marine Ecology Progress Series*. 215, 275-282.
- Hsu, H-H., Joung, S-J., Liao, Y-Y. and Liu, K-M. (2007). Satellite tracking of juvenile whale sharks, *Rhincodon typus*, in the Northwestern Pacific. *Fisheries Research*. 84 (1), 25-31.
- IUCN. (2009). *IUCN red list of threatened species*. Version 2009.2. [Online] Available from: <http://www.iucnredlist.org> [Accessed 30th January 2010]
- Jameel, A., Hameed, F., Shakeel, H., Ahmed, H., Shareef, H.A., Shareef, M., Saleem, M., Aslam, M., Faiz, M., Zuhair, M., Hassan, Z.M. and Saeed, S. (2002). *National Biodiversity Strategy and Action plan of the Maldives*. Malé: Ministry of Home Affairs Housing and Environment. [Online] Available from: <http://www.cbd.int/doc/world/mv/mv-nbsap-01-en.pdf> [Accessed 2nd September 2010]
- Jones, T., Wood, D., Caitlin, J. and Norman, B. (2009). Expenditure and ecotourism: predictors of expenditure for whale shark tour participants. *Journal of Ecotourism*. 8(1), 32-50.

- Marshall, A., Ishihara, H., Dudley, S.F.J., Clark, T.B., Jorgensen, S., Smith, W.D. and Bizzarro, J.J. (2006). *Manta birostris*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1[Online] Available from: <http://www.iucnredlist.org> [Accessed 31st August 2010].
- Marshall, A.D., Compagno, L.J.V. and Bennett, M.B. (2009). Redescription of the genus *Manta* with resurrection of *Manta alfredi* (Krefft, 1868) (Chondrichthyes; Myliobatoidei; Mobulidae). *Zootaxa*. 2301, 1-28.
- Mau, R. (2008). Managing for conservation and recreation: the Ningaloo whale shark experience. *Journal of Ecotourism*. 7(2), 213-225.
- Meekan, M.G., Bradshaw, C.J.A., Press, M., McLean, C., Richards, A., Quasnicka, S. and Taylor, G. (2006). Population size and structure of whale sharks *Rhincodon typus* at Ningaloo Reef, Western Australia. *Marine Ecology Progress Series*. 319, 275-285.
- Meekan, M.G., Jarman, S.N., McLean, C. and Schultz, M.B. (2009). DNA evidence of whale sharks (*Rhincodon typus*) feeding on red crab (*Gecarcoidea natalis*) larvae at Christmas Island, Australia. *Marine and Freshwater Research*. 60 (6), 607-609.
- Ministry of Legal Reform, Information and Arts. (2008). *Constitution of the Republic of Maldives 2008*. Functional translation by D.Hussein. [Online] Available from: <http://www.presidencymaldives.gov.mv/publications/constitution.pdf> [Accessed 2nd September 2010]
- Ministry of Tourism, Arts and Culture. (2009). *Tourism Yearbook 2009*. [Online] Available from: http://www.tourism.gov.mv/downloads/stat_yearbook_2009.pdf [Accessed 2nd September 2010]
- Ministry of Tourism and Civil Aviation. (2007). *Maldives Third Tourism Master Plan 2007-2011*. [Online] Available from: <http://www.tourism.gov.mv/downloads/ttmp.pdf> [Accessed 2nd September 2010]

- Neves, L. (2009). *Investigating anthropogenic impacts on the manta rays and whale sharks of Hanifaru, Maldives*. MSc Thesis, University of York, UK.
- Neves, L. and Stevens, G. (2009). *Investigating anthropogenic impacts on the manta rays and whale sharks of Hanifaru Bay, Maldives: a short report of the Ministry of Environment, Maldives; EPA and AEC project*.
- Peters, H. and Hawkins, J.P. (2009). Access to marine parks: a comparative study in willingness to pay. *Ocean and Coastal Management*. 52 (3-4), 219-228
- Pierce, S. (personal communication). Foundation for the protection of marine megafauna, Mozambique. 2009.
- Quiros, A.L. (2007). Tourist compliance to a code of conduct and the resulting effects on whale shark (*Rhincodon typus*) behaviour in Donsol, Philippines. *Fisheries Research*. 84 (1), 102-108.
- Riley, M.J., Hale, M.S., Harman, A. and Rees, R. (2010). Analysis of whale shark *Rhincodon typus* aggregations near South Ari Atoll, Maldives Archipelago. *Aquatic Biology*. 8, 145-150.
- Roe, D., Leader-Williams, N. and Dalal-Clayton, B. (1997). Take only photographs leave only footprints: the environmental impacts of wildlife tourism. *Wildlife and Development Series No.10*. International Institute for Environment and Development.
- Rowat, D and Engelhardt, U. (2007). Seychelles: a case study of community involvement in the development of whale shark ecotourism and its socio-economic impact. *Fisheries Research*. 84 (1), 109-113.
- Rowat, D. and Gore, M. (2007). Regional scale horizontal and local scale vertical movements of whale sharks in the Indian Ocean off Seychelles. *Fisheries Research*. 84 (1), 32-40.

Sorice, M.G., Shafer, C.S. and Scott, D. (2003). Managing endangered species within the use/preservation paradox: understanding and defining the harassment of the West Indian manatee (*Trichechus manatus*). *Coastal Management*. 31 (4), 319-338.

Stevens, G. (personal communication). Maldivian Manta Ray Project, Maldives. 2010.

Stevens, G. (unpublished data). Maldivian Manta Ray Project, Maldives. 2010.

Wilson, S.G., Polovina, J.J., Stewart, B.S. and Meekan, M.G. (2006). Movements of whale sharks (*Rhincodon typus*) tagged at Ningaloo Reef, Western Australia. *Marine Biology*. 148 (5), 1157-1166.

Appendix 1.

Memorandum of Understanding between Baa Atoll Resorts, 2009

MEMORANDUM OF UNDERSTANDING

Because of Hani Faru's extreme importance to the manta rays and whale sharks in the Maldives as well as to the local tourism industry, [Resort / Dive Centre / Water Sports Centre] formally agrees to follow the below Code of Conduct when visiting the Hani Faru area in order to avoid any injuries to animal and visitors.

1. Boats ENTERING and LEAVING the Hani Faru area MUST reduce their speed and have a staff member at the front of the boat looking out for animals and swimmers on the surface. Should mantas or whale sharks be spotted, the boat must keep a safe distance of at least 20 meters away from animals and people.
2. Once in Hani Faru, boats MUST leave the bay area where the animals are feeding and anchor in the shallow sandy lagoon. If the animals are near the middle Thila*, snorkellers can be dropped in the water at a safe distance; then the boat MUST move to the anchoring site. Snorkellers MUST swim back to the boat. If mantas are spotted at the entrance of Hani Faru, snorkellers can be dropped and picked up at a safe distance from the animals.
3. We formally agree that there should be a maximum of 5 boats anchored in the designated area. In order to avoid an excessive number of boats at Hani Faru, resorts and dive centres should communicate with each other to avoid overcrowding the area. (Snorkelling boats from:- Valtur:12:15-13:00 / Soneva Fushi:13:00-13:45 / Four Seasons:14:00-15:00 / Reethi Beach:15:00-16:00 hrs resort time) Also, the number of boats per resort and dive centre should be coordinated and restricted to as few as possible.
4. Guides, boat crews and dive instructors MUST brief the visitors about the fact that the boat will be anchored and that they have to swim back to the boat. NO pick up will be allowed inside the bay area, except if an emergency arises.
5. Guides, boat crews and instructors have to brief the visitors, "It is NOT allowed to TOUCH, RIDE or SWIM AFTER any animal". Divers and snorkellers should keep the suggested distance of 3 to 4 meters from the animals (whale sharks, manta rays or any other marine life). (This place is so unique, that the feeding animals are always coming back toward the end of the bay.)
6. Resorts sending snorkellers must ensure that there is always an in-water supervisor. The ratio SHOULD be at least 1 guide for a maximum of 8 guests. Where possible each boat should not have more than 16 guests. Snorkellers must be proficient swimmers.
7. Should a diver or snorkelling enthusiast not follow these guidelines and rules, the guide / instructor or boat crew MUST intervene to ensure the animals are not bothered.

8. Boat captains, dive masters and guides MUST have sufficient training on the boat guidelines and appropriate in-water behaviour.
9. Boat captains, dive masters and guides not following the guidelines should be reprimanded by their resort management. Adhering to the above STATED RULES is a MUST.
10. Outside boats, such as Safari boats, need to be kindly instructed about the rules and provided with information material. Every Baa Atoll resort boat visiting Hani Faru should have a spare set of information material for this purpose.
11. Jet skis, catamarans and other such small vessels should not be allowed within Hani Faru.

* The little shallow reef inside the bay at the southern edge of the bay. To be highlighted in the Map

Date:

Representative (in print):

Signature:

Appendix 2.

Government Directive No. 133-EE/2009/19

Unofficial translation of the Directive No: 138-EE/2009/19 (5th June 2009) of the Ministry of Housing, Transport and Environment

With reference to Clause 4 of the "The Environmental Protection and Preservation Act: 4/93," commencing from 5th June 2009, the following sites has been declared as marine protected areas.

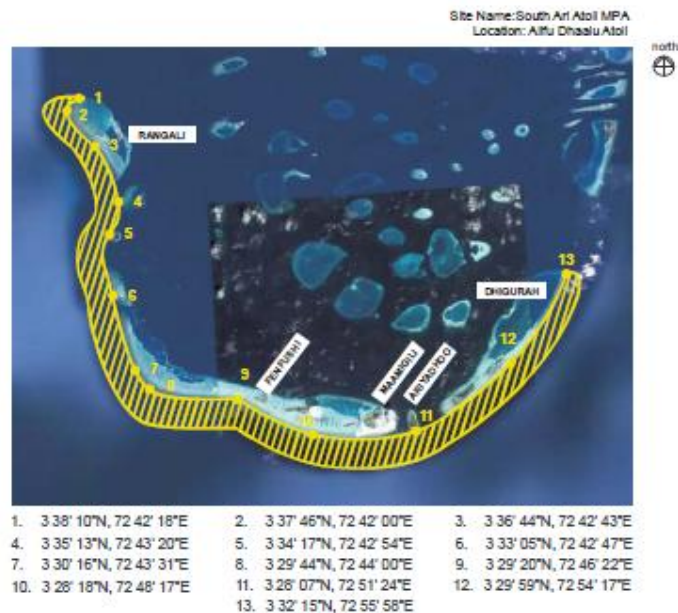
1. The area encompassing from the north western tip of the reef crest of Rangali island up to the North Eastern tip of Dhigurah island, the boundary extending 1km seaward from the epipelagic reef fringe.
2. The area surrounding B. Hanifaru encompassing a 200m boundary outside outer reef edge; excluding the land area of Hanifaru Island.
3. B. Angafaru Area an area encompassing 200m boundary outside the outer reef edge of Angafaru, Dhiguthila, Dhonfanu Thila and Mahaanagaa Thila

1. The area encompassing from the north western tip of the reef crest of Rangali island up to the North Eastern tip of Dhigurah island, the boundary extending 1km seaward from the epipelagic reef fringe.

The declared dimensions of the MPA envisage the boundary extending 1km seaward from the reef crest (algal ridge) of Rangali island (3° 38' 12N, 72° 41' 52E) up to the North Eastern tip of Dhigurah island (3° 32' 27N, 72° 55' 57E). See Figure 1.

Figure 1.

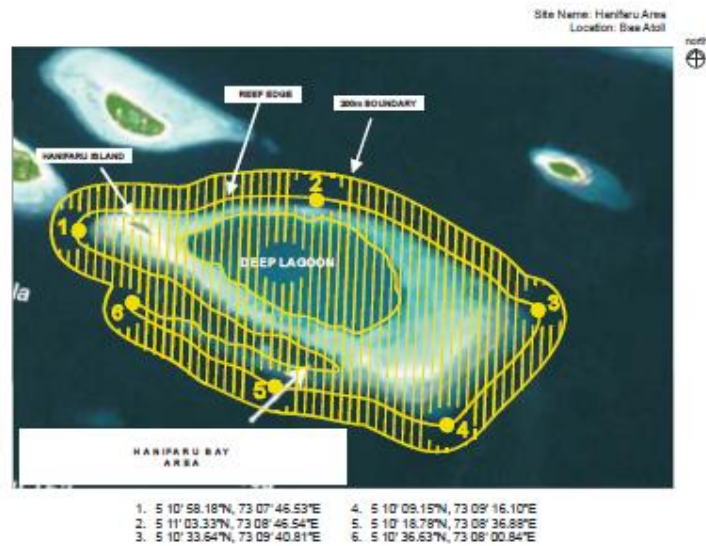
The South Ari Atoll marine protected area is demarcated and shaded in green.



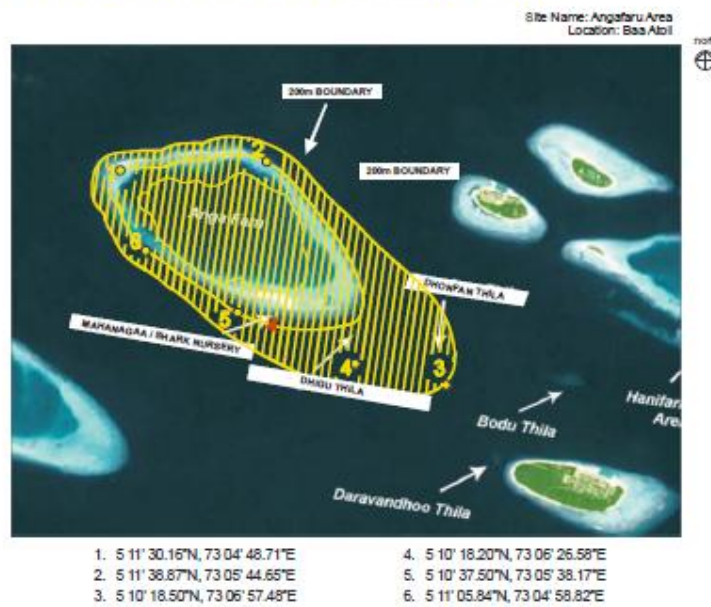
Commencing from 5th June 2009, the following activities are prohibited within this South Ari Atoll MPA.

1. To carry out any activity which could lead to destruction or alter the site/habitat or the living and non living things within that environment.
2. Coral and sand mining.
3. Disposal or dumping of any materials.
4. Anchoring except in an emergency situation which is life threatening or leading to destruction of the vessel.
5. No person entering the protected area is allowed to disturb or tamper whale shark or any other fauna. A person entering the sea to watch whale sharks must at all times maintain a distance of at least 4 metres from the whale shark.
6. The speed limit within this protected area should not exceed 10 nautical miles.
7. No vessel should come closer than 10 meters to the whale shark
8. No vessels larger than 20 metres overall length should be engaged in any activity within the MPA
9. Safari vessels, vessels with overall length greater than 20meters and using of jets skis are prohibited.
10. Catching, Collecting or killing of any fauna especially birds

2. The area surrounding B. Hanifaru encompassing a 200m boundary outside the outer reef edge; excluding the land area of Hanifaru Island. (Figure 2)



3. B. Angafaru Area an area encompassing 200m boundary outside the outer reef edge of Angafaru, Dhiguthila, Dhonfanu Thila and Mahaanagaa Thila. (Figure 3)



The following activities are prohibited within the Baa Atoll MPAs of Hanifaru and Angafaru

1. To carry out any activity which could lead to destruction or alter the site.
2. Any extractive use other than the traditional bait fishing (bait fishing with lights is strictly prohibited).
3. Coral and sand mining from these areas.
4. Extraction, catching or fishing for any resources within the declared sea, reef, lagoon, or on land within the declared sites.
5. Disposal or dumping of any materials
6. Catching, Collecting or killing of any fauna especially birds
7. Anchoring except in an emergency situation which is life threatening or leading to destruction of the vessel.
8. The speed limit within this protected area should not exceed 10 nautical miles.
9. No vessels should come closer than 10 meters reach to the whale shark, manta rays or other fauna.
10. The number of swimmers or divers entering the sea to view a shark is limited to a maximum of 80 persons in total.
11. The number of vessels that could be engaged within the MPA is limited to 5.
12. No person entering the MPA is allowed to disturb or tamper whale shark, manta rays or any other fauna.
13. Disposal or dumping of any materials.
14. Safari vessels, vessels with overall length greater than 20meters and using of jets skis are prohibited.

The regulations mentioned above have to be respected and adhered to all times in the 3 MPAs mentioned above. Prior permission has to be obtained in writing from the Environmental Protection Agency to conduct any other activities not mentioned in this directive.

In addition, to the above mentioned regulations, all visitors to the 3 MPAS has to respect and act accordingly to the "Maldivian Whale Shark Tourist Encounter Guidelines" which is available at the ministry's website www.mhte.gov.mv

Appendix 3.

Guidelines for whale shark interactions

Appendix I – South Ari Atoll MPA

Maldivian Whale Shark Tourist Encounter Guidelines

5th June 2009

1. **Restriction on vessels in or near contact zone:**
 - a. An exclusive contact zone of a 250 metres (820.2 feet) radius applies around any whale shark.
 - b. A vessel establishing a contact zone should identify itself by raising the designated flag.
 - c. Any other vessel engaging in whale shark related activities must not enter a contact zone to observe a whale shark.
 - d. The operator of a vessel establishing a contact zone shall record the details of the contact on the form provided and return this to the appropriate authority within the time specified.
2. **Restrictions on period in contact zone:**
 - a. A contact vessel must not remain in the same contact zone for longer than 40 minutes if there are other vessels queuing to view the shark.
 - b. Notwithstanding clause 2 (1) above, the contact period is deemed as having ended once the contact vessel has lost contact with the shark and should lower the contact flag indicating that the contact zone and contact period have lapsed.
3. **Restrictions on vessel speed in contact zone:**
 - a. Subject to clause (2 & 3) below, a contact vessel must not exceed 5 knots (9.3km/hr) in a contact zone.
 - b. A contact vessel must not exceed 2 knots (3.7 km/hr) within 50 metres (164 feet) of the contact whale shark.
 - c. If, for reasons of safety, a contact vessel must exceed 5 knots (9.3km/hr) in a contact zone, that vessel must leave the contact zone as soon as is practicable.
4. **Proximity of contact vessel to the whale shark:**
 - a. A contact vessel must maintain a distance of at least 10 m (32.8feet) from the nearest whale shark.
 - b. Should a whale shark swim towards the vessel to within 10 m (32.8 feet), all engines should be in neutral or switched off until the shark has moved more than 10 m away from it.
5. **Direction of approach:**
 - a. Subject to clause 3 (1 & 2) if swimmers or divers are to enter the sea from a contact vessel to view a whale shark, the contact vessel should wherever possible approach a whale shark from in-front or from the side without the vessel forcing the shark to change direction.
6. **Number of swimmers or divers:**
 - a. The number of swimmers or divers entering the sea from a contact vessel to view a shark is limited to a maximum of 12 persons in total.

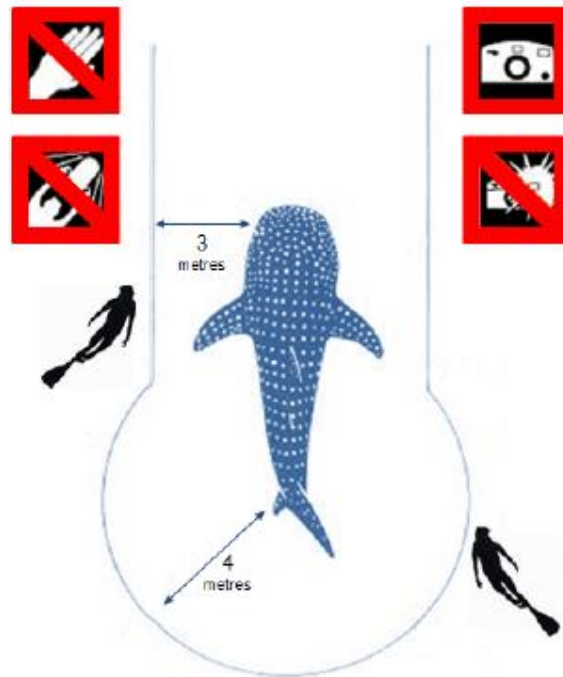
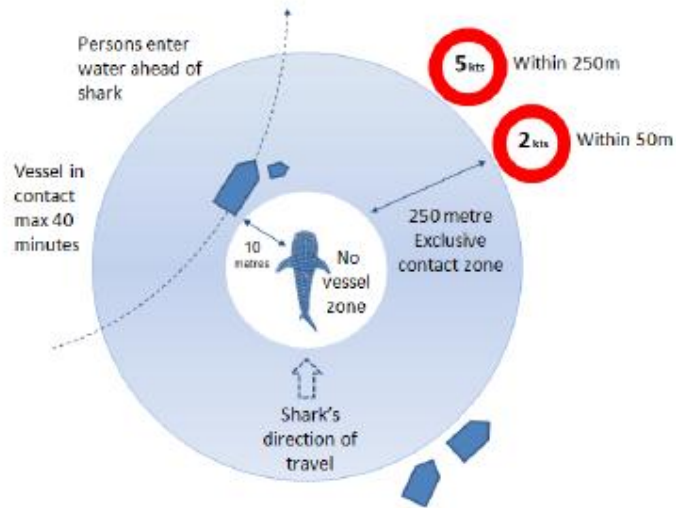
Appendix I – South Ari Atoll MPA

7. **Physical contact with whale shark prohibited:**
 - a. A person must not touch or ride on, or attempt to touch or ride on, a whale shark under any circumstance.
8. **Proximity of swimmers or divers to the whale shark:**
 - a. A person in the sea must
 - i. at all times maintain a distance of at least:
 - ii. 3 metres (9.84 feet) from the head or body of the whale shark, when approaching a whale shark from any direction; and
 - iii. 4 metres (13.1 feet) from the tail of the whale shark, when approaching the tail from any direction.
 - b. Must not deliberately cross in front of the whale shark's direction of travel or impede its movement.
9. **Motorized swimming and other activities prohibited:**

A person in the sea must not:

 - a. use a motorized or otherwise powered swimming or diving aid in a contact zone.
 - b. use any device capable of towing or carrying a person, that is towed behind a vessel, in a contact zone.
 - c. use flash photography
10. **Exceptions when authorized by the authorised Government Agencies:**
 - a. Clauses 5, 7, 8 and 9 do not apply to a person who is undertaking authorized scientific research. Authorized scientific teams should also adhere to their allocated timings provided in the permits and should collect their deployed equipments prior to leaving the MPA.

Appendix 2. Graphical Summary of Maldivian Whale Shark Encounter Policy



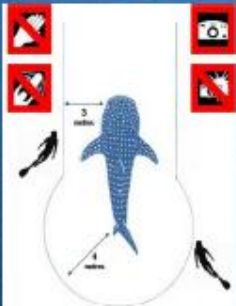
Appendix 4.
MMRP guidelines for site use at Hanifaru Bay

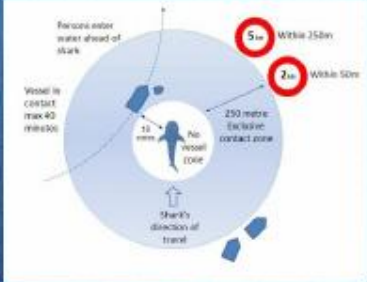
Marine Life Encounters

Whale Sharks & Manta Rays

Code of Conduct


Diving or snorkelling with whale sharks and manta rays is one of the most spectacular underwater experiences possible. To make sure that encounters with these magnificent creatures are conducted in a safe and environmentally conscious the Maldivian government **requires** that the following guidelines are adhered to:





Swimmers and Divers:

- **Do not** attempt to touch, ride or chase the whale sharks or mantas.
- **Do not** restrict normal movements or behaviour of the animals.
- **Do not** swim directly in front of the whale sharks



Research & Conservation

Help collect valuable scientific data by taking ID photographs of the individual sharks and manta rays seen and then submitting your images to a global network of scientific researchers.

Please send manta and whale shark images to:
mantaraproject@hotmail.com
www.maldivianmantas.com






Photo Identification

Every individual manta ray and whale shark has its own unique spot pattern. Just like a fingerprint, these patterns can be used to identify individuals, enabling researchers to estimate population sizes, map migration routes, unravelling the life history strategies of these poorly understood giants of our oceans.



The spots within the red boxes are used to distinguish the individual mantas and whale sharks from each other

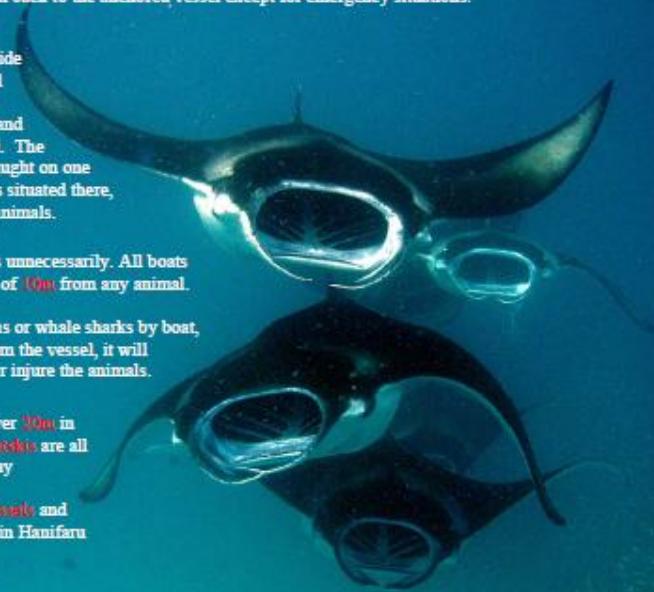


Hanifaru Bay

Boat and Tourist Regulations

(Government Directive: 138-EE/2009/19)

- All boats should approach the site with extreme care and reduced speed by following the routes marked in **RED** below. Mantas and whale sharks are there to feed and they will be close to or just beneath the waters surface.
- If animals are present in the main feeding area (see map below), anchor the boat in the shallow sandy lagoon at the Eastern end of Hanifaru before allowing divers or snorkelers into the water. If the animals are present, further up the bay drop the divers & snorkelers before anchoring in the lagoon.
- Inform the guests that the boat will be anchored and that they can easily swim back to the boat whenever they want. Guests should ALWAYS swim back to the anchored vessel except for emergency situations.
- Do not anchor boats in the deeper water inside the lagoon, mantas and whale sharks may be feeding in these areas and can easily be disturbed. The anchor may also get caught on one of the cleaning stations situated there, further disturbing the animals.
- Do not maneuver boats unnecessarily. All boats should keep a distance of **10m** from any animal.
- Do not approach mantas or whale sharks by boat, just to take pictures from the vessel, it will unnecessarily disturb or injure the animals.
- **Sabai boats**, vessels over **20m** in length and the use of **jetskis** are all prohibited inside the bay
- A **MAXIMUM** of **5 vessels** and **80 people** are allowed in Hanifaru Bay at any one time



Main Feeding Area Enlarged Below

