

Maldivian Manta Ray Project

2012 Season Summary

Executive Summary

This report presents data collected by the Maldivian Manta Ray Project (MMRP) on Baa Atoll's reef manta ray (*Manta alfredi*) population between June and December 2012.

Baa Atoll has an international reputation as one of the most reliable places in the world to see manta rays and whale sharks (*Rhincodon typus*). These animals frequent the waters of Baa Atoll due to the conditions created by the South Asian Monsoon, which provide an abundant source of food for these planktonic creatures in this region during the Southwest Monsoon. In Baa Atoll these animals have been continuously studied since 2007 by the Maldivian Manta Ray Project (MMRP), a non-profit, independent conservation and research focused organisation; and the founding project of the UK charity, The Manta Trust.

Key findings of the MMRP in 2012 include more than 3,000 sightings of 762 individual manta rays, recorded during some 135 days of survey. This equates to an increase in sightings of 30% on the previous year and an increase of 17% on the number of individual mantas seen. It is important to note that during the 2011 season the MMRP observed the lowest number of manta ray sightings since this project began. These increases between 2011 and 2012 are therefore of great importance, suggesting (as was hypothesised in the 2011 report) that the numbers and sightings of mantas are influenced very strongly by environmental factors, most importantly wind speed.

It is also worth noting however that this increased number of sightings has also been influenced by a greater level of effort in research in recent years and therefore when standardised and compared to previous years 2012 sightings were in fact less on average than 2008-2010.

The 762 individual rays seen is the highest number observed during a season since 2008. Also encouraging is that this is an increase of more than 100 rays from 2011. When considered alongside the full sightings data set, on average



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each manta observed was observed 3.94 times during this season, again an increase from 2011

(average 3.21 sightings per ray). In addition the proportion of rays seen on more than one occasion increased in 2012 to 69%, a figure much more comparable to pre 2011. These facts together suggest longer residency periods for mantas in Baa Atoll this year, again, supporting the hypothesis that environmental factors and the strength of the monsoon are key to this population of animals being present in Baa Atoll. This is reassuring as it means a decline in the manta ray population overall is not likely.

However, of concern was that during 2012 no pregnancies were observed for the third consecutive year. Again this might likely have links with the monsoons and food availability. Encouragingly mating chains and other behaviours which indicate reproductive activity were observed at the end of the 2012 season, behaviours not observed in recent years and therefore encouraging evidence that we might begin to observe pregnancies again in the near future.

Due to the strong correlations observed in 2011 between environmental variables and manta ray abundance, the MMRP continued to collect data such as wind speed, wind direction and other weather variables. All of these environmental factors appear to have a strong influence on the numbers of manta rays seen in the atoll during the Southwest Monsoon, however wind speed appears to have a direct implication on manta ray numbers and this trend was apparent in the 2012 data set. We can only speculate about the reasons for the decreased wind speeds recorded in recent years, but it seems likely they are linked to broader scale climatic events such as the Indian Ocean Dipole (IOD) and El Niño-Southern Oscillation (ENSO). These large scale fluctuations to the regional climate and weather patterns in the Maldives need to be studied in more detail, as the negative implications for the fecundity of the manta population, and the overall health of the reef ecosystem as a whole, are very concerning if recent trends continue in the coming years.



Direct human influence is also a factor considered by the MMRP in their research. Tourism in Baa Atoll has seen a significant increase over the last few years particularly due to the presence of the high numbers of manta rays and whale sharks in these waters. Recognising this the Maldivian government has taken numerous steps to protect key areas for these species and in 2011 Baa Atoll was designated as a UNESCO World Biosphere

Reserve, recognised upon its designation as having *“great potential for demonstrating sustainable development throughout the Maldives and the region, while relying on a green economy”*. Following the declaration of Baa Atoll as a UNESCO World Biosphere Reserve and Hanifaru Bay as a core protected zone at the end of June 2011, the MMRP’s 2012 season marked the one year anniversary

of Hanifaru Bay and Baa Atoll under their new designations. Shortly into the 2012 season, the much anticipated Hanifaru Bay Management plan came into full effect. July saw the first appearance of a daily team of rangers whose presence helped monitor tourism activities and implement the stricter regulations for site uses. The MMRP worked closely with these rangers and the EPA this season to establish more effective moorings inside the MPA as well as a clearer access route through the outer reef surrounding Hanifaru Bay. Unfortunately, part-way through the 2012 season research access for the MMRP in Hanifaru Bay was suspended by the EPA and therefore studies within the waters of the bay itself were not as robust as those conducted in previous years and important data collecting opportunities were lost.

As the measures to conserve and manage the environment and human impacts in Baa Atoll become more rigorous there is much to look forward to in 2013 and beyond. However, it is imperative that active research into manta rays and other marine life continues in order to monitor the effects of both tourism and environmental change. Manta rays are an incredibly important economic resource for the Maldives bringing tens of thousands of people to the country each year to dive and snorkel with them, generating millions of USD for the economy annually. Being able to pinpoint the reasons for any observed trends in, or threats too, the Maldivian manta ray population is crucial for the ongoing management and protection of these animals.

Understanding the Southwest Monsoon

As outlined in previous MMRP reports understanding the effects of the Maldives Southwest Monsoon is critical to understanding the reasons for the abundance of manta rays, and indeed whale sharks, that are seen in Baa Atoll during this season.

The monsoons, which dictate the weather in the Maldives, are characterised their winds, which blow consistently and reverse their direction seasonally. The Maldives Southwest Monsoon, or Hulhangu, runs from May-October, while the Northeast Monsoon, or Iruvai, runs from December-March each year, with the months of November and April acting as transitional periods of change in between. The Southwest Monsoon typically brings with it much more rain and cloud cover, with reduced visibility and rougher seas.



During the Southwest Monsoon the strong winds in turn create oceanic currents which flow from the southwest towards the northeast. The Maldivian islands and atolls, rising some 2,000 meters from

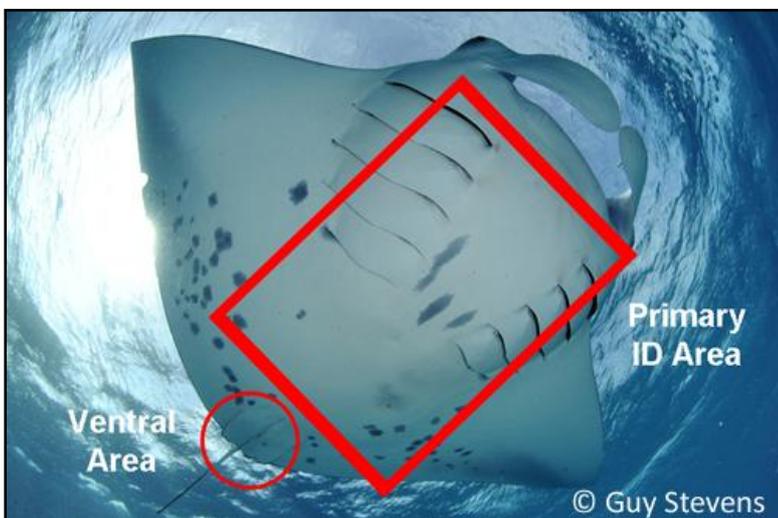
the sea floor act like a barrier to these currents, forcing the water up and through the atolls. These upwellings bring nutrient rich water within reach of the sun's life giving energy and through photosynthesis kick start the food chain, first with phytoplankton, then with zooplankton which predate upon the phytoplankton. Zooplankton is the prey of manta rays (and whale sharks) and as the currents flow into the shallows of the atolls, primary productivity is reaching its peak and the zooplankton is so abundant that the Maldivian waters support the world's largest known population of reef manta rays.

During a typical Southwest Monsoon the wind blows consistently and steadily from the southwest, causing the greatest concentrations of the mantas planktonic food on the monsoonal down-current edges of the atolls. Stronger monsoonal winds generate stronger currents, more upwelling and more primary productivity, which in turn generate more of the zooplankton food, therefore attracting higher numbers of these animals. When tidal exchanges bring water from the outside of the atoll in through the channels along the atoll's eastern edges they become, temporarily, dense plankton funnels and these are the sites at which we are more likely to observe planktivorous megafauna in the greatest concentrations.

Study Period and Sampling

Surveys to look for manta rays were carried out in Baa Atoll between the 11th June and 24th November 2012 on as many days as possible where conditions allowed. Survey trips were made on 135 days within this 162 day survey period.

As per the 2011 season, management measures (see section below), meant that access to the main study site Hanifaru Bay MPA was more restricted than in the years prior to 2011. Therefore both Hanifaru and other sites around the eastern border of Baa Atoll were surveyed, as per the protocol implemented during 2011. To account for changes in sampling efforts at key sites data from all years, data was standardised where possible to give comparable results.



Access to Hanifaru Bay MPA was denied to the MMRP team from August onwards and as a result sighting data from this site was much reduced in this year's data collection. Some data from this site continued to be provided by guests and staff on tourist boats visiting this site and was submitted to the MMRP for analysis.

On each research trip; location, wind strength, wind direction and other



environmental weather conditions were noted alongside manta ray numbers and prevalent behaviours. In-water, individual mantas were documented by photographing the unique spot patterns on their undersides (ventral surface). The whole team were experienced free divers, using this advanced snorkelling technique to allow them to take photo-ID shots with the minimum of disturbance to the animals. For the purposes of this report a *sighting* is defined as a confirmed photo identification of an individual manta ray on a given day.

Management Changes and Initiatives

Management initiatives at Hanifaru Bay MPA are continuing to be implemented and new measures were put into effect during the 2012 season. Effective from the beginning of January 2012 SCUBA diving is no longer permitted inside the Hanifaru Bay MPA and all guests are restricted to snorkelling.

Starting 11th July 2012, EPA Rangers began patrolling Hanifaru and paid tokens for entrance into the bay by all boats and guests were collected. The rangers also strictly enforced the schedule for the alternation of entrance days between safari boats and resort boats that was first outlined in 2011.

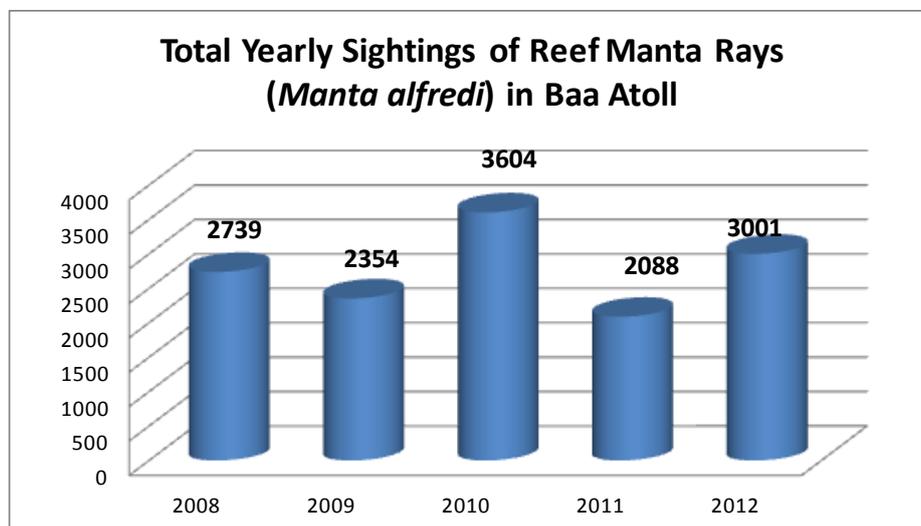
Dive and snorkel guides using Hanifaru Bay were also required to sit an exam qualifying them to guide tourists inside the bay. Minimum levels of in-water/dive qualifications and first aid certifications were also required for these guides.

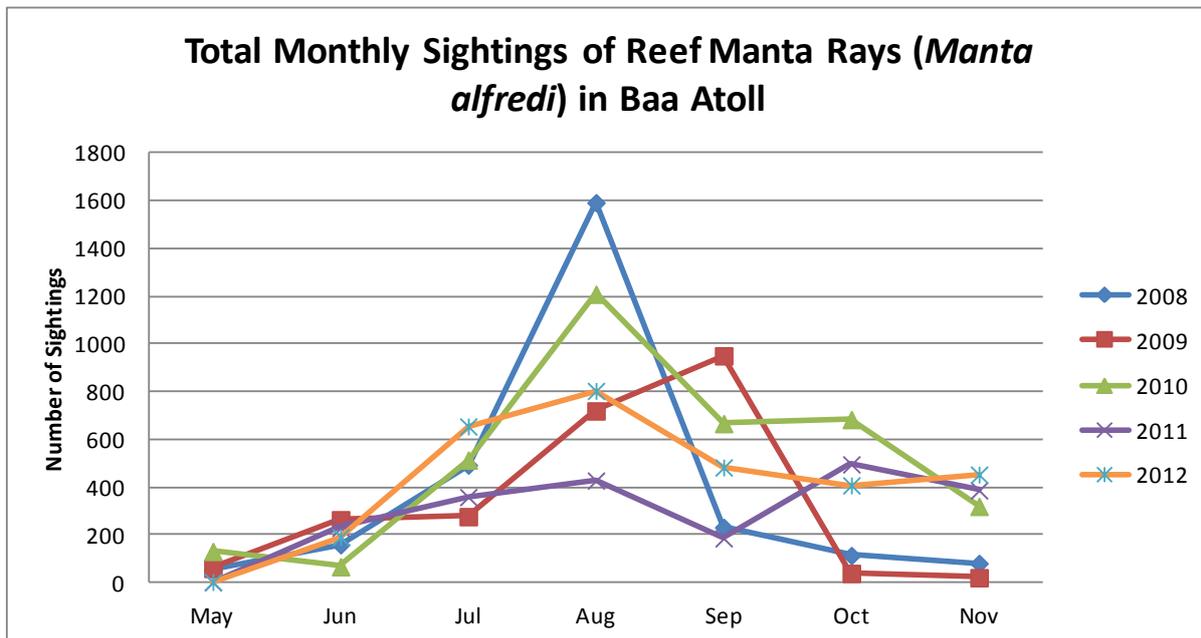
Manta Ray Sightings

Total Baa Atoll Sightings:

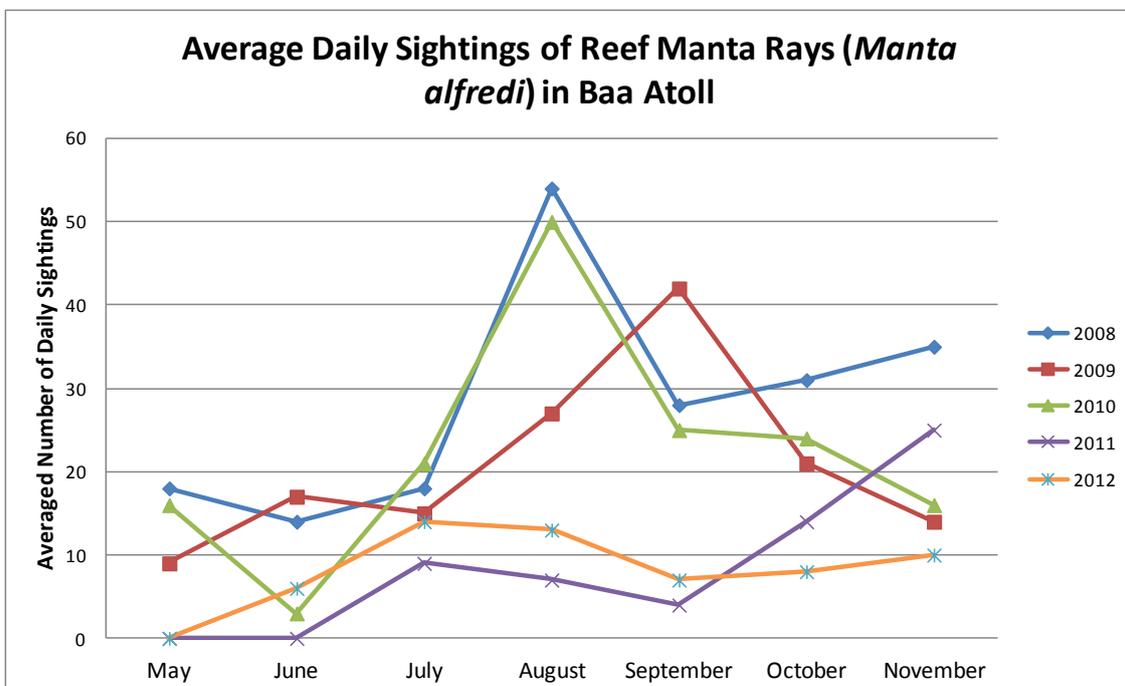
Sightings across the whole of Baa Atoll in 2012 have increased from the low sighting numbers collected in 2011 and remained relatively consistent throughout the course of the season.

The graphs below depict sightings over the years and on a monthly basis:



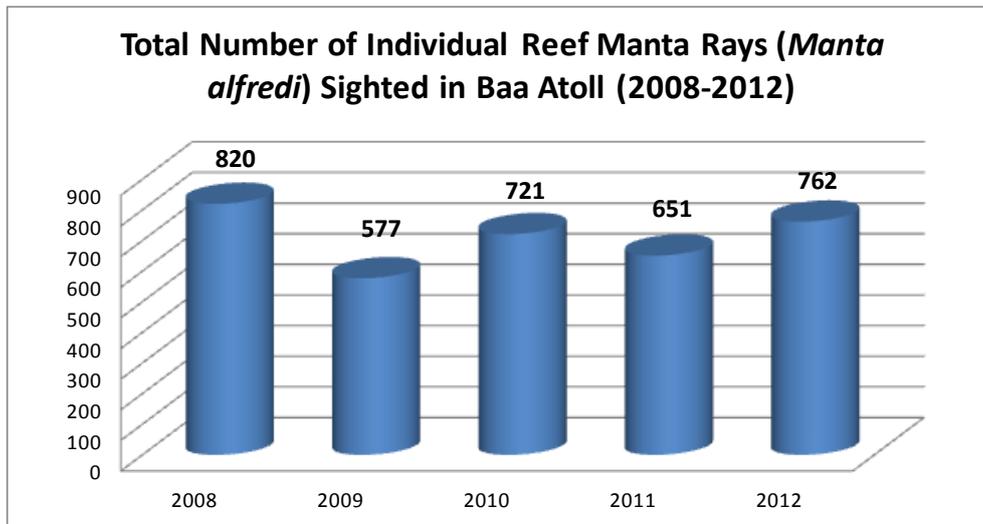


However, whilst total sighting numbers suggest an uplift in manta numbers in 2012, when standardised for survey effort which has increased in recent years, it is important to note that 2012 sightings were in fact lower than in previous seasons. The graph below where sightings are averaged for the number of survey days each month clearly depicts this trend:

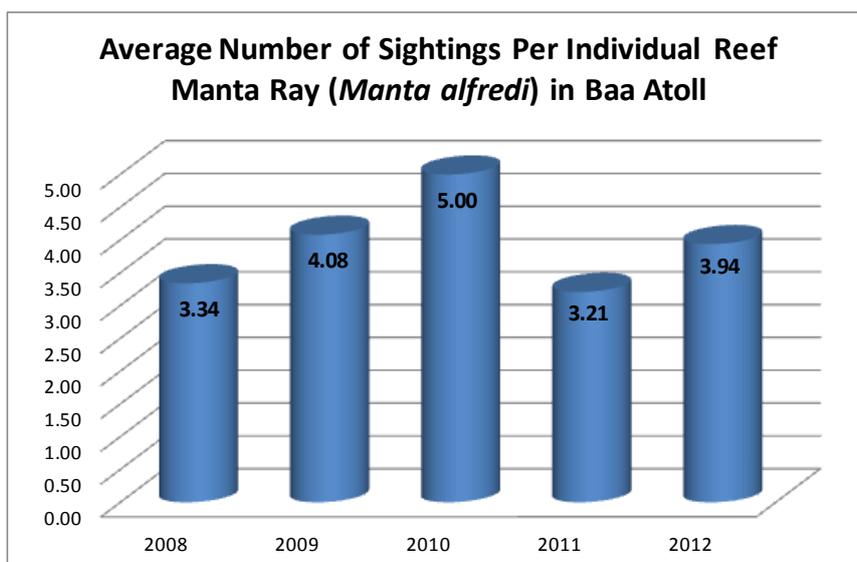


Total Number of Manta Rays:

The overall number of individual manta rays sighted throughout Baa Atoll totalled the second highest since surveying began in 2008. A total of 762 different individual manta rays were recorded in Baa Atoll during the 2012 southwest monsoon, which is 28% of the total recorded Maldivian population of 2,763 individuals. In the last six years the total number of different individual mantas which have been recorded in Baa Atoll is 1,567, or 57% of the total recorded population in the Maldives.

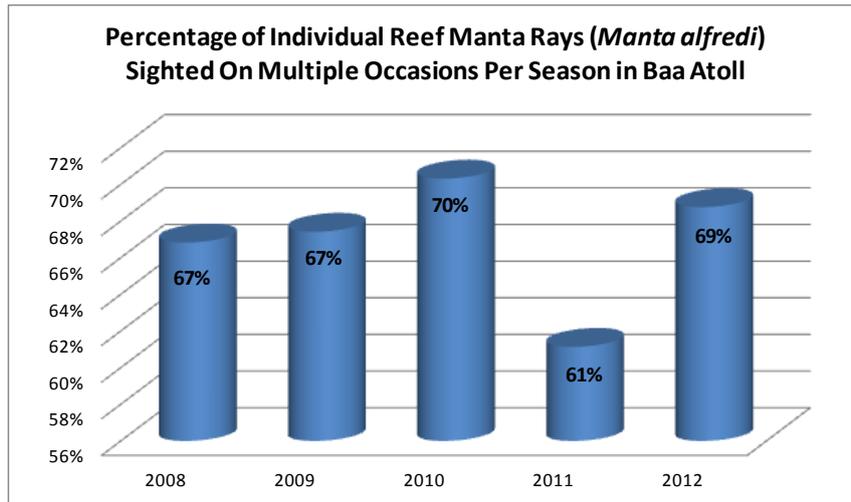


In 2011 the overall sightings were the lowest recorded to date across the five study years and the number of manta rays recorded was the second lowest to date. Not surprisingly, the average number of sightings per individual manta ray sighted was also the lowest in 2011 when compared to the other four surveyed years, with an average of only 3.21 sightings per individual.



Supporting this is data it is interesting to note the percentage of individual manta rays sighted on multiple occasions per season compared between years (see graph below). In the 2011 survey period

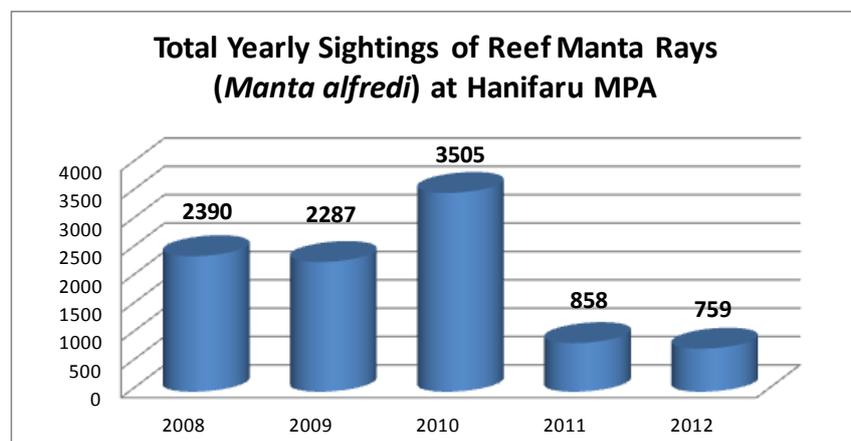
there was a marked reduction in the number of individuals sighted on multiple occasions, again suggesting a more transient population of mantas during this time. In 2012 the sighting frequency returned to levels exhibited in the first three study years. This transient behaviour exhibited in 2011 would make sense if there was a reduction in the localised abundance of the manta ray's planktonic food source, causing the foraging animals to migrate through the study area in search of richer foraging grounds.



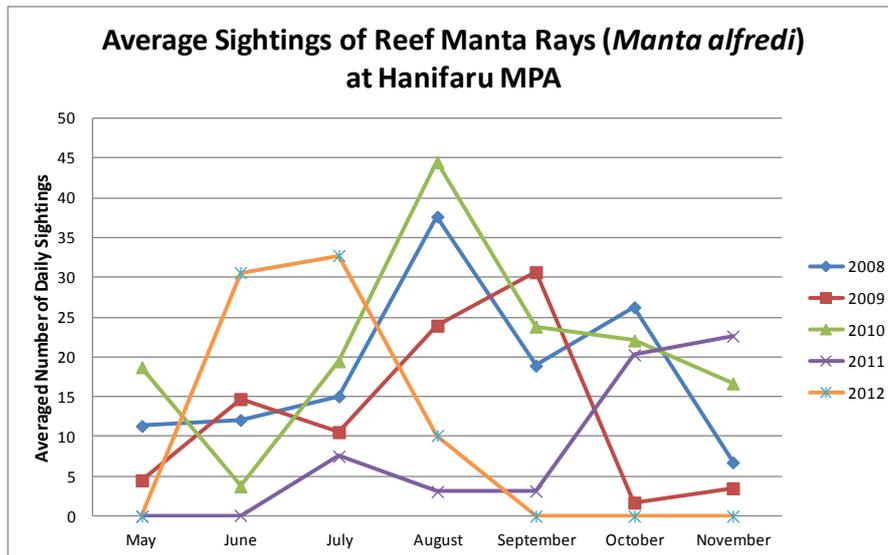
Sightings at Hanifaru Bay MPA:

Sightings of mantas rays at Hanifaru Bay (MPA) were lower than in 2011 and significantly lower than previous years, a result of access restrictions which led to insufficient data collection within Hanifaru Bay from August to November 2012. Only nine survey days were logged between 1st August and 24th November; seven in August and two in October, most of these from tourist boats visiting the sites and submitting their images. Despite limited access, regular patrols were completed around the outside of the MPA and manta rays were sighted inside from August to November.

The graph below shows the total numbers of sightings recorded at Hanifaru per year since 2008:



To account for the changes in sampling effort over the last 5 years the graph below shows the averaged daily numbers of mantas observed each month (standardised for effort) between May and December each year since 2008:

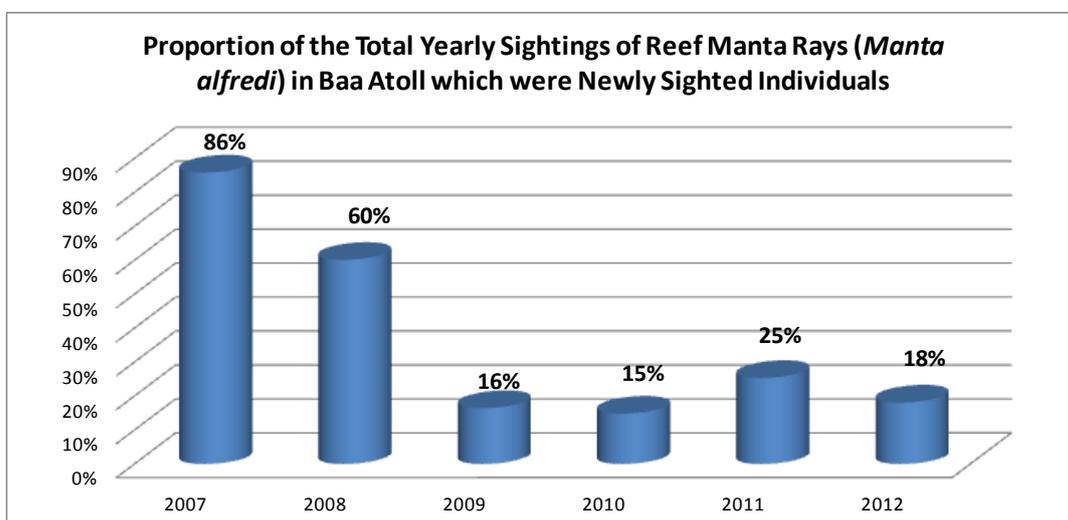


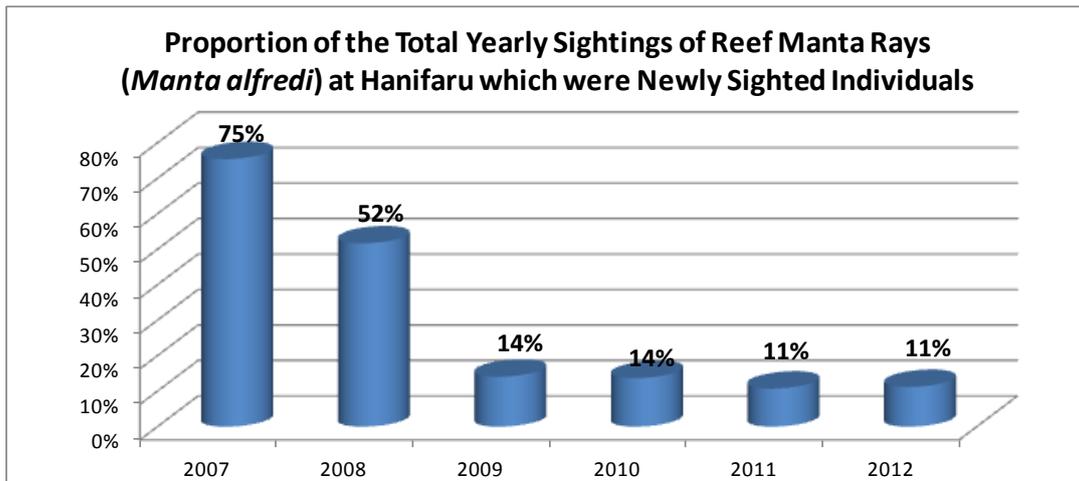
Note: Data points for the months of August to November 2012 (orange) are low to zero. This is due to access restrictions which resulted in insufficient data collection. Manta rays were known to be inside Hanifaru Bay during these months.

New Individual Manta Rays:

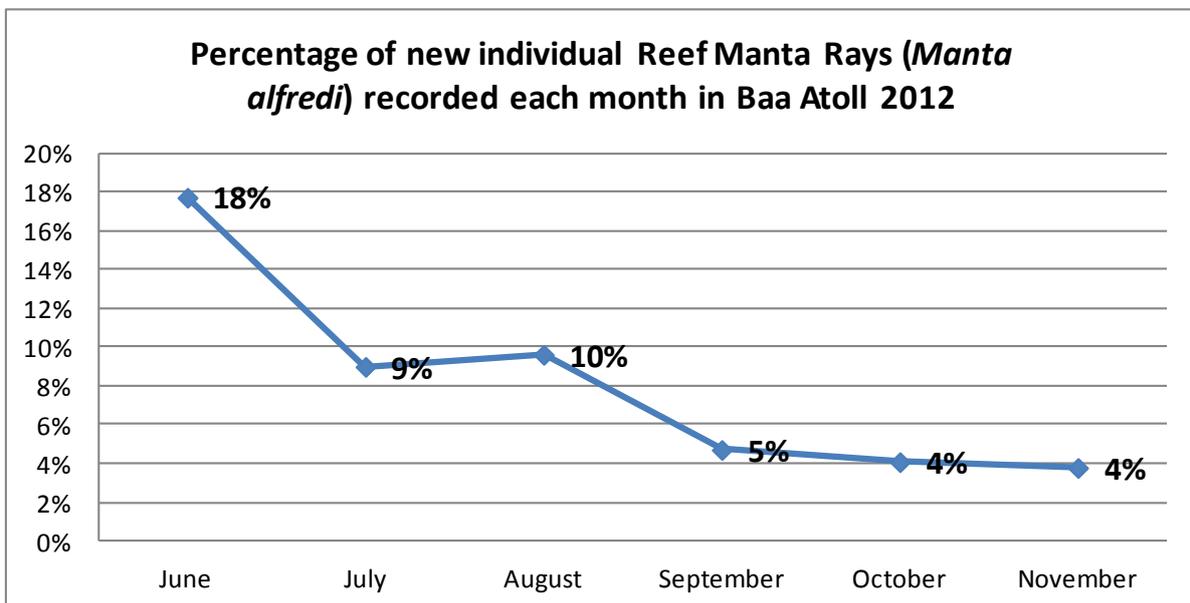
In total 138 new individual manta rays were identified during the survey period in Baa Atoll in 2012.

The graphs below shows how the proportion of newly sighted individuals sighted between 2007 and 2012 both in Baa Atoll as a whole and more specifically in Hanifaru Bay. As expected the numbers of new mantas seen as a proportion of the population follows a downward trend, as more years pass and more data is collected, new mantas become less frequent.



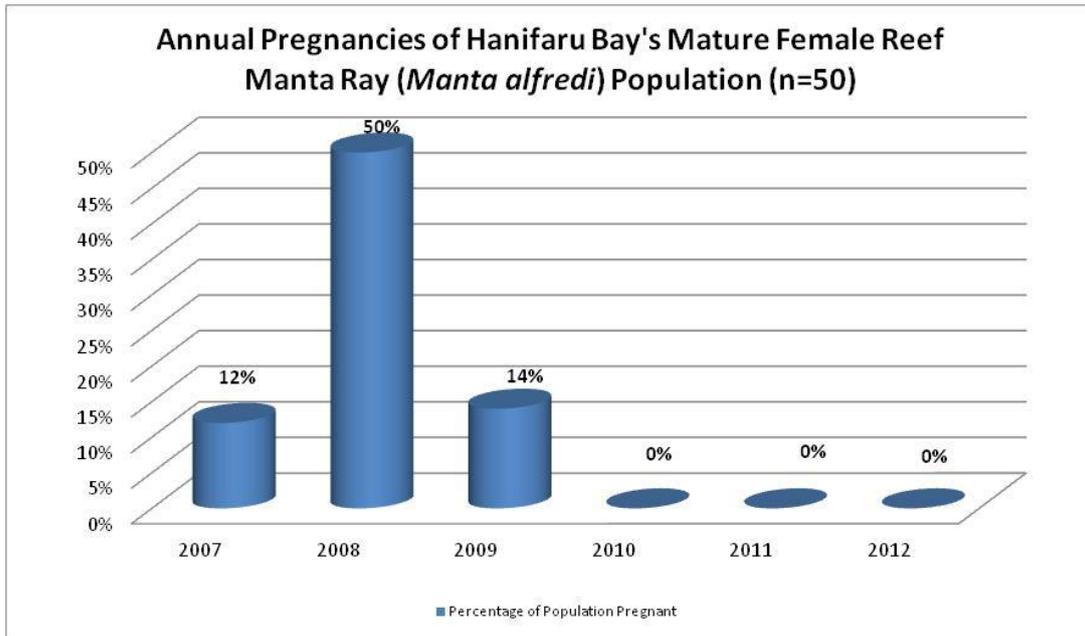


It is interesting to note that despite the overall lack of sightings in Baa Atoll in 2011 there was an uplift in the proportion of new mantas seen (10%) when compared to the previous year. This increase of newly sighted individuals in Baa Atoll, but not Hanifaru in 2011, can most likely be attributed to the addition of several new survey sites established around Baa Atoll when daily access to Hanifaru became limited. As surveying at these new sites continued in 2012, this proportion of newly sighted mantas has again fallen. This yearly trend can also be observed within a season (see below):



Total Number of Pregnant Manta Rays:

Despite considerably increased sampling effort of the manta ray population across the entire Maldivian Archipelago in recent years, there has not been a single recorded observation of a pregnant female for the last three years. The graph below shows the annual percentage of pregnancies recorded within a core group of Hanifaru Bay's most frequently sighted mature females:

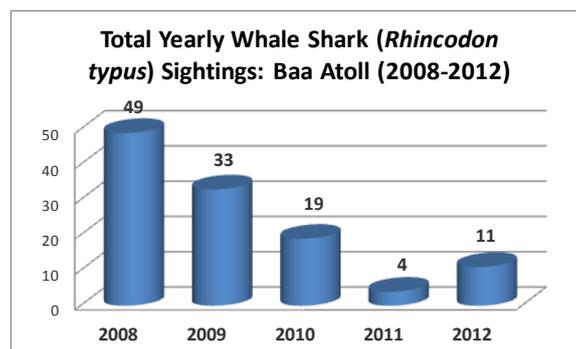


Potential reasons for these decreased numbers of pregnancies are numerous, but might include the effects of a weakened monsoon and associated lack of food. Identifying the reasons for this is a priority in the ongoing work of the MMRP as it could have long term implications for the stability of this population of mantas.

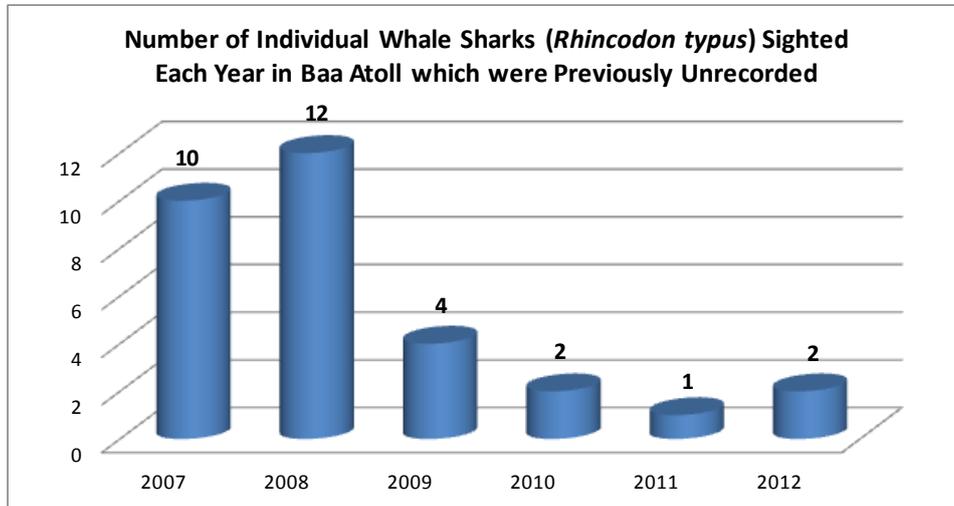
Despite the continuance of no pregnancies, towards the end of the 2012 season, mating behaviours were recorded at a number of different locations across the Maldives Archipelago. This is a promising sign that subsequent pregnancies will be observed in 2013 and into 2014.

Whale Shark Sightings

Surveys for manta rays as described above also looked for whale sharks as the two species often aggregate at the same locations to feed. During the 2012 season in Baa Atoll whale sharks sightings have rebounded slightly from 2011 in correlation with manta sightings. Although lower than in previous years, and much lower than the initial survey of 49 in 2008, 11 confirmed whale shark sightings is an upward trend:

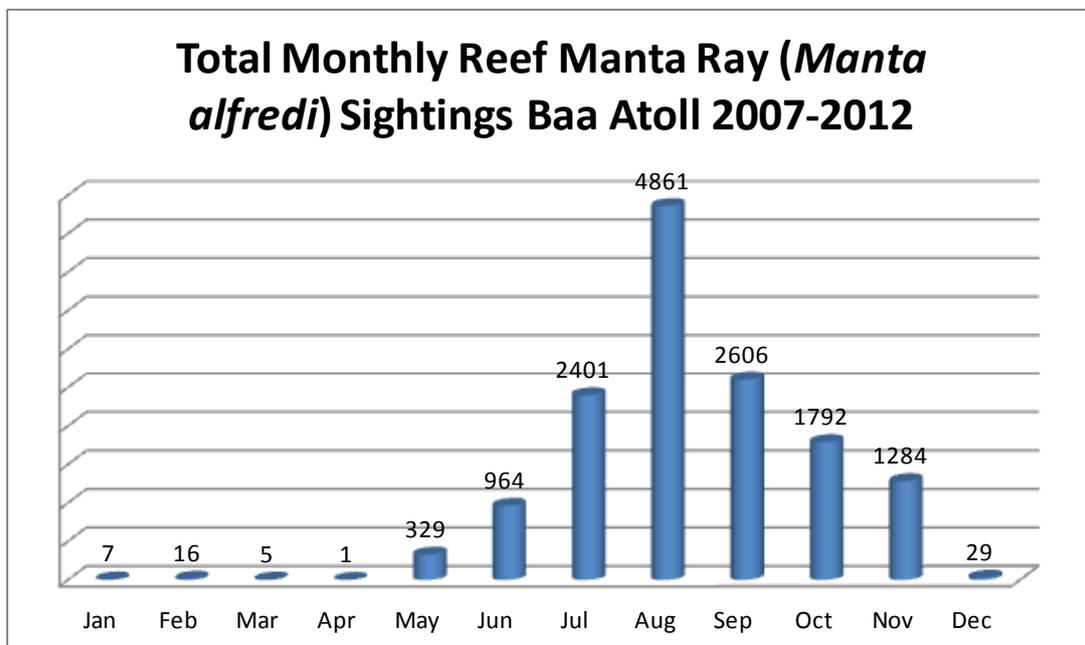


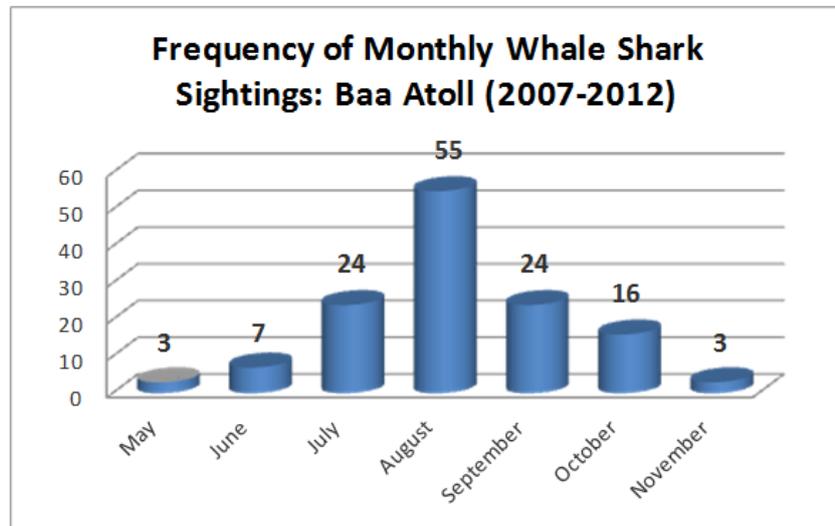
As with the manta rays, there is also a similar trend of decreasing numbers of previously unrecorded whale shark individuals recorded each year (see below).



In Season Sighting Variation:

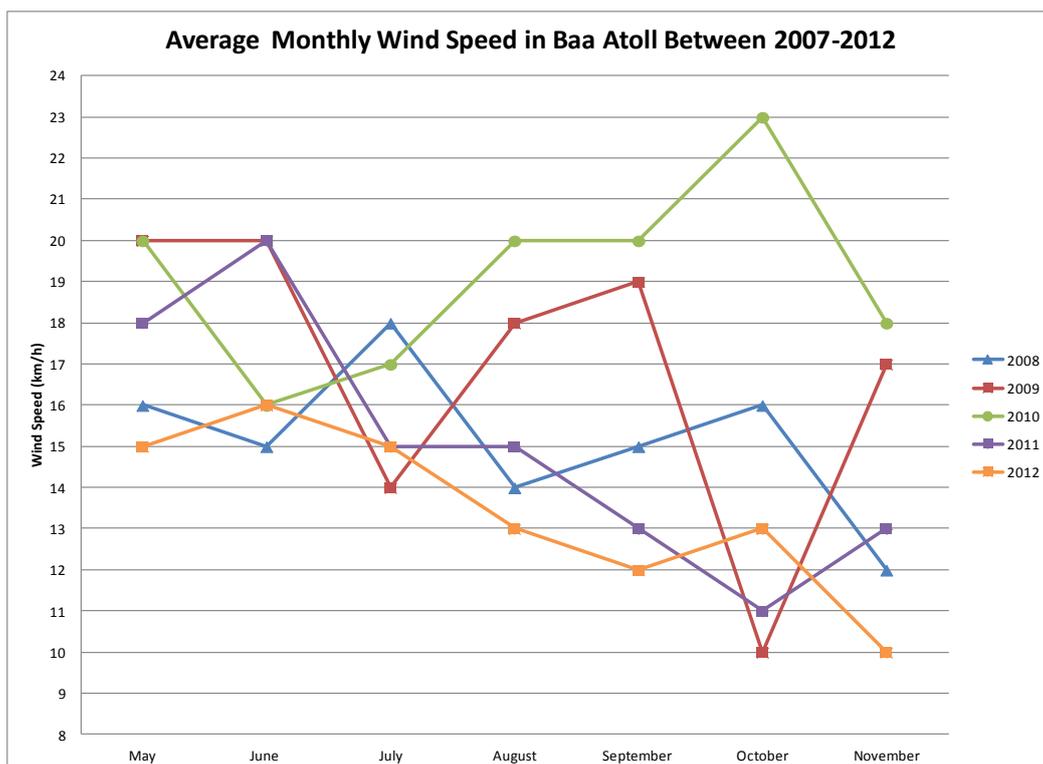
The two graphs below clearly show the concentration of sightings for both manta rays and whale sharks occur in the months of June through November, with 34% and 41% of the total yearly manta and whale shark sightings respectively occurring in the month of August alone:





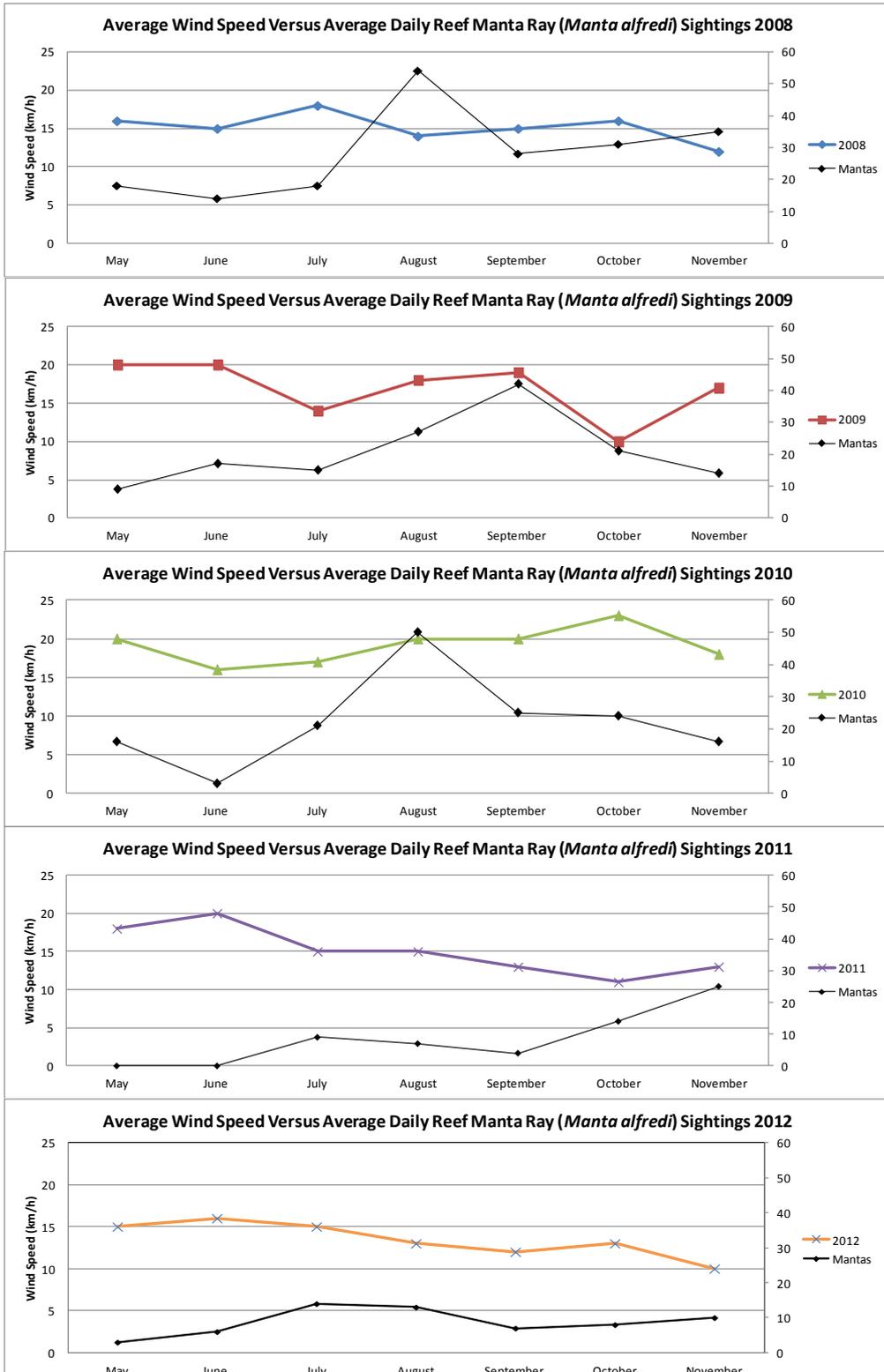
Weather and Climatic Variation

As a continuation of the investigation instigated in 2011 to look into the possible links between manta ray sightings and the strength of the Southwest Monsoon, the MMRP continued to look at the correlations between weather patterns and mega fauna abundance in 2012. Wind direction observed in 2012 followed trends established in the previous year but had many more variable days and less consistent and continuous southwest gusts. The wind speeds observed in 2012 were slightly lower than even those of 2011 and are, on average, the lowest recorded over the five year survey period:





Without the wind and therefore the strong monsoonal currents required to kick start the plankton production, food availability for these planktivorous species is greatly reduced. The graphs below show that the spike in manta sightings that typically occur in August and September, following an increase in wind speeds in July, have not occurred in the last two years:

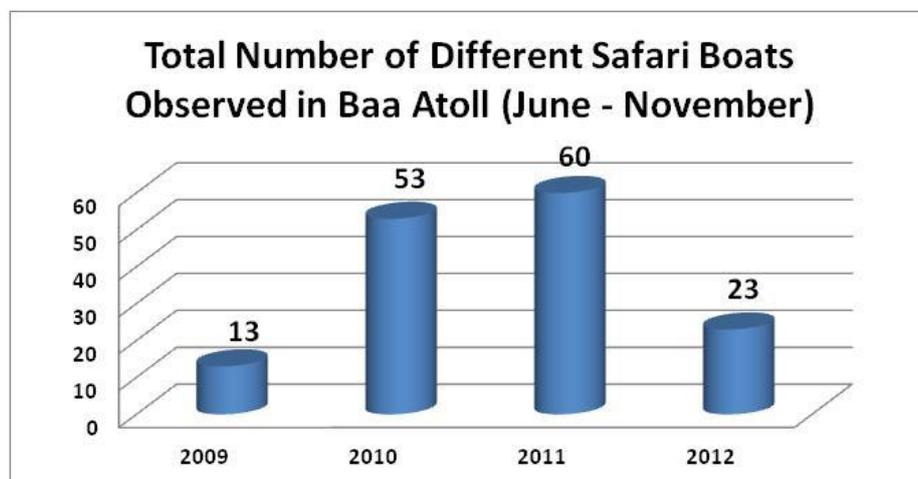


These trends are of great concern, they might be part of a natural cycle of weather events or part of a wider scale climatic phenomenon, such as the Indian Ocean Dipole (IOD) or its Pacific Ocean equivalent the El-Niño Southern Oscillation (ENSO), both of are known to have geographically far reaching implications. These trends might also have links with wider scale climatic changes. Only ongoing and consistent monitoring will show what might be causing such changes, and therefore what measures need to be taken to manage them. Regardless of cause, and leaving aside the ecological ramifications, these observations should be considered very seriously because of the negative economic consequences they will have if these trends continue. Not only will these trends affect manta ray tourism directly, but also on a wider scale they will affect the fishing industry which is also heavily reliant upon the ocean's productivity, and therefore the strength of the monsoons.

It is very likely that this lack of food, brought about by the weakened Maldives monsoon, is responsible to some extent for the lack of pregnancies observed in the Maldivian manta ray population in recent years. Elasmobranch reproduction varies widely between species and reproduction within the genus *Manta* is very poorly understood, with most of what we know coming from one single manta ray reproducing under aquarium conditions. Sharks and rays within the subclass Elasmobranchii have a wide range of reproductive techniques with some species able to store sperm or to repress or stagger pregnancies. It is likely these strategies have been developed in order to provide offspring with the best chances of survival. It is not unlikely that manta rays might use such strategies to ensure that their offspring are born during years which have a greater abundance of food to increase their chances of survival.

Tourism

Continuing the mandate put in place in 2011, safari boats and resorts had access to Hanifaru Bay MPA only every other day on an alternating schedule. The schedule was strictly regulated by EPA rangers. This applied to the MMRP team as well (operating on the resort schedule).





The ban on SCUBA diving in Hanifaru that came into effect starting January 2012, had a significant impact on the number of safari boats observed despite the usual guarantee of manta ray sightings in the MPA, many safari boats cater strictly to SCUBA divers and have a diving intensive schedule and will not take the time to travel to Hanifaru Bay to snorkel. This has effectively cut the number of safari boats that were seen in Baa Atoll in 2012 by nearly 62% since 2011.

Conservation and Management

The declaration at the end of June 2011 that Baa Atoll was to become a UNESCO World Biosphere Reserve remains an important milestone for the Maldivian manta rays, with great implications for their ongoing protection, especially given the designation of Hanifaru Bay MPA as a core zone of the reserve. Management of these newly protected areas is also key, so it is positive to see the commitments made by the Maldivian government's Environmental Protection Agency (EPA) to manage this site and the tourism that takes place within.

A World Biosphere Reserve strives to better understand the human impact and help safeguard natural ecosystems for the future. Long term, consistent data collection is crucial to grasp the influence and impact of tourism on this very unique population of animals and gain a broader understanding of manta rays worldwide. Without access to consistent and reliable manta ray sightings and the constant monitoring of tourism, little weight can be placed on any data collected. Interrupted and inconsistent data collection is much harder to accurately analyse or extrapolate trends from, resulting in more inconclusive results. Although previously gathered data is useful as a baseline, continuous and ongoing research of manta rays in Baa Atoll and throughout the Maldives must remain a priority if Baa Atoll's UNESCO World Biosphere Reserve is to be successful.

Maldivian Manta Ray Project (MMRP)

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

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

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The MMRP and the Manta Trust are happy to share any data collected as a part of this study. For further information or please email: guy@mantatrust.org or katie@mantatrust.org.