Manta TRUST

The Value of Traditional Knowledge in Manta Ray Conservation in the Maldives

Environment Department
MSc Marine Environmental Management
Summer Placement Project

MALDIVIAN MANTA RAY PROJECT

UNIVERSITY of York

Table of Contents

Abstract

Increasing fishing pressure worldwide poses a considerable threat to manta rays (Manta spp.) with reports of population declines in many parts of the globe. The K-selected life history strategy of mantas further intensifies their vulnerability as population recovery is likely to be slow. Conservation of this vulnerable species is dependent on understanding their biology, ecology, and current (as well as future) threat status. Since 2005 the Maldivian Manta Ray Research Project has contributed extensively to the knowledge of reef manta ray (*Manta alfredi*) behaviour, population dynamics, and migration patterns in the Maldives. However, it is not possible to fully interpret this information without considering observations over longer time-scales. Given that limited direct data exists prior to 2005, this study aimed to gather the historical knowledge of local fishermen to evaluate how manta ray abundances may have changed over time by drawing comparisons between this traditional knowledge and current day observations. Sixty two semi-structured interviews were conducted between July and August across nine inhabited islands within Baa Atoll, Maldives. Fishermen were questioned on their local ecological knowledge of charismatic species, with particular reference to manta rays, their awareness of regulations regarding the protection of this species, and their attitudes towards conservation in the region. The survey aimed to ascertain whether any direct anthropogenic impacts pose a potential threat and to help identify how management can improve their conservation. The findings reveal a consensus amongst local fishermen to protect manta rays with 98% of the respondents recognizing the importance of safeguarding mantas for tourism, to identify places with abundant baitfish and for intrinsic values. The research conducted also afforded the opportunity to assess changes in the abundance of other charismatic species frequenting the region with results highlighting concern over declining abundances of whale sharks, tuna, reef fish, and baitfish (noted by 58%; 48%; 45% and 32% of the respondents respectively) and suggesting an increase in shark populations, mentioned by 77% of the fishermen. The use of traditional knowledge has also proved to have been instrumental in the identification of 'hotspots' for manta and whale shark aggregations in need of future monitoring and protection and has exposed weaknesses in the management of the Baa Atoll UNESCO biosphere reserve. The findings indicate a need for improved education and communication between authorities and the public and highlight the value of traditional knowledge in complementing scientific information for improved conservation management in the Maldives.

Photo © Guy Stevens

Keywords: Traditional fishers knowledge; reef manta ray; *Manta alfredi*; whale shark; *Rhincodon typus*; historical abundance; protection; conservation; anecdotal; Baa Atoll; Maldives

Introduction

Manta rays (subfamily Mobulinae) (O'Malley et al., 2013) are the largest batoid fishes in the world and one of the biggest planktivorous filter-feeding elasmobranchs (Couturier et al., 2012). They have a circumglobal distribution and are found in tropical and subtropical waters (Couturier et al., 2012; Jaine et al., 2012).

The genus Manta was considered to be monospecific but a recent reappraisal revealed at least two distinct species, the reef manta-*Manta alfredi* and the oceanic manta- *Manta birostris* (Couturier et al., 2011; O'Malley et al., 2013). Failure to differentiate between these two species prior to 2009 has compromised the vast majority of existing knowledge on their biology and ecology. Most of the current knowledge is attributed to information pertaining to *M. birostris* leaving many biological attributes of *M. alfredi*, including population dynamics, ecology, biology, and movement patterns, unknown or undefined (Couturier et al., 2011; 2012).

The general consensus is the genus Manta, collectively referred to as manta rays, are predominantly zooplanktivorous feeders with distribution patterns which are consequently linked to local productivity and food availability (Anderson et al., 2011a; O'Malley et al., 2013). Mantas aggregate seasonally to feed at specific locations where plankton becomes concentrated with changes in seasons, current circulation patterns and water temperature (Couturier et al., 2012; O'Malley et al., 2013; Rohner et al., 2013). Predictable aggregations also occur at sites functioning as cleaning stations, potential mating sites, or nursery grounds (Couturier et al., 2012; O'Malley et al., 2013). These predictable spatio-temporal aggregations have made mantas highly susceptible to anthropogenic activities (Couturier et al., 2012). Increasing global fishing pressure, responding to Asian market demands for gill plates or branchial filaments of Mobulinae, pose a considerable threat to manta rays (Deakos et al., 2011; Marshall et al., 2010; Rohner et al., 2013). The K-selected life history strategy (slow growth, late maturity and low fecundity)


Photo © Guy Stevens


Photo © Guy Stevens

of manta rays further intensifies their vulnerability as it makes their population recovery slow (Couturier et al., 2014). The above factors have spurred increasing concern for the conservation of mantas and have highlighted the considerable need to fill gaps in baseline information for better manta status assessment and protection (Couturier et al., 2012).

The Maldives provides a unique setting for researchers to address these concerns as it constitutes the largest known population of unfished reef mantas in the world. This unfished population represents a more accurate baseline from which to assess anthropogenic impacts over time (Anderson et al., 2011 (a)(b)).

In the Maldives the economic gains concomitant with manta-associated ecotourism have long been recognised and since 1995-1996 the export of all rays and ray skins has been banned (Anderson et al., 2011b). Between 2006-2008 diving and snorkelling at manta sites was estimated to generate US$8.1 million per year in direct revenue to the Maldives (Anderson et al., 2011b). Manta ray associat-

ed ecotourism has facilitated substantial economic growth and given research and conservation in the Maldives a considerable boost (Anderson et al., 2011b). The regular seasonal occurrence of manta rays throughout the archipelago is stimulated by two monsoons characteristic of the region (Anderson et al., 2011(a)(b)): the North East monsoon from December to April, and the South West Monsoon from May to November (Anderson et al., 2011a). The atolls act as barriers to oceanic currents causing wake eddies to develop in response to the Island Mass Effect, and resulting in nutrient upwelling in the surrounding surface waters (Anderson et al., 2011a; Doty & Oguri, 1956; MMRP, 2011). This initiates productivity blooms in different regions, depending on the season, and encourages seasonal migrations of mantas throughout the archipelago (Anderson et al., 2011a).

An on-going manta ray conservation and research programme which has taken advantage of this setting is the Maldivian Manta Ray Research Project (MMRP), a leading project of the Manta Trust. Since 2005 research by MMRP has added to existing knowledge on the abundance, ecology, behaviour and use of popular aggregation sites by *M. alfredi* (Manta Trust, 2014a). Their work has provided an extensive database of observations into regional dynamics of manta populations and with continued research this will help identify appropriate management priorities required for conservation (Manta Trust, 2014a).

Since 2008 the MMRP has also provided seasonal reports on *M. alfredi* abundances in the Maldives. The results have shown fluctuations in manta ray sightings over this period and these appear to be associated with variations in weather patterns and consequential changes in manta food availability (MMRP, 2011; 2013). Although work by the MMRP has contributed key findings, to fully interpret this information the consideration of long term observations is essential. It has therefore been suggested that it would be valuable to gather the historical knowledge of local fishermen as very little data exists pre-2005. Traditional fishers' knowledge (TFK) has therefore been considered an approach to complement the incomplete and limited scientific information pertaining primarily to manta ray abundances, seasonal occurrences and population dynamics in the Maldives.

An interview with a local fisherman

Experience-based knowledge of traditional fishers is most commonly associated with successive generational development of practical skills and knowledge by those who derive their livelihoods from the natural environment (Davis & Wagner, 2003; Drew 2005; Huntington, 2000). Traditional Knowledge (TK) is inextricably linked and influenced by evolving patterns of environmental change and associated resource use (Berkes et al., 2000; Davis & Wagner, 2003). The assimilation of this TK into conservation programmes has many obvious advantages for providing improved insight into where conservation action and management should be directed (Makinson, 2001; Shackeroff & Campbell, 2007; Stacey et al., 2012).

Through a series of interviews with local fishermen this project aimed to evaluate how abundances of large charismatic species, particularly manta rays and whale sharks, may have changed over time in the Maldives. The survey also aimed to ascertain whether any direct anthropogenic impacts pose a potential threat to these species and to help identify how management can improve their conservation. Finally this study aimed to investigate community perceptions of conservation and how improved relations may help promote an integrated, holistic approach to conservation management.

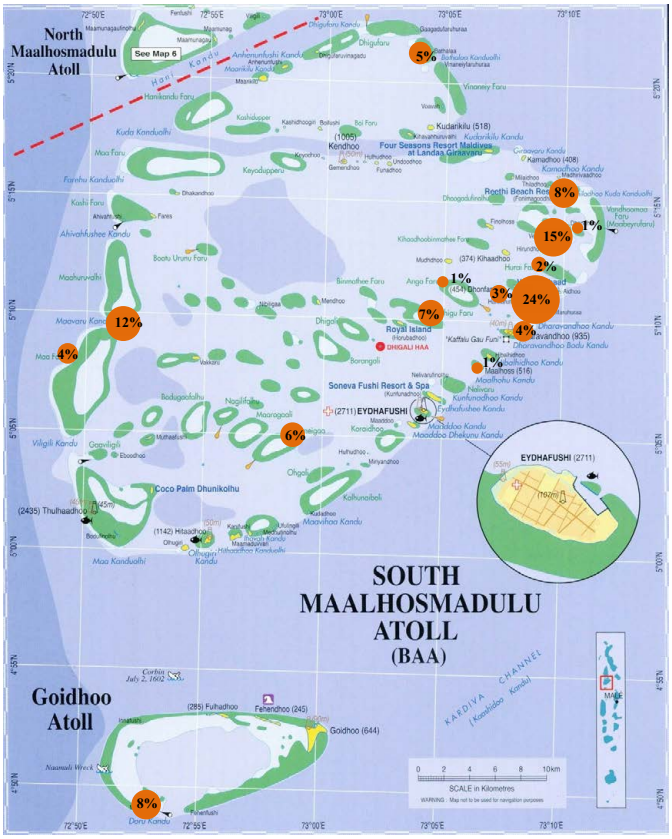


Figure 1: Location of the study site- Baa Atoll, Maldives. *Circles of varying size highlight areas where studies were conducted and are indicative of the relative number of interviews conducted at each site

Methods

This study focussed on Baa Atoll, situated in the North West of the Maldives Atoll chain (EPA, 2011). The atoll is approximately 1200 km2 in area and together with neighbouring Goidhoo Atoll, constitutes 75 islands comprising 5.5 km2 of land (EPA, 2011). Thirteen of these islands are inhabited with a total population of 11000 people (EPA, 2011). Seven islands have been developed as resorts and 53 islands are uninhabited. In recognition of the high degree of biodiversity represented in Baa Atoll, it was declared a World Biosphere Reserve by UNESCO (United Nations Educational, Scientific and Cultural Organization) on the 28th of June, 2011 (EPA, 2011). Hanifaru Bay constitutes a core component of the Baa Atoll Biosphere Reserve (EPA, 2011). It was declared a Marine Protected Area (MPA) in 2009 for the direct protection of the bay and its natural resources for mega-fauna (EPA, 2011). As a key area for mega-faunal sightings, it was expected that fishermen within Baa Atoll would provide background information that would shed light on the population dynamics, ecology, behavioural patterns and potential threats to mantas, whale sharks and other charismatic species.

A total of 62 semi-structured interviews were conducted with local fishermen from nine different islands within Baa Atoll between July and August, 2014. Pilot studies on random Maldivian personnel were carried out prior to initiating formal interviews to identify any problem areas that the intended questionnaire might create. Selection of candidates for the sample population of the formal interviews was deliberately non-random. To interview fishermen with the most experience, Island Councillors were contacted to identify who key informants should be and meetings with these fishermen were subsequently arranged. Interviewee recommendations then provided additional contacts. Questionnaires were translated into the native Maldivian language-Dhivehi, and a Dhivehi translated questionnaire was transcribed to ensure uniformity between different translators who accompanied the interview process (Appendix I). All questionnaires were typically 30-45 minutes long and comprised of open and closed questions. Open questions were included to permit detailed answers to complex questions and to identify unanticipated findings (Mackinson, 2001).

During pilot studies it became apparent that memory recall was difficult and, to overcome this, formal surveys used important historical dates as benchmarks. These included important political dates or years denoted by changes in fishing practices (Anderson & Ahmed, 1993).

Visual aids, such as maps and species identification photographs, were used to guide memory, eliminate responses based on species misidentification, avoid confusion over locations and prevent misunderstandings in colloquial terminology. Visual aids also helped gauge the trustworthiness of responses. In order to gauge the honesty in interviewee responses, questions involving photos of species known not to occur in the Maldives were presented to the respondents (Appendix I). Answers exhibiting lack of knowledge on a picture indicated that respondents freely acknowledged they lacked information, were not providing

information they believed interviewers wanted to hear, and were therefore likely answering the questions truthfully.

To try to eliminate response bias, interviewers did not mention they were affiliated with The Manta Trust. Respondents signed informed consent for the interview process to allow for this information to be used in the current research.

Interviews comprised questions on the fishermen's experience, local ecological knowledge about charismatic species, their awareness of regulations regarding their protection and attitudes towards conservation. The survey was also designed to identify any anthropogenic threats toward manta rays in the Maldives (Appendix I).

Data Analysis

Descriptive statistics were used to summarise the responses obtained from the sample questionnaires. All data was recorded and assessed using Microsoft Excel 2010.

Results

Fishermens' experience and their suitability as informants

The average age of fishermen interviewed was 53 years with the oldest respondent aged 78 and the youngest 28. Those interviewed had on average 30 years' fishing experience with a maximum of 57 years and a minimum of 7 years. Seventy four percent of the fishermen were still actively involved in fishing with the majority (66%) working at least six days per week. This high level of experience suggests that these respondents would be good key informants. Their practical knowledge rendered them well-suited to offer insights into population dynamics and changes in the historical abundance of marine species.

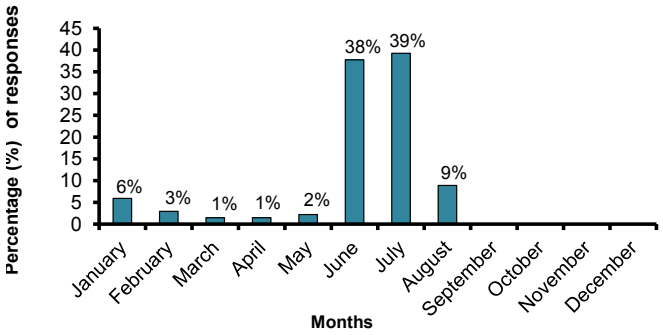


Figure 2: The percentage of responses recorded for a particular month being acknowledged as a predominant month for manta ray (*Manta alfredi*) sightings.

Manta ray sightings & seasonal patterns

The respondents were queried on the seasonal occurrence, frequency of manta sightings and areas where mantas were most often seen. June and July were stressed as the predominant months for peak manta abundances, accounting for 38% and 39% of the total recorded mentions for each month respectively (Fig. 2).

Hanifaru Bay, Veyofushi and Maavaru Faru, were highlighted as the primary sites where mantas were seen, with Hanifaru Bay accounting for the majority of recorded mentions (24%). Veyofushi and Maavaru Faru were the second and third most important regions for manta ray sightings, mentioned by 15% and 12% of respondents respectively (Fig. 3a). Hanifaru Bay was also acknowledged by the majority of fishermen (29%) to be where they witnessed the largest aggregation of mantas and Maavaru Faru was noted as the second most prominent location (18% of fishermen) (Fig. 3b).

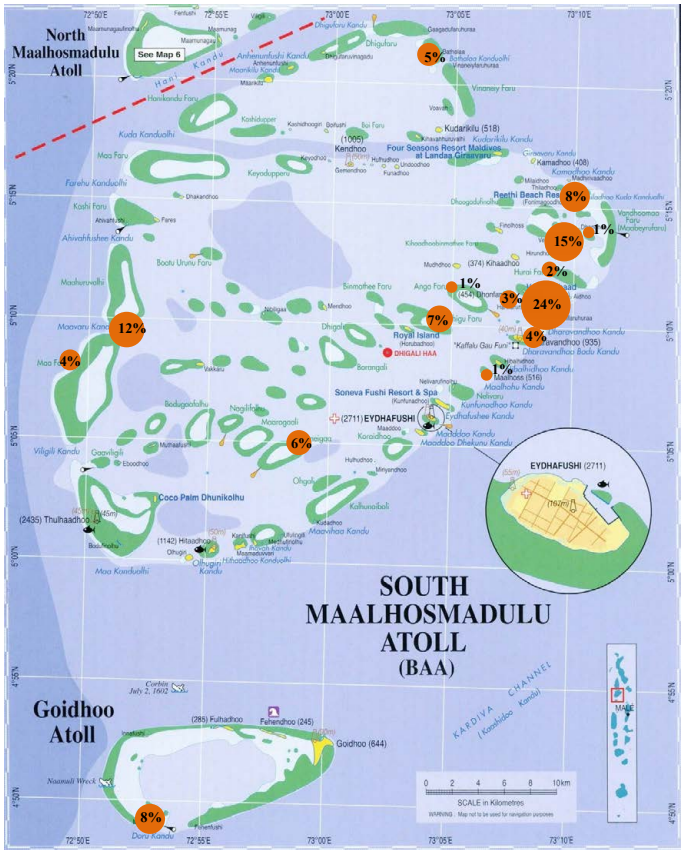


Figure 3a: Areas denoted as primary sites for observing manta rays (*Manta alfredi*) within Baa Atoll. Circles of varying size are indicative of the relative proportion of the percentage for each of the place-name mentions.

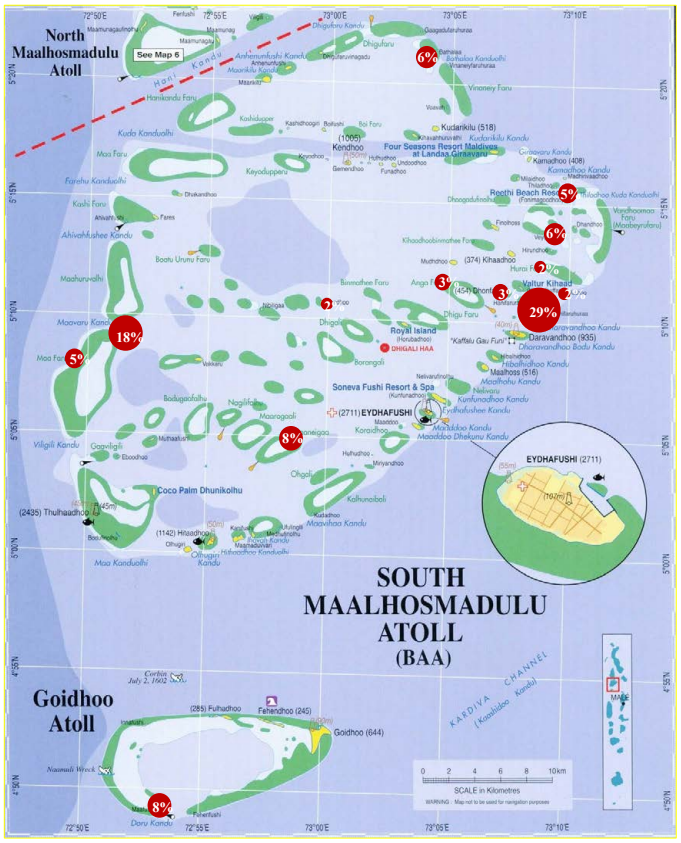


Figure 3b: Areas highlighted by fishermen as the sites for observing the largest aggregations of manta rays (*Manta alfredi*) within Baa Atoll. Circles of varying size are indicative of the relative proportion of the percentage of fishermen acknowledging each site.

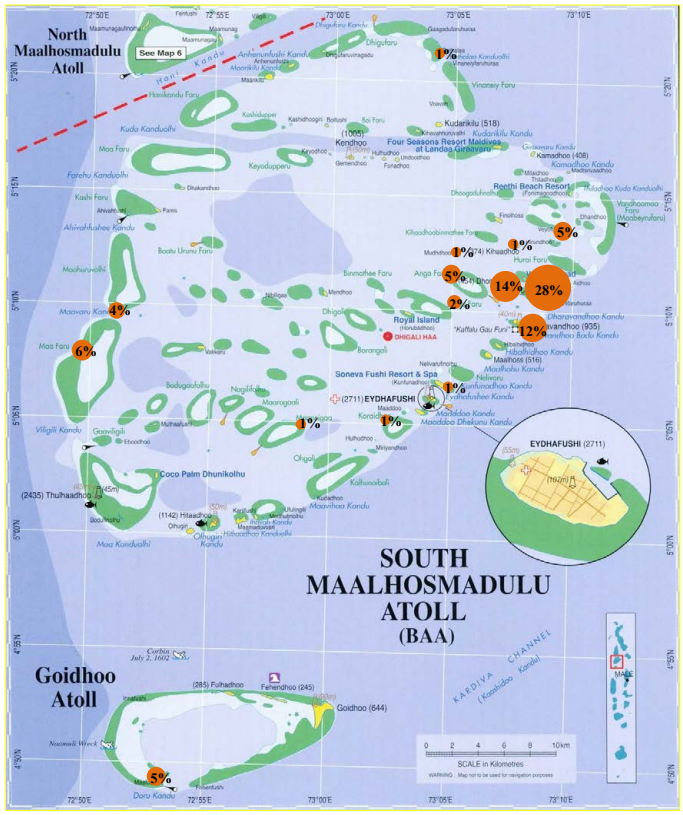


Figure 5a: Areas denoted as primary sites for observing whale sharks (*Rhincodon typus*) within Baa Atoll. Circles of varying size are indicative of the relative proportion of the percentage for each of the place-name mentions.

Whale shark sightings

Fishermen questioned on whale sharks and whale shark hotspots mentioned Hanifaru Bay, Dhonfanu, and Dar-avandhoo as prime areas for regular sightings. Hanifaru Bay was highlighted as the most reliable area for whale shark encounters accounting for 28% of the total place-name mentions, while Dhonfanu comprised 14% and Dar-avandhoo 12% (Fig. 5a). Hanifaru Bay was also recognised

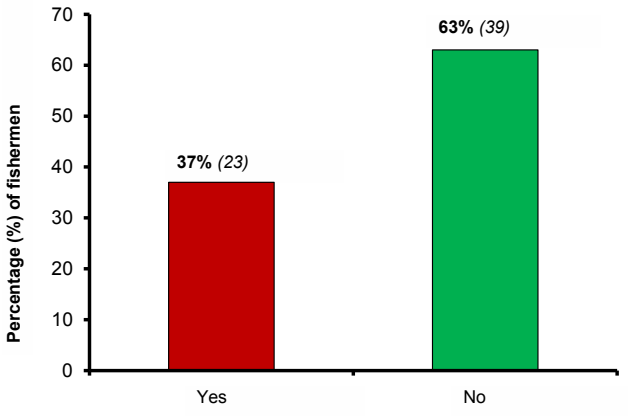


Figure 4: Fishermen's acknowledgement of any change in the abundance of manta rays (*Manta alfredi*) throughout their fishing career. n= (number of fishermen)

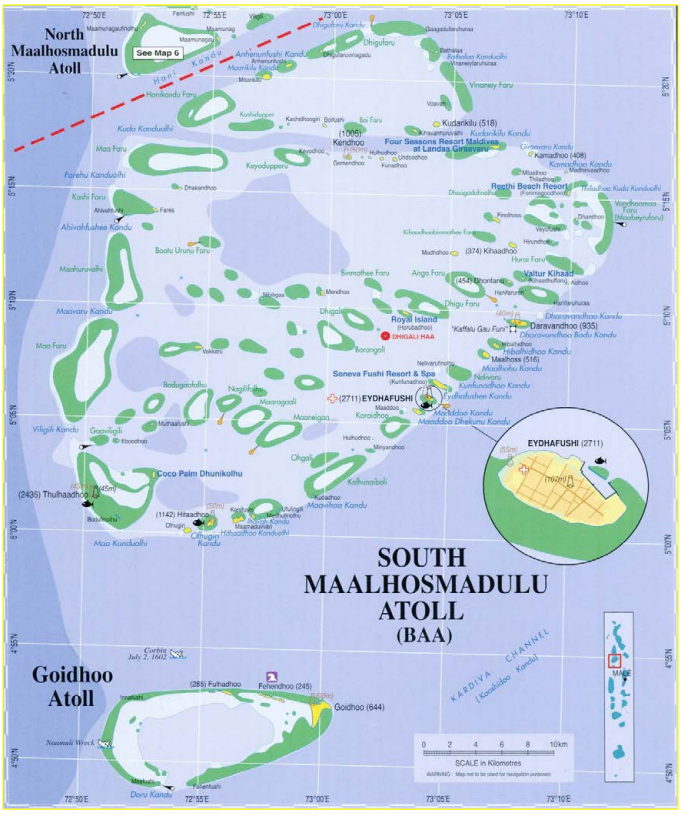


Figure 5b: Areas highlighted by fishermen as the sites for observing the largest aggregations of whale sharks (*Rhincodon typus*) within Baa Atoll. Circles of varying size are indicative of the relative proportion of the percentage of fishermen acknowledging each site.

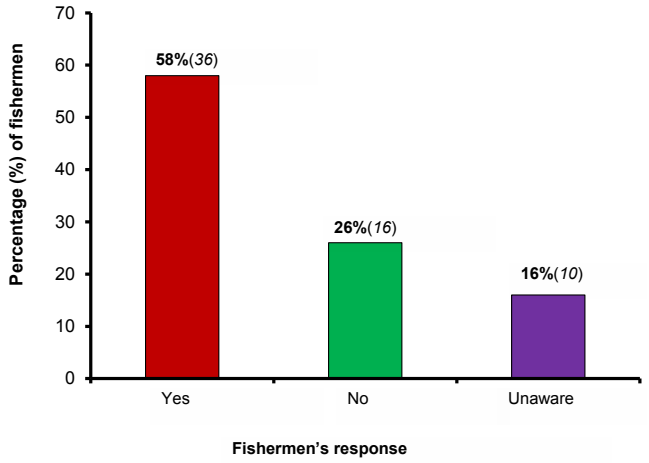


Figure 6: Fishermen's acknowledgement of any change in the abundance of whale sharks (*Rhincodon typus*) throughout their fishing career. *n= (number of fishermen)*

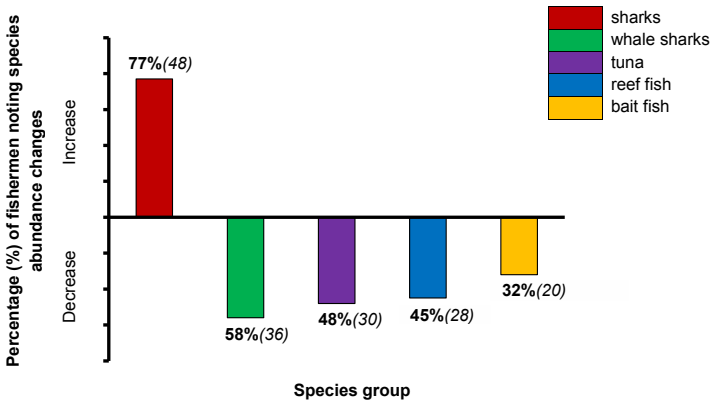


Figure 7: Fishermen acknowledge a change in the abundance of other marine species groups. *n= (number of fishermen)*

as the predominant site for large aggregations of whale sharks, named by 40% of the fishermen (Fig. 5b) with Maavaru Faru being of second most importance (identified by 13% of fishermen) (Fig. 5b).

All fishermen (100%) said the most likely locations for whale shark sightings had remained unchanged throughout their fishing careers. However, questions pertaining to population numbers showed that only 26% believed whale shark abundance had remained stable while 16% were unsure of any variations in whale shark population status (Fig. 6). The majority of the fishermen interviewed (58%) mentioned a change in whale shark numbers. All of these respondents that noted a change stated that there had been a decrease in sightings (Fig. 6; 7).

Abundance changes in other marine fauna

When fishermen were questioned on changes in the abundance of any other marine animals, 77% mentioned an increase in numbers of sharks, particularly tiger and reef sharks (Fig. 7). They primarily attributed this to the shark fishing ban, implemented in 2010, and voiced their concern over potential future increases (Table I). The fishermen also acknowledged a decrease in fish availability in Maldivian waters with 32% of the respondents mentioning a decrease in the abundance of baitfish, 45% recognising a decrease in reef fish and 48% acknowledging a decrease in tuna (Fig. 7).

Anthropogenic threats

Sixty eight percent of fishermen were aware of traditional hunting of manta rays in the Maldives in the past. Obtaining mantas for their liver oil was the primary reason noted (75%) for this traditional practice (Table II). Other reasons given for historical hunting were for the use of manta skin to craft traditional drums and meat for human consumption or as bait for shark fishing (13%, 6% and 6% respectively) (Table II).

Nineteen percent of fishermen noted they had unintentionally caught a manta ray in their fishing careers, with all cases occurring on hook and line. All interviewees were adamant that the unintentional capture of manta rays is extremely uncommon and if they do become entangled in line, they are immediately released.

When questioned on their knowledge and perceptions of rules and regulations regarding mantas, 92% of respondents said they were fully aware that it is illegal to catch and export mantas. Ninety eight percent of the respondents believed the protection of manta rays is vital. Sixty nine percent (n=43) of these respondents attributed this to the role mantas constitute in ecotourism and 42% (n=26) highlighted the importance of protecting mantas as they are 'identifiers' of baitfish. A further 19% (n=12) believed mantas should be protected for intrinsic values-"They are beautiful creatures and close to the hearts of Maldivians" (Fig 8; Table I)

Reference	Quote
Sharks	
	"Certain channels are now off limits as sharks team in these waters"
	"We can no longer practice certain fishing methods as the associated dangers are too great"
	"Before we have time to bring it to the surface the sharks have already had their go"
	"Hauling themselves onto boats"
	"We can no longer let our children swim in certain areas around the islands for we fear they may be in danger"
Manta rays	
	"They are the herders of bait fish"
	"They are beautiful creatures and close to the hearts of Maldivians"
	"There is no need for unwanted killings"
	"We as fishermen respect them"

Table I: Fishermens' quotes related to views over shark increases and manta ray conservation

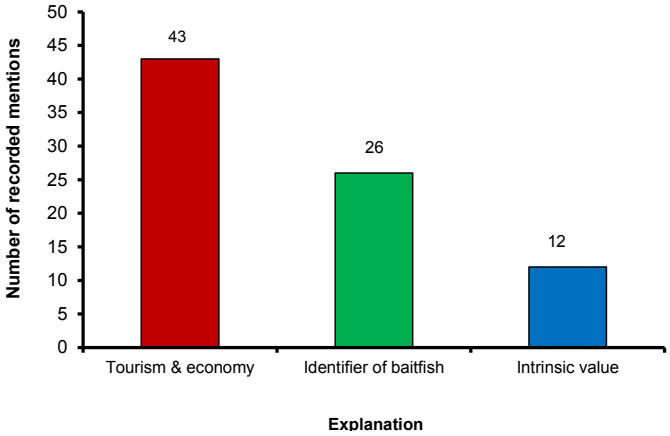


Figure 8: Fishermen's reasoning for the importance of protecting manta rays (*Manta alfredi*). *98% (61 individuals) of the population recognise the importance

Reason for exploitation	No. of mentions	% of total mentions
Oil	40	75
Skin	7	13
Meat	3	6
Bait	3	6

Table II: Explanations recorded for the historical hunting of manta rays in the Maldives

Fishermen's perception of conservation

Interviewees were asked whether they considered the establishment of the biosphere reserve and designation of Hanifaru MPA to be beneficial. Thirty four percent believed it had been beneficial, with 8 fishermen attributing the benefits to tourism and 13 recognising its value in conserving the natural environment for future generations (Table III). Sixty six percent thought it had not been beneficial with 7 respondents saying they had not received sufficient information and felt side-lined and angered by this lack of communication (Table III). Eight fishermen believed it was unnecessary while the majority (26 fishermen) believed the establishment had adversely affected their lifestyle (Table III). The designation of Hanifaru Bay as an MPA, and the subsequent loss of traditional baitfish grounds, was voiced by 52% of respondents as the primary concern.

Response	No. of responses
Positive (34%)	
Tourism	8
Conserving natural environment	13
Negative (66%)	
Lack of information	7
Unnecessary	8
Adversely affected community	26

Table III: Fishermens' perceptions of the conservation initiatives

Opinion on biosphere management varied as 27% believed it was well run while 73% thought management was inefficient (Fig. 9). Of those who mentioned inefficient

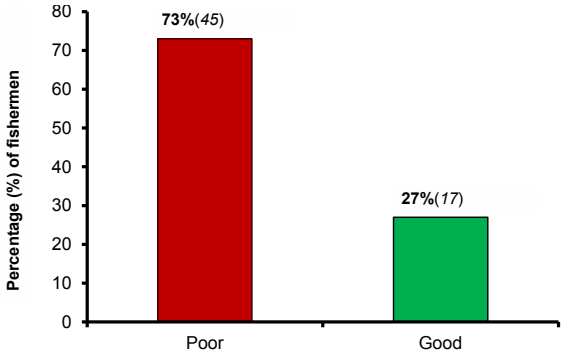


Figure 9: Fishermens' opinions on the effective management of the UNESCO Biosphere Reserve. n= (number of fishermen)

Response	No. of mentions
Rules not enforced	26
Corruption	14
Headquarters	5
Rangers untrained	4

Table IV: Explanation for insufficient management of the Biosphere Reserve and Marine Protected Area

* Insufficient management- acknowledged by 73% of the population (Fig. 9).

management, 26 respondents said that the rules had not been adequately enforced, 14 individuals thought the set-up of the MPA had been corrupt, 5 interviewees said that rangers were not adequately trained, and 4 respondents mentioned the headquarters as being too far away for sufficient monitoring (Table IV).

Prospects for future conservation work

Fishermen were asked how they thought conservation efforts and scientific work in the Maldives could be improved to benefit them or their community. Fifty two percent openly said they would like the younger generation to be taught conservation practices and 48% felt teaching the whole community about conservation would ensure concerted effort for the protection and preservation of the area (Fig. 10).

Discussion

For efficient conservation and management initiatives it is necessary to attain a broader understanding of a particular species' biology, ecology, and current, as well as potential future, threat status (Deakos et al., 2011). This is especially

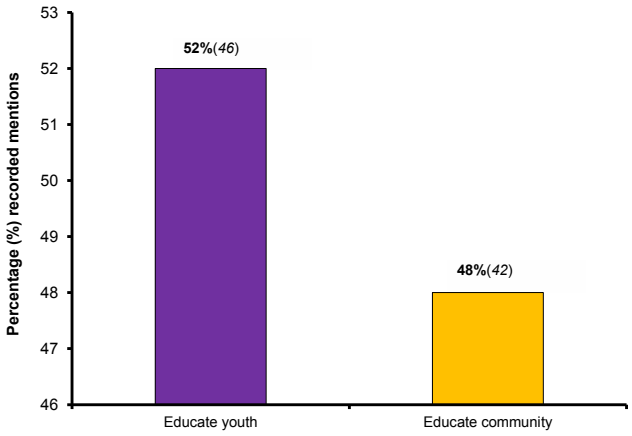


Figure 10: Fishermens' suggestions for ways in which conservation efforts can benefit them or their community. n= (number of mentions)

true of species that exhibit regional fidelity, making them more prone to pressures within a particular area and thus in need of specific management (Deakos et al., 2011). To illuminate the specific situation in the Maldives, this paper focused attention on information gained from local fishermen to improve on the current understanding of charismatic species, specifically manta rays and whale sharks frequenting the region. The livelihood dependencies of fishermen are expected to predict an intimate association between the people and their natural resources thereby providing a detailed understanding of local environmental conditions and ecological dynamics (Davis & Wagner, 2003).

International data on the status of these animals is not prolific but reports acknowledge a decline in sightings particularly in regions where they constitute the target catch of fisheries (Bradshaw et al., 2008). Alava et al. (2002) highlight a 50% decrease in the number of mantas caught in the Philippines between 1960 and 1990. Recent statistics from Mozambique suggest a possible 88% decrease in reef mantas over the past 9 years primarily due to exploitation (Marshall et al., 2010; Marshall et al., 2011(a)(b)(c); Rhoner et al., 2013). Similarly, considerable declines in manta populations have been perceived in Indonesia, Western Australia, Mexico and China (Dewar, 2002; Hendrichs et al., 2011; Marshall et al., 2011(b)(c)). Declines in the abundance of whale sharks follow a comparable trend with a 40% reduction recorded within a decade amongst Australian populations (Bradshaw et al., 2008). In the

Maldives, manta rays and whale sharks are protected from target fisheries following bans initiated between 1995-1996 (Anderson et al., 2011b; MRC, 2006). Despite this, documented sightings of two whale sharks, one impaled by a harpoon and the other with a near severed dorsal fin, suggests the practice of whale shark fishing may still persist in the Maldives (Riley et al., 2009).

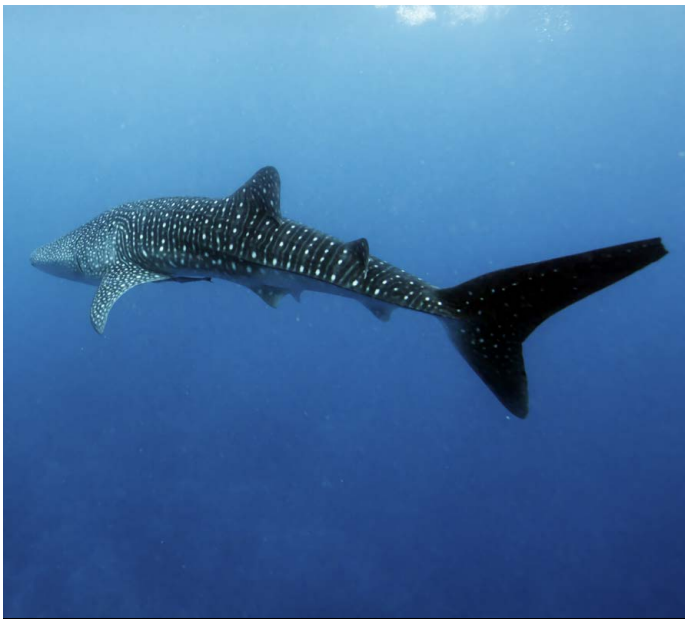
The current study provides support for the possibility of continued illegal fishing of whale sharks as 58% of the local fishermen report a decrease in whale shark sightings over their fishing careers. Other possible explanations for this decline could be linked to global climate change (Sequeira et al., 2014) or exploitation outside Maldivian waters. Bradshaw et al. (2008) attributed declines in protected whale shark populations of Ningaloo Reef, Australia, to their propensity to migrate vast distances and fall victim to capture by Southeast Asian fisheries (Bradshaw et al., 2008). The evidence for this hypothesis was placed above the alternative of environmental change by the researchers and, since deliberate injuries by people have been recorded in whale sharks frequenting the Maldives (Riley et al., 2009), this poses a possible explanation for reductions noted here.

Since 1995 the export and trading of all ray products has been banned in the Maldives (Anderson et al., 2011b). Further legislation effected in June 2014 has provided another important landmark in the conservation of manta rays throughout the region. The implementation of the national protective legislation officially adds all ray species to the list of Protected Species in the Maldives deeming the capture, rearing, trade or smuggling of rays or ray parts illegal, and any act of cruelty or abuse towards these animals and their habitats a violation of the Environmental Protection and Preservation Act (Baa Atoll UNESCO Biosphere Reserve Office, 2014; Manta Trust, 2014b). This study found no reported cases of illegal capture of manta rays within the Maldives, suggesting that it is no longer practiced and in keeping with the new law. The historical hunting of mantas for oil, skin and flesh in the Maldives was recognised by the majority of local fishermen (68%) but it was made abundantly clear by them that this is no longer practiced.

Almost all of the respondents (98%) acknowledge the importance of protecting mantas for ecotourism, identifying baitfish, and for intrinsic values. The respondents also highlighted the unintentional capture of manta rays is very unlikely and, if it does occur, they are immediately released. The majority of fishermen (68%) believed the abundance of manta rays had not changed throughout their fishing career and those who did acknowledge a change noted an increase in abundance which they attributed to conservation efforts in the Maldives. These findings instil a positive response to the conservation of manta rays in the Maldives.

The use of Traditional Knowledge (TK) has until recently been repudiated as 'anecdotal' or 'inaccurate' evidence' (Makinson, 2001). However, it has become increasingly recognised as a source of valuable information (Davis & Wagner, 2003; Rosa et al., 2005). Numerous studies provide overwhelming support for the useful role that TK can contribute in guiding biologists to identify key sites for conservation and for helping implement suitable management protocols (Drew 2005; Gandiwa, 2012; Padmanaba et al., 2013). This study further supports this acknowledged use of TK. The survey findings have highlighted several different hotspots for manta and whale shark sightings with the majority of respondents identifying Hanifaru Bay as a predominant site for regular sightings and witnessing the largest aggregations there. This lends support for the currently established MPA status of the region, which was designed to protect the mega-fauna and conserve natural resources. This study has also highlighted Veyofushi, Dhonfanu and Maavaru Faru as prominent sites for observing mantas and whale sharks. While Veyofushi and Dhonfanu are currently included in the daily monitoring programme of the Manta Trust research team, this study has now revealed Maavaru Faru as a potentially new site requiring surveillance and further research to assess its importance as a mega-fauna hotspot, its vulnerability towards human impacts, and its potential as a new MPA.

Ford, (2001); Orlove et al. (2000); Riedlinger & Berkes, (2001); and Huntington et al. (2004) highlight the value



of TK in predicting natural environmental patterns and identifying early warning signs of environmental change. For conventional science to fully understand and interpret any large scale changes over extensive areas there is a need to include a greater understanding of the knowledge pertaining to historical conditions (Chin et al., 2010; Gandiwa, 2012). One of the aims of the questionnaire was to use fishers' traditional knowledge to assess if present day fluctuations in manta ray seasonal occurrences (MMRP, 2011-2013) are an element of historically natural events or a relatively new phenomenon, possibly linked to climate change. The majority of fishermen reported no change in seasonal timing or abundance of mantas during their fishing careers, with June and July recognized by 77% as predominant months for witnessing high concentrations of manta rays within Baa Atoll. The only reports that indicate a peak season outside of this period were those from Thulhaadhoo, where mantas were said to be most frequently observed between December and March. This is explained by the location of Thulhaadhoo within Baa Atoll and the influence of the North East monsoon here.

These findings imply that fluctuations recorded in recent MMRP seasonal reports are not an element of natural cycles but may rather be early warning signs of changes associated with climate change. It is possible these fluctuations have not yet had a considerable influence on fishermen's observations to warrant acknowledgement.

Abundance changes in other marine fauna

Literature on using TK to estimate abundance trends shows this information is systematically becoming included as a vital constituent for fisheries management and resource use (Johannes et al., 2000). This current study also revealed concerns over declines noted in tuna, reef fish and baitfish by local fishermen. Some attribute this decrease to Fish Aggregation Devices (FAD) positioned out to sea making it impossible for many artisanal fishermen, limited by inadequate equipment, to access these waters. Others believe there has been an overexploitation of reef fish with the growing demands from resorts.

Against a backdrop of heightened concerns over the catastrophic decline in shark numbers worldwide (Worm et al., 2013) the current study also provided some interesting insight into Maldivian shark populations. On a global scale, documented evidence shows between 63-273 million sharks are lost per annum bringing the annual exploitation rate to 6.4%-7.9% (Worm et al., 2013). This has spurred increasing efforts to recover dwindling populations through global conservation initiatives, with the latest banning the trade of five threatened shark species (oceanic white tip, porbeagle and three types of hammerhead) and providing newly instated protection under Appendix II of CITES (McGarth, 2014).

In direct contradiction to these witnessed declines, the current study suggests this is not the case in Maldivian waters. The perceived increase in shark numbers in recent years was intensely discussed by concerned fishermen during interviews. Documented accounts of sharks hindering fishing efforts and the impending dangers associated with their increased abundance around swimming sites has encouraged fishermen to voice a request for the reinstatement of limited shark fishing.

It is important to consider whether these views are representative of real change in shark abundances or if local fishermen were using this interview as a platform to elicit a response from the researchers and law enforcers to get the shark fishing ban repealed. Corroborated evidence of

similar shark increases in areas where some shark species have been afforded protection show that in these cases population increases have occurred over reasonable periods of time. A recent reappraisal of the white shark population off California, USA provides possible support for this observation in protected waters following the implementation of a Shark fishing ban in 1994 (Burgess et al., 2014). Burgess et al. (2014) provide evidence for a rise in white shark numbers in recent years attributing this to protection governing this species and possible increase in food availability from other fishing bans over a period of 20 years. In the Maldives however, the total ban on shark fishing was only legalised in 2010 (Ushan et al., 2012) and, considering the K-selected life history strategy of sharks, it would seem unlikely that population numbers could have increased so dramatically over such a short period of time as recounted in this study. Taking this into account it would be advisable to verify the fishermen's accounts with future research, including diver's encounters to validate this local observation, and over an extended period of time.

Perceptions towards conservation

The interviews questioned whether the monitoring, efficiency and overall management of Baa Atoll as a UNESCO biosphere reserve have been sufficient. Sixty six percent of the respondents said the establishment of the reserve and MPA had not been beneficial. They felt it was an unnecessary development with little dissemination of information concerning rules and improvements. The vast majority of these 'dissatisfied' individuals also noted the community had been adversely affected by the reserves' implementation. Respondents felt Hanifaru Bay had always been an area of reliable abundance of baitfish and were angered about loss of access and lack of compensation.

Contrary to local understanding however, bait-fishing is still permitted in Hanifaru MPA by law as long as fishermen refrain from the use of lights. Directive No: 138-EE/2009/19 (2009) of the Ministry of Housing, Transport and Environment in the Maldives stipulates that any extractive use in Hanifaru MPA other than the traditional bait fishing is prohibited (EPP.Act:4/93).


Photo © Guy Stevens

Moreover 73% of the sample population voiced their concern over the ineffective management of the biosphere reserve and MPA attributing this primarily to the lack of monitoring, enforcement, and corruption, as well as inept financial management.

Cumulatively these perceptions suggest a lack of education and community involvement concerning conservation practices and an apparent miscommunication between government authorities and general public. It also highlights fundamental flaws in the biosphere reserve and identifies aspects which could engender discontent and disrespect by local communities towards government initiated directives which, if not addressed, may fuel future problems in resource management and conservation of vulnerable species.

An encouraging outcome of the interviews was the clear desire of respondents to learn more about conservation initiatives with 52% acknowledging the importance of educating the younger generation about conservation practices. A further 48% suggested the whole community could benefit from further education to improve awareness. Research has shown a positive correlation exists between those who are educated and those who exhibit positive attitudes towards conservation (Braga & Schiavetti, 2013).

Photo © Guy Stevens

Conclusion

Although manta rays have been recorded for over four centuries (Couturier et al., 2012), they remain largely enigmatic with little known about their biology, ecology, migration patterns and population dynamics. Against a background of increasing anthropogenic pressures these charismatic species face substantial population declines. Bridging gaps in baseline information and developing a broader understanding of manta population dynamics and threat status are paramount to the effective conservation of the group (Deakos et al., 2011).

This study has provided the first attempt in the Maldives to access fishers' historical ecological knowledge to address conservation concerns and to construct a more comprehensive account of charismatic species frequenting the region. It has shed a positive light on conservation efforts towards manta rays and elicited a local response that confirms this protected species is perceived to benefit where targeted conservation is practiced. It has also produced valuable information concerning declines in protected whale shark populations as well as other fish species, stimulating investigation of the causes. The study has also noted recent increases in shark populations locally, a phenomenon which contrasts dramatically with the excessive declines reported elsewhere in the world and encourages research in the near future. Fishermen's knowledge from the study has also identified new sites which require future monitoring and conservation for manta ray and whale shark populations thereby providing a fundamental step towards the improved protection of these charismatic species and their natural resources.

The integration of traditional ecological knowledge is not only expected to complement conventional science by adding to the biological and ecological information obtained, but is also expected to encourage improved communication between scientists and local communities (Davis & Wagner, 2003). This often results in eliciting a mutual sense of respect and co-operation and invokes a sense of responsibility amongst indigenous populations to support conservation initiatives (Becker & Ghimire, 2003; Pierotti & Wildcat, 2000). Based on this premise the study's findings have emphasized the ideas, theories and concerns of the Baa Atoll fishing community and it is hoped that incorporating these views into future conservation initiatives could help promote an integrated and holistic approach to conservation management here and elsewhere in the Maldives.

Acknowledgements

I would just like to thank Ibrahim Dhaanish Nashid, Mohamed Hammadh, Hussein Hussan, Moosa Mohammed, and Ibrahim Lirar Hussain Mohamed for all the long hours spent travelling to different islands and helping with the interview process; to Annie Murray, Niv Froman, Guy Stevens, Callum Roberts and Julie Hawkins for their advice and guidance and for providing me with this incredible opportunity. To all the members of the Manta Trust Team and to the staff at Four Seasons Landaa Giraavaru for their friendship, kindness, support, encouragement, endless hours of laughter, and all-round fantastic experience. And last but not least to the class of 2013/2014 for all the great memories and wonderful friendships, Thank you.

References

Alava, E.R.Z., Dolumbaló, E.R., Yaptinchay, A.A., and Trono, R.B. (2002). Fishery and trade of whale sharks and manta rays in the Bohol Sea, Philippines. In: Fowler, S.L., Reed, T.M., Dipper, F.A. (eds) Elasmobranch Biodiversity, Conservation and Management: Proceedings of the International Seminar and Workshop. Sabah, Malaysia, July 1997, pp 132–148.

Anderson, R. C., Adam, M. S., & Goes, J. I. (2011a). From monsoons to mantas: seasonal distribution of *Manta alfredi* in the Maldives. *Fisheries Oceanography*, 20(2), 104–113.

Anderson, R. C., Adam, M. S., Kitchen-Wheeler, A.-M., & Stevens, G. (2011b). Extent and Economic Value of Manta Ray Watching in Maldives. *Tourism in Marine Environments*, 7(1), 15–27.

Anderson, R.C., and Ahmed, H.(1993).The Shark Fisheries of the Maldives. Ministry of fisheries ad agriculture, Republic of Maldives. Food and Agriculture organisation of the United Nations. Pp 1-77.

Baa Atoll UNESCO Biosphere Reserve Office. (2014). *Rays included in the protected species list*. News and Events. Accessed: 5/11/2014

Becker, C. D., & Ghimire, K. (2003). Synergy Between Traditional Ecological Knowledge and Conservation Science Supports Forest Preservation in Ecuador. *Conservation Ecology* 8(1). 1. http://www.ecologyandsociety.org/vol8/iss1/art1/ Accessed: 10/09/14

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as Adaptive Management. *Ecological applications*, 10(5), 1251–1262.

Bradshaw, C., Fitzpatrick, B., Steinberg, C., Brook, B., & Meekan, M. (2008). Decline in whale shark size and abundance at Ningaloo Reef over the past decade: The world's largest fish is getting smaller. *Biological Conservation*, 141(7), 1894–1905.

Braga, H. D. O., & Schiavetti, A. (2013). Attitudes and local ecological knowledge of experts fishermen in relation to conservation and bycatch of sea turtles (reptilia: testudines), Southern Bahia, Brazil. *Journal of Ethnobiology and Ethnomedicine*, 9, 15.

Brook, R. K., & McLachlan, S. M. (2008). Trends and prospects for local knowledge in ecological and conservation research and monitoring. *Biodiversity and Conservation*, 17(14), 3501–3512.

Burgess, G. H., Bruce, B. D., Cailliet, G. M., Goldman, K. J., Grubbs, R. D., Lowe, C. G., … O'Sullivan, J. B. (2014). A re-evaluation of the size of the white shark (Carcharodon carcharias) population off California, USA. *PloS One*, 9(6), e98078.

Chin, A., Kyne, P. M., Walker, T. I., & McAULEY, R. B. (2010). An integrated risk assessment for climate change: analysing the vulnerability of sharks and rays on Australia's Great Barrier Reef. *Global Change Biology*, 16(7), 1936–1953.

Couturier, L. I. E., Dudgeon, C. L., Pollock, K. H., Jaine, F. R., Bennett, M. B., Townsend, K., Weeks, S.J., Richardson, J. (2014). Population dynamics of the reef manta ray *Manta alfredi* in eastern Australia. *Coral Reefs*, 33(2), 329–342.

Couturier, L. I. E., Marshall, a D., Jaine, F. R. a, Kashiwagi, T., Pierce, S. J., Townsend, K., Weeks, S.J., Bennet, M.B., Richardson, J. (2012). Biology, ecology and conservation of the Mobulidae. *Journal of Fish Biology*, 80(5), 1075–119.

Couturier, L.I.E., Jaine, F.R.A., Townsend, K.A., Weeks, S.J., Richardson, A.J., Bennett, M.B. (2011).Distribution, site affinity and regional movementsof the manta ray, *Manta alfredi* (Krefft, 1868),along the east coast of Australia. *Marine and Freshwater Research*, 62, 628–637

Davis, A., & Wagner, J. R. (2003). Who Knows ? On the Importance of Identifying "Experts" When Researching Local Ecological Knowledge. *Human Ecology*, 31(3), 463–489.

Deakos, M., Baker, J., & Bejder, L. (2011). Characteristics of a manta ray *Manta alfredi* -population off Maui, Hawaii, and implications for management. *Marine Ecology Progress Series*, 429, 245–260.

Dewar, H. (2002). *Preliminary Report: Manta Harvest in Lamakera*. Pfleger Institute of Environmental Research and the Natural Conservancy.

Drew, J. (2005). Use of Traditional Ecological Knowledge in Marine Conservation. *Conservation Biology*, 19(4), 1286–1293.

Doty MS, Oguri M (1956) The island mass effect. *Journal of Marine Science*, 22, 33-37

Environmental Protection Agency (EPA). (2011). *Management Plan For Hanifaru Marine Perotected Area Baa Atoll, Maldives*. Atoll Ecosystem Conservation Project. Pp1-22

Environmental Protection and Preservation Act: 4/93. (EPP. Act:4/93). (2009). Translation of the Directive No: 138–EE/2009/19 (5th June 2009) of the Ministry of Housing, Transport and Environment. Pp 4

Fernando, D., & Stevens, G. (2011). A Study of Sri Lanka's Manta and Mobular Ray Fishery Manta Trust, 1–29.

Ford, J. (2001). The Relevance of Indigenous Knowledge to Contemporary Sustainability. Proc. International Fisheries Economics and Trade, pp 7

Gandiwa, E. (2012). Local knowledge and perceptions of animal population abundances by communities adjacent to the northern Gonarezhou, 5(3), 255–269.

Hendrichs, S., O'Malley, M., Medd, H., Hilton, P. (2011). Manta Ray of Hope, 2011 Report: The global threat to manta and mobular rays. Pp 39

Huntington, H., Callaghan, T., Fox, S., Krupnik, I., Huntington, H., & Callaghan, T. (2004). Matching traditional and scientific observations to Detect Environmental Change: A Discussion on Arctic Terrestrial Ecosystems. *Ambio Special Report*, 13, 18-23.

Huntington, H.P. (2000). Using Traditional Ecological Knowledge In Science : Methods And Applications. *Ecological Applications* 10(5), 1270–1274.

Jaine, F. R., Couturier, L. I. E., Weeks, S. J., Townsend, K. a., Bennett, M. B., Fiora, K., & Richardson, A. J. (2012). When Giants Turn Up: Sighting Trends, Environmental Influences and Habitat Use of the Manta Ray *Manta alfredi* at a Coral Reef. *PLoS ONE*, 7(10), e46170.

Johannes, R. E., Freeman, M. M. R., & Hamilton, R. J. (2000). Ignore fishers ' knowledge *and miss the boat*, 1, 257–271.

Kimmerer, R. W. (2002). Weaving Traditional Ecological Knowledge into Biological Education : A Call to Action, *Bioscience* 52(5), 432–438.

Mackinson, S. (2001). Integrating Local and Scientific Knowledge: An Example in Fisheries Science. *Environmental Management*, 27(4), 533–545.

Manta Trust. (2014a). Conservation through Research, Awareness and Education UK Registered Charity Number: 1145387. http://www.mantatrust.org/about-us/the-manta-mission/ Accessed: 27/08/14

Manta Trust. (2014b).*The Maldives announces all ray species now added to the Maldives Protected Species List*. Press Release: 05 June 2014

Marshall AD, Dudgeon CL, Bennett MB (2011a) Size and structure of a photographically identified population of manta rays *Manta alfredi* in southern Mozambique. *Marine Biology*, 158: 1111–1124

Marshall, A., Kashiwagi, T., Bennett, M.B., Deakos, M., Stevens, G., McGregor, F., Clark, T., Ishihara, H. & Sato, K. (2011b). *Manta alfredi*. The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org. Accessed: 5/11/2014.

Marshall, A., Bennett, M.B., Kodja, G., Hinojosa-Alvarez, S., Galvan-Magana, F., Harding, M., Stevens, G. & Kashiwagi, T. (2011c). *Manta birostris.* The IUCN Red List of Threatened Species. Version 2014.2. www.iucnredlist.org. Accessed: 5/11/2014.

Marshall, D., & Bennett, M. B. (2010). Reproductive ecology of the reef manta ray *Manta alfredi* in southern Mozambique. *Journal of Fish Biology*, 77(1), 169–90.

McGarth, M. (2014). First ban on shark and manta ray trade comes into force. Environment correspondent, BBC News. http://www.bbc.co.uk/news/science-environment-29175592. Accessed: 14/09/2014.

MRC. (2006). *Status of the Shark Fishery of the Maldives*. Marine research Centre. Ministry of Fisheries, Agriculture and Marine Resources. pp21.

O'Malley, M. P., Lee-Brooks, K., & Medd, H. B. (2013). The global economic impact of manta ray watching tourism. *PloS One*, 8(5), e65051.

Orlove, B., Chiang, J., & Cane, M. (2000). Forecasting Andean rainfall and crop yield from the influence of El Nino on Pleiades visibility. *Nature*, 403(6765), 68–71.

Padmanaba, M., Sheil, D., Basuki, I., & Liswanti, N. (2013). Accessing local knowledge to identify where species of conservation concern occur in a tropical forest landscape. *Environmental Management*, 52(2), 348–59.

Pierotti, R., Wildcat, D. (2000). Traditional Ecological Knowledge: The Third Alternative. *Ecological Applications*, 10(5), 1333-1340.

Riedlinger, D., and Berkes, F. (2001). Contributions of traditional knowledge to understanding climate change in the Canadian Arctic. Polar Record, 37, pp 315-328.

Riley, M. J., Harman, A., & Rees, R. G. (2009). Evidence of continued hunting of whale sharks *Rhincodon typus* in the Maldives. *Environmental Biology of Fishes*, 86(3), 371–374.

Rohner, C., Pierce, S., Marshall, A., Weeks, S., Bennett, M., & Richardson, A. (2013). Trends in sightings and environmental influences on a coastal aggregation of manta rays and whale sharks. *Marine Ecology Progress Series*, 482, 153–168.

Rosa, I. M., Alves, R. R., Bonifácio, K. M., Mourão, J. S., Osório, F. M., Oliveira, T. P., & Nottingham, M. C. (2005). Fishers' knowledge and seahorse conservation in Brazil. *Journal of Ethnobiology and Ethnomedicine*, 1, 12

Sequeira, A.M.M., Mellin, C., Meekan, M.G., Bradshaw, C.J.A. (2014). Predicting current and future global distributions of whale sharks. *Global Change Biology*, 20(3), 778-789.

Shackeroff, J. M., & Campbell, L. M. (2007). Traditional Ecological Knowledge in Conservation Research : Problems and Prospects for their Constructive Engagement, *Conservation and Society*, 5(3), 343–360.

Stacey, N., Karam, J., Meekan, M., Pickering, S., & Ninef, J. (2012). Prospects for whale shark conservation in Eastern Indonesia through bajo traditional ecological knowledge and community-based monitoring. *Conservation and Society*, 10(1), 63.

Stevens, G., Brooks, K.L. (2013). A short report for the Ministry of Environment, Maldives; EPA and AEC Project. Maldivian Manta Ray Project 2013. Season Summary. Pp. 19

Stevens, G., Brooks, K.L., Sciambi, D. (2012). A short report for the Ministry of Environment, Maldives; EPA and AEC Project. Maldivian Manta Ray Project 2012. Season Summary. Pp. 16

Stevens, G., Brooks, K.L. (2011). A short report for the Ministry of Environment, Maldives; EPA and AEC Project. Maldivian Manta Ray Project 2011. Season Summary. Pp. 12

Ushan, M., Wood, E., Saleem, M., Sattar, S.A. 2012. Maldives Sharkwatch Report for 2009 – 2010. Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012. Darwin Reef Fish Project, Marine Research Centre, Ministry of Fisheries and Agriculture, Male', Republic of Maldives. Pp. 4. http://www.icrs2012.com/proceedings/manuscripts/ICRS2012_13D_2.pdf. Accessed: 20/08/2014.

Ward-Paige, C., Davis, B., & Worm, B. (2013). Global population trends and human use patterns of Manta and Mobula rays. *PloS One*, 8(9), e74835.

Worm, B., Davis, B., Kettemer, L., Ward-Paige, C. A., Chapman, D., Heithaus, M. R., Gruber, S. H. (2013). Global catches, exploitation rates, and rebuilding options for sharks. *Marine Policy*, 40, 194–204. doi:10.1016/j.marpol.2012.12.034

Appendix

Research Questionnaire

Introduction:

I am a student of the University of York in England and would like to thank you for agreeing to assist me with my survey. I am studying for my Masters' Degree and have chosen to focus my research on Manta Rays in the Maldives and the value of traditional knowledge of these animals.

My name is Tam, and this is _____ who will be helping me today with the interview process. At the outset it is very important for you to understand that everything that we discuss today will be completely confidential and all information will be anonymous.

Before we begin I would like to tell you a little about this study, why we are asking these questions and what we hope to find out. We want to know about what Maldivian seas were like in the past, especially to understand whether there are any changes in the abundance of some of the largest species that live in them, like manta rays.

We know very little about the manta rays of the world, but here in the Maldives we have a great opportunity to study them. Since 2005 researchers and conservationists have been gathering information on the manta rays that live here. However, in order for us to fully understand and interpret this information we need to know more about manta ray occurrences in the past (prior to 2005), as well as other large animals like whale sharks. This is why we want to talk to you.

I want to begin by asking you about your experience as a fisherman. I then want to ask some questions about manta rays and other big fish. If you do not understand anything or want to ask any questions during the interview, please stop me at any time.

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

Right, let us begin:

Interview

Introduction:

A. Fishing experience

1. How old are you?
2. How many years have you been fishing for? (Open)
3. Are you still actively involved in fishing? (Yes/No)
4. How many days would you spend fishing in a typical month? (Open)
5. What do/did you fish for? (Open)
6. Has your target catch changed since you began fishing? (Yes/No)
7. If yes, then:
    a. When did this change occur? (Open)
    b. Why did it change? (Open)
8. Has your method of fishing changed since you began fishing (Yes/No)
9. If yes, then when did you change the way you fished (Open)

To gauge the trustworthiness of the respondent's answers I will ask them to answer a couple of questions on pictures of different fish species some of which are known not to exist or be of great abundance in the Maldives (eg. Dugong).

B. Historical abundances of large fish

This is a **Manta ray** – show photograph:

1. What time of the year are manta rays most commonly observed? (open)
    a) Has this changed since you started fishing? (Yes/No)
        i. If yes, how has it changed?
2. **How often** do you see manta rays on your fishing trips?
   (always/ almost every time/occasionally/rarely/never)
3. **Where** do you most often see manta rays?
   (Using a map to identify location) (Open)
    a) Has this changed since you started fishing? (Yes/No)
        i. If yes, how has it changed?

4. Sometimes manta rays gather together in large numbers.....

a) What is the largest number of manta rays you have ever seen at once? (Open)

b) Where did you see them? (Open)

c) Can you remember what year you saw them in? (Open)

5. Do you think the numbers of manta rays has changed since you first began fishing? (Yes/No)

a) If yes, are they more or less common today than they were then? (Open)

i. When you began fishing how often would you see manta rays?

ii. When you go fishing today how often do you see manta rays?

6. Are manta rays ever seen together with any other big fish? (Yes/No)

7. If yes, then which species are they likely to be seen with? (Open)

8. Have you ever seen manta rays offshore (Yes/ No)

9. If yes

a) How far offshore? (Open)

b) Where did you see you this? (Open)

c) How many individuals did you see? (Open)

This is a **Whale shark** – show photograph:

10. What is the largest number of whale sharks you have ever seen at once? (Open)

a) Where did you see them? (Open)

b) Can you remember what year you saw them in? (Open)

11. Do you think the numbers of whale sharks has changed since you first began fishing? (Yes/No)

a) If yes, are they more or less common today than they were then? (Open)

i. *When you began fishing how often did you see whale sharks? (Open)*

ii. *When you go fishing today how often do you see whale sharks? (Open)*

12. **Where** do you most often see whale sharks?
(Using a map to identify location) (Open)

a) Has this changed since you started fishing? (Yes/No)

i. If yes, how has it changed?

13.Have you ever seen Whale sharks offshore (Yes/ No)

14.If yes

a) How far offshore? (Open)

b) Where did you see you this? (Open)

c) How many individuals? (Open)

15. Can you think of any animals that are more common today than they were when you started fishing? (Open)

a) If yes, what are they?

C. Potential threats

1. Have manta rays ever been intentionally caught in the Maldives? (Yes/No)

2. If yes, then:

a) What were they fished for? (Open)

b) How many would be caught? (Open)

3. Have you ever caught a manta in your fishing gear (intentionally or unintentionally)? (Yes/No)

4. If yes, in which fishing gear? (Open)

5. Is this common? (Yes/No)

6. What happens to any manta rays that are caught? (Open)

D. Locals perception of conservation efforts in the Maldives (particular focus on manta rays)

Hanifaru Bay and the Biosphere Reserve-

In 2009 Hanifaru Bay was declared a Marine Protected Area and 2 years later, on the 28 June 2011, the whole of Baa Atoll was declared as a World Biosphere Reserve by UNESCO.

1. Do you know why the MPA was established? (Yes/No)

a) If yes, what was the reasoning behind designating Hanifaru an MPA? (Open)

2. How did the establishment of the MPA affect you? (your livelihood/quality of life) (Open)

3. Would you like to take your family, children and friends to visit and swim with the mantas in Hanifaru Bay? (Open)

4. Has anything changed since the establishment of the MPA and Biosphere Reserve? (Yes/No)

5. Do you think the establishment of the Biosphere Reserve has been beneficial? (Yes/No)

a) Why?_____

6. Is the Biosphere Reserve well managed? (Yes/No)

    a) Why?_____

7. How do you feel about the work of scientists and conservationists in the Maldives?
   If this cannot be answered as an open question I will use the following prompts
   Is it (important/ too strict/ cause problems/ unnecessary/I don't know)

    a) Why: _____

8. How do you think the rest of your community feels about the work of scientists and conservationists?
   Are they (important/ too strict/ cause problems/ unnecessary/I don't know)

9. Would you like to learn more about what scientists and conservationists do and why they do it? (Yes/No)

10. What benefits do you expect to receive from conservation programmes in the Maldives? (Open)

Perceptions of local fishers to manta rays and their conservation-

1. Are you aware of any rules and regulations about the capture of manta rays in the Maldives? (Yes/No)?

2. If yes, what is your understanding of the rules? (Open)

3. In general how do fishermen feel about manta rays?
   (Are they seen as a: menace/feared/respected/don't bother/I don't know)

4. Do you think manta rays should be protected? (Yes/No)

    a) Why: _____

Final comments-

5. Is there anything else you would like to tell me?

6. Is there anything you would like to ask me?

7. Having completed this survey, can you recommend anybody else we should talk to?

Thank you very much for the time you have taken to answer these important questions. As I said at the beginning, all the information you have provided will remain completely anonymous. Can I please have your consent to use this information in my research?

Signature of consent _____ Date _____

If you have any further queries regarding manta rays or work being conducted by the Manta Trust team please feel free to get in contact with us any time (provide contact details).

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

Tam Sawers - BSc (Hons), MSc (Hons)
Database Manager - The Manta Trust

Guy Stevens - BSc (Hons), PhD Candidate:
Chief Executive / Founder - The Manta Trust.

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

For further information please email:

tam@mantatrust.org or guy@mantatrust.org