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Occurrence of whale shark (*Rhincodon typus*) in the Indian Ocean: A case for regional conservation

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Abstract

From the first whale shark (*Rhincodon typus*) described in 1828 from the Indian Ocean, the region continues to be one of the most important areas for whale shark sightings. However, the species has been the subject of several targeted fisheries and thus sustained massive, rapid declines in population numbers.

The known range of occurrence and targeted fisheries for whale sharks in the Indian Ocean are discussed, along with stated national conservation measures in the range states. The results of a preliminary survey of 16 regional cooperative partners from 11 of the Indian Ocean range states are presented for whale shark occurrence, monitoring, perceived threats and realized conservation measures. These data are already proving valuable by facilitating cooperation between organisations regionally.

The current international conservation framework is briefly described and suggestions made as to possible linked regional conservation initiatives, such as under the auspices of the Convention on Migratory Species.

Keywords: Whale shark; *Rhincodon typus*; Indian Ocean; Conservation; Distribution

1. Introduction

The first historic account describing a whale shark (*Rhincodon typus*) was from Seychelles waters in an entry in the ship's log of the Marion Dufresne expedition in 1768, just 12 years after the first settlement of these islands (Lionnet, 1984). The first record of a whale shark being fished is also from these waters, in the 1805 log of Captain Philip Beaver (Smyth, 1829), and foretells the fate of this species in the Indian Ocean.

Despite these early records and the first scientific recording of the species being from the Indian Ocean by Andrew Smith in 1828 and 1829 (Smith, 1829), remarkably little is known about the whale sharks range and status in this region (Fowler, 2000). Targeted fisheries in the northern Indian Ocean have shown dramatic declines (Hanfee, 2001) and prompt the need for an urgent review of the species status in this region.

2. Review of known occurrence of whale sharks

In terms of their spatial distribution, whale sharks occur in the following Indian Ocean states: Australia (Western Australia), Bangladesh, Djibouti, India, Indonesia, Kenya, Madagascar, Malaysia, the Maldives, Mauritius, Mozambique, Seychelles, Somalia, South Africa, Sri Lanka, Tanzania and Thailand (Irvine and Keesing, 2007; Norman unpublished). Whale sharks are regarded as a broad ranging species and globally have been found in many areas with surface sea water temperatures of 18–30 °C (Fowler, 2000). However they have been recorded in latitudes with far cooler temperatures as far as 41°N and 36.5°S (Wolfson, 1986). Other studies have shown they are commonly found in temperatures of 28–32 °C (Eckert and Stewart, 2001).

There is some published information on the variability of their temporal occurrence in the region such as from the Maldives where they are found in the west during the Northeast monsoon, and in the east during the Southwest monsoon (Anderson and Ahmed, 1993). There is also good information on the timing of their occurrence at Ningaloo where they feed on krill (Taylor, 1994; Wilson and Newbound, 2001).

A number of targeted fisheries have developed within the Indian Ocean, some from traditional roots, such as the fisheries in India, Pakistan and the Maldives that originated to supply the oil from the shark's liver for waterproofing boats (Anderson and Ahmed, 1993; Hanfee, 2001). This escalated especially in India during the 1990s due to the demand for whale shark meat to supply the demand in Taiwan for 'Tofu shark'. Reported figures indicate a peak in this Indian fishery of 279 sharks in 1999

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but that despite increased effort only 160 were taken in 2000 (Hanfee, 2001). This fishery was closed in 2001 when the species received protected status (Irvine and Keesing, 2007). The fishery in the Maldives previously took 20–30 whale sharks per year (Anderson and Ahmed, 1993) but proved unsustainable with declining catches and the fishery was stopped in 1995 (Colman, 1997).

This paper reviews current regional and international measures and describes the development of an informal Indian Ocean whale shark regional network. It presents information that participants have supplied as to the occurrence, conservation status, monitoring and threats to the species in their areas.

3. Current regional and international measures

The whale shark is listed on Appendix II of the Convention on the International Trade in Endangered Species (CITES, 2002). This status should allow for the closer monitoring of and restriction in international trade in whale shark products, and by so doing assist in the conservation of the species on a global scale.

The whale shark is also listed on Appendix II of the Bonn Convention for the Conservation of Migratory Species (CMS) as species whose conservation status would benefit from the implementation of international cooperative agreements (CMS, 1999). On listing in 1999, a call was made for co-operative actions by 2001–2002, however, it was not until November 2005 that the CMS approved a 'Recommendation for the conservation of migratory sharks' proposed jointly by Australia, New Zealand and Seychelles (CMS, 2005). It is hoped that this recommendation will achieve appropriate actions on behalf of the species.

The whale shark is also included in the Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks of the United Nations Convention on the Law of the Sea (UNCLOS, 1982). This agreement recognizes that as the whale shark is a highly migratory species, coordinated management and assessment of shared migratory populations would promote an understanding of the cumulative impacts of fishing effort on the status of shared populations. To date, no such measures have been proposed.

Under the *International Plan of Action* for Sharks as requested by the Food and Agriculture Organisation (FAO, 2000) there is a potential framework for whale shark conservation. Unfortunately implementation of even National Plans of Action by FAO members has been extremely limited thus hampering plans for an international instrument.

4. Methods

In contrast to the apparent paucity of information in scientific literature, the reporting of whale shark sightings within recreational diving and eco-tourism activities has grown. An initial marker and satellite tagging study of the species by the Marine Conservation Society Seychelles (MCSS) showed that the species ranged widely (Rowat and Gore, 2007). This prompted MCSS to launch an informal regional outreach programme in 2002 to try to gather more information on whale shark occurrence from other areas around the region.

A short one page questionnaire was developed requesting details on position and time of year of sightings, local threats, local monitoring, any relevant legislation and the respondent's appreciation of the status of the sharks in their area. Internet searches, magazine articles and leads from various sources were followed to produce a contact list of people and organisations that had some form of activity with whale sharks. The questionnaire was sent with a cover letter to these contacts along with a completed version of the questionnaire for the Seychelles area. This was done to show willingness to share information, to inform the recipients of the work in Seychelles, and to alert people to the possibility of sighting and reporting whale sharks with marker tags used in the Seychelles.

On receipt of a completed questionnaire form from a new respondent, the data were compiled into a database and a copy of the form was sent in pdf format to all other respondents in the survey. Reciprocally, pdf copies of the forms from all the other respondents were sent to the new respondent; in this way all the network members were aware of the whale shark status and activities in all the other areas.

5. Results

A number of organisations have been contacted mainly within the Indian Ocean. In total, 20 organisations or individuals responded, 16 of which were from 11 Indian Ocean countries (Fig. 1).

The periods of occurrence all showed marked temporal variations with only one area, the Maldives, indicating a year round occurrence. Table 1 summarises the period of whale shark occurrence reported by the respondents, it should be noted that a question mark denotes occasional sightings during this particular month. These responses are shown graphically for the quarterly periods in Fig. 2.

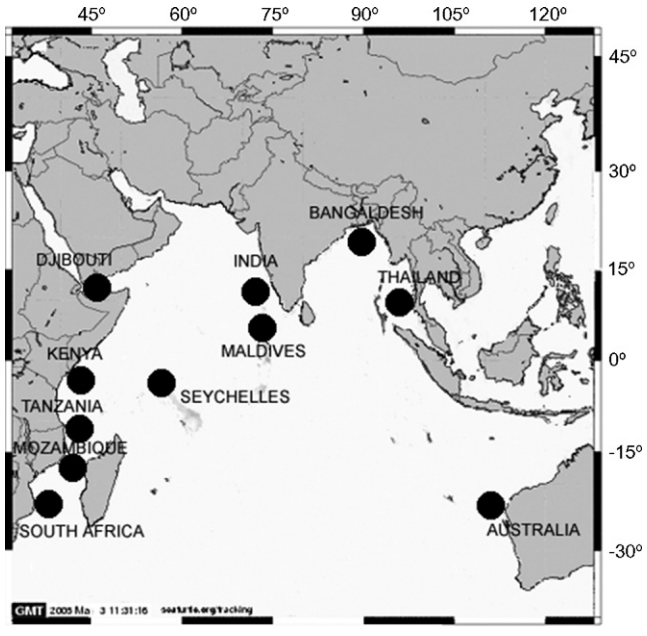

Fig. 1. Geographic location of respondents in the Indian Ocean whale shark survey.

Table 1
Temporal occurrence of whale sharks reported by respondents

Country	Area	J	F	M	A	M	J	J	A	S	O	N	D
Bangladesh	Bay of Bengal	Y	Y	Y	?							?	Y
Djibouti	Arta area	Y							Y		Y	Y	Y
India	Southern	Y	Y	Y	Y	Y							
Kenya	Shimoni	Y	Y	Y				Y	Y	Y	Y	Y	Y
	Mombassa	Y	Y								Y	Y	Y
Maldives	General	Y	Y	Y	?	Y	Y	Y	Y	Y	?	Y	Y
	South Ari	Y	Y	Y	Y	Y	Y	?	?	Y	Y	Y	Y
Mozambique	Southern	Y										Y	Y
	Tofo	Y	Y	Y	Y	Y						Y	Y
Seychelles	Mahe	Y	Y	?		?	Y	Y	Y	Y	Y	Y	Y
S. Africa	KZN (NSB)	Y	Y	Y	Y	Y	Y					Y	Y
	Sodwana	Y	Y	Y	Y							Y	Y
	SRI (KZN)	Y	Y	Y							Y	Y	Y
Tanzania	Zanzibar			Y					Y	Y	Y	Y	
Thailand	Andaman Sea			Y	Y	Y					Y	Y	
Western Australia	Ningaloo			Y	Y	Y	Y						

'Y' denotes well supported annual occurrence and '?' denotes occasionally reported occurrence.

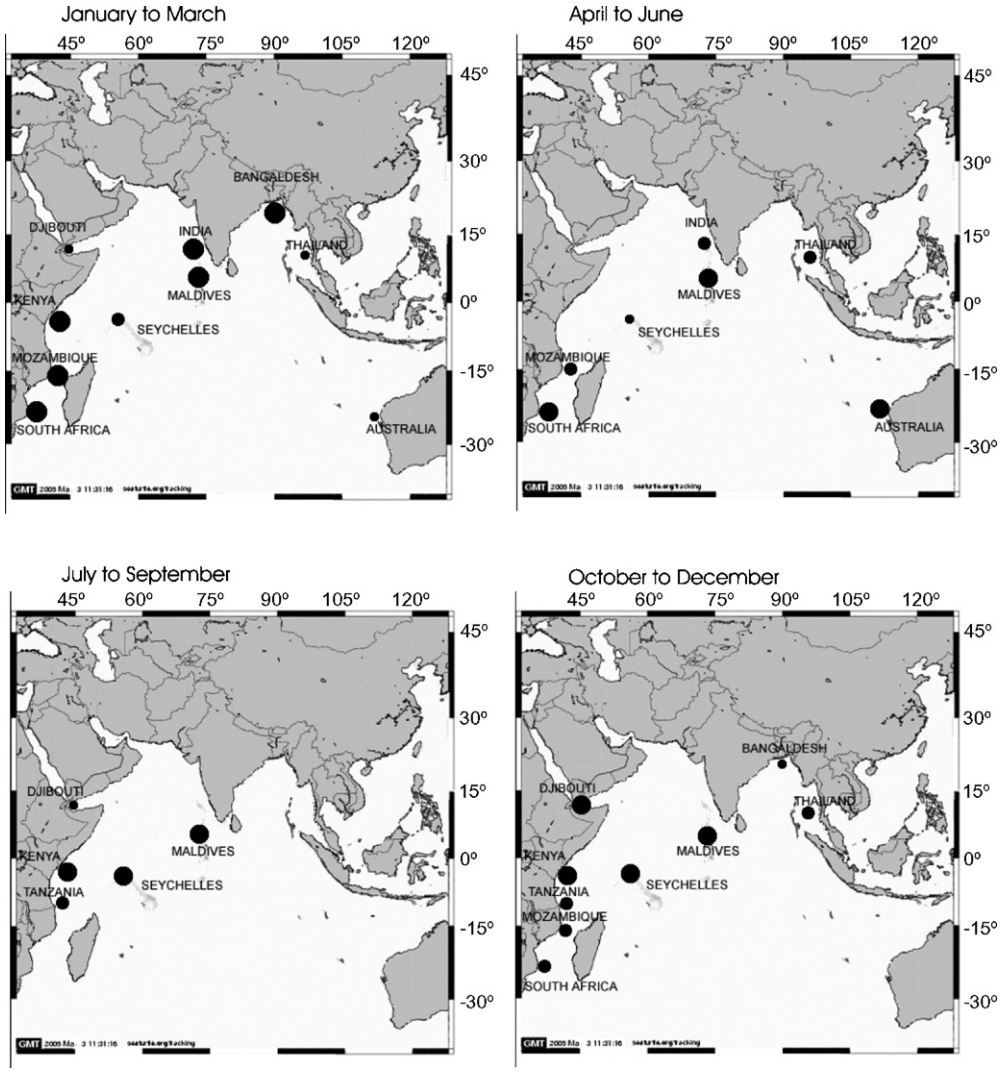

Fig. 2. Whale shark occurrence in the Indian Ocean on a quarterly basis as indicated by network respondents; the size of dot indicates relative frequency of sightings reported during each period.

Table 2
Conservation, monitoring and utilisation status of whale sharks reported by respondents

Country	Area	Protected	Monitoring	Aerial survey	Boat based	Photo I.D.	Tagging	WS trips	Code of conduct	Fishery
Bangladesh	Bay of Bengal	N	Occ	N	Y	Y	N	N	N	Y
Djibouti	Arta area	2004	Y	N	Y	Y	Y	Y	N	N
India	Southern	2001	Occ	N	Y		N	N	N	Y
Kenya	Shimoni	N	N		Y	Y	N	Y	N	N
	Mombassa		Y	N	Y	Y	N	Y	N	N
Maldives	General	1995	Y	N	Y	Y	N	Y	N	N
	South Ari		Y	N	Y	Y	N	Y	Y	N
Mozambique	Southern	N	N	Y	Y	N	N	Y	N	Y
	Tofo	N	N	Y	N	Y	N	Y	Y	Y
Seychelles	Inner Islands	2003	Y	Y	Y	Y	Y	Y	Y	N
S. Africa	KZN (NSB)	Imminent	Y	Y	Y		N	Y	Y	N
	Sodwana		Y	Y	Y	Y	N	Y	Y	N
	SRI (KZN)		Y	Y	Y		Y	Y	Y	N
Tanzania	Zanzibar	N	N	N	N	Y	N	N	N	N
Thailand	Andaman Sea	2000	N	N	N	Y	N	Y	N	?
Western Australia	Ningaloo	1994	Y	Y	Y	Y	Y	Y	Y	N

'Y' denotes activity occurring, 'N' denotes activity not occurring, and '?' denotes unsure whether the activity is occurring.

Responses with regards to the protected status of the sharks in each area are presented in Table 2, along with information on any monitoring activities and any utilisation of whale sharks, either consumptive or non-consumptive. Six areas had protected the sharks nationally, while three areas confirmed the presence of a targeted whale shark fishery.

The responses with respect to the perceived impacts showed that 11 of the 16 respondent felt that boat strikes were a major problem, Table 3. The questionnaire did not list impacts by type and the categories in the table were derived from the answers received. This table also shows what each respondent perceived as being the priorities for action in their particular region: 12 of the 16 indicated that the need for regional protection was 'high', 'urgent' or a 'priority'.

6. Discussion

The pattern of temporal occurrence reported by the majority of respondents shows that the sharks are generally seen on a regular basis during specific periods. The East and South African coastal areas seemed to share a common period of occurrence starting in October/November through until May. Data from Kenya indicated an extended season starting in August which is very similar to the pattern found around Seychelles, which has a similar latitude.

A few areas have reported occasional sightings year round but only one area described what might be a resident population of sharks at South Ari Atoll in the Maldives. A photo identification study is running there which might show if this is indeed the case. Generally the Maldives showed two distinct seasonal groupings, December to March and May to October. The shark locations varied according to the monsoon wind seasons, as had been reported by Anderson and Ahmed (1993).

This sharing of information between the network partners has already resulted in a new formal monitoring programme being implemented in Djibouti and has revealed support for additional programmes in other important whale shark areas if technical assistance and funding can be procured.

Initial analysis of data from the western Indian Ocean pelagic purse-seine tuna fishery indicates that in January the sharks are generally found between 0°S to 10°S and 55°E to 65°E. There follows a slow movement south and east so that in April and May they are mainly between 10°S to 20°S and 40°E to 50°E, the Mozambique channel. This is when the peak of sightings is made by this industry confirming indications from the respondents in this area of their peak sightings. Thereafter the sharks are seen mainly in the more northerly latitudes and by August and September are spanning from 5°N to 5°S and 45°E to 60°E (Fig. 3) (Fontenau and Talma, personal communication).

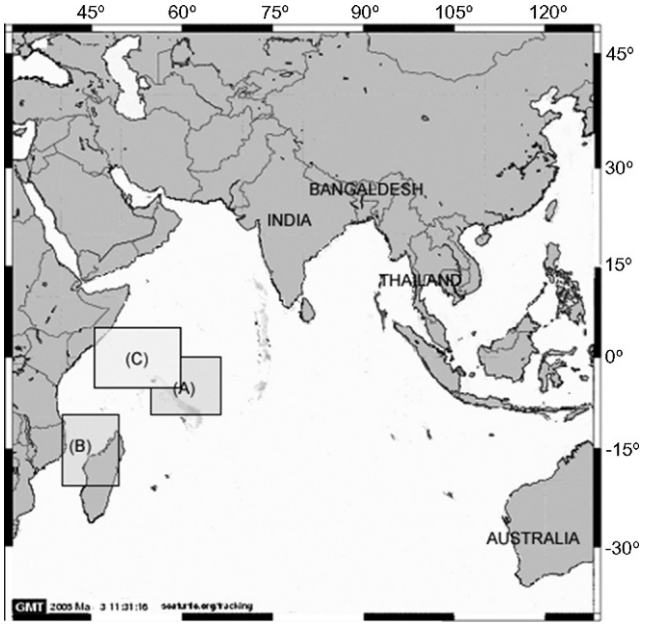

Fig. 3. Pelagic occurrence of whale sharks in the western Indian Ocean as reported by purse-seine tuna fishing fleets: (A) January; (B) April to May; (C) August to September.

Table 3
Perceived impacts and priorities identified by respondents

Country	Area	Impacts			Priorities		
		Boats	Ecotourism	Fishing	Educate fishermen	Tourism guidelines	Regional protection
Bangladesh	Bay of Bengal	?		Y	Y		High
Djibouti	Arta area	Y	Low	N	High	Y	High
India	Southern	Y	Low	Y	High	Y	High
Kenya	Shimoni	Y	Some	N		Y	Urgent
	Mombassa	Y	Low	N	N	Y	Urgent
Maldives	General	Low	Low	N	N		Necessary
	South Ari	Y	Y	N	N	Y	Priority
Mozambique	Southern	Y	Y			Y	Necessary
	Tofo	Y	Y	Y	Y	Y	Urgent
Seychelles	Mahe	Y	Low	N	N	In place	Urgent
S. Africa	KZN (NSB)	Y	Low	Shark nets	N	In place	Urgent
	Sodwana	Y				Self managed	Urgent
	SRI (KZN)	N/R	N/R	N/R	N/R	N/R	N/R
Tanzania	Zanzibar	Low		By-catch	Y		Urgent
Thailand	Andaman Sea	N/R	N/R	N/R	N/R	N/R	N/R
Western Australia	Ningaloo	Y	Low	N	N	In place	Urgent

'Y' denotes impact is occurring or priority is required, 'N' denotes impact is not occurring or this is not a priority in this area, and '?' denotes unsure whether the impact is occurring. Where respondents graded an impact or priority the input shown is their own grading of the severity of impact or urgency of priority.

The movements of sharks into and out of the Ninglaoo area has been tracked by satellite tags but as yet no definitive patterns have been revealed, the sharks moved towards Indonesia and Christmas Island before contact was lost (Norman, unpublished).

The tracking data from Seychelles has shown that sharks seen here migrate East towards continental Africa, then both south into the Mozambique area and to the north off Somalia, and also west towards Sri Lanka. This combined with the opportunistic reports from the purse seine fishery indicate that whale sharks in the Indian Ocean generally, and certainly in the western Indian Ocean, are highly migratory. As such any efforts to estimating their population and in their management or conservation must be addressed on a regional basis.

The responses with respect to the perceived threats and priorities are fairly conclusive across the group. Where fishing was an impact respondents felt there was a need to educate fishermen. Most areas indicated that boat strikes were of concern, and areas that had tourism interactions believed that guidelines were needed if they were not already in place. All respondents indicated that regional or international conservation was either necessary or an urgent priority.

7. Why a regional approach?

It is apparent that there is still a dearth of hard factual information about the occurrence, biology and ecology of whale sharks. Although the Indian Ocean may have more information about whale sharks at specific locations than in some other regions, this information has not prevented the collapse of the Indian Ocean's targeted whale shark fisheries (Hanfee, 2001). The fact that all network respondents in this study felt that some form of regional or international protection was urgently needed is a good indication of the general perception.

As a number of countries around the Indian Ocean have already declared the whale shark protected in their territorial waters, it makes sense to extend this protection to the species as it moves from one area to the next. Several of these states are Parties to the CMS and as the CMS has recently made a recommendation for conservation action for listed migratory shark species (CMS, 2005), it would seem that this would be the logical vehicle for international and regional approaches.

8. Conclusions

Given the relatively little knowledge that we have on whale sharks, a precautionary approach should be adopted towards an effective conservation and management plan. This should allow the on-going development and review of a strategy and action plan for this species which in turn can help direct research into the issues that need resolution. While a global programme would be the ideal answer, this is unlikely to be achieved, at least in any sensible time frame; in contrast the Indian Ocean community has a remarkable opportunity to act on a regional perspective and in so doing provide answers for other regions to benefit from.

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