



---

## WHALE SHARKS IN MOZAMBIQUE: KEY MANAGEMENT AND CONSERVATION STRATEGIES

---

The whale shark (*Rhincodon typus*) is by far, Earth's largest fish. Individuals of up to 20 m in length have been measured. Their very name comes from this huge size, which is comparable to the largest of the true whales. Whale sharks are found throughout tropical and subtropical seas, and individuals roam widely seeking their primary prey which consists of zooplankton and small fishes. Their huge size and placid disposition have made the species a popular focus of marine tourism but, unfortunately, these same characteristics have also made them susceptible to fishing pressure. At present, whale sharks in Mozambique are still regularly caught accidentally in large-mesh gillnets, purse-seine nets offshore, and hit by ships. Whale sharks are a globally threatened species, and without effective conservation measures they will continue to be pushed toward extinction.

Whale Sharks are incredibly important in conservation terms as their role as an ambassador species. *R. typus* are wide-ranging, gigantic fish that depend heavily on a small number of highly productive areas within tropical and sub-tropical oceans. These locations are also critical habitats for hundreds of other threatened species. Because of the public profile of whale sharks, their significant economic value in tourism industries, they are viewed as much higher priorities for conservation action by most governments. By focussing on the whale shark and its most important habitats, we can leverage efforts to conserve entire marine ecosystems.

There are several priorities that MMF has identified for future whale shark conservation strategies; first, where are the female sharks and how does their habitat use differ from males. We will also investigate the reasons behind some

whale sharks transiting quickly through feeding areas, while others become inter-annual residents – thus varying their exposure to local threats.

Second, we will identify a specific priority area for field conservation initiatives. This work will involve visits to areas where we presently lack data and active work on identifying key threats and mitigation strategies. Details of connectivity between countries will be used to activate global protection mechanisms such as the *Convention on Migratory Species* (CMS).

Third, we will actively support the development of sustainable tourism as an economic alternative to shark fishing. With a few simple protocols in place, tourism is a positive force for conservation through engagement. It also provides a funding mechanism for social development projects, linking direct financial benefits to the preservation of a healthy marine ecosystem.

## REGIONAL CONSERVATION THEMES

### 1. BUILDING ECOLOGICAL KNOWLEDGE

*Improve knowledge of general whale shark biology and ecology, as relevant to conservation initiatives, by characterising population structure, movements and the most important drivers of abundance at key sites.*

#### **3.1 Diet assessment of Mozambican whale sharks:**

Our intention was to understand how important the Mozambican coastal zone is to the regional ecology of whale sharks so that we can determine how much time they are likely to spend in the area. This work will use fatty acid analysis of tissue samples to evaluate diet, along with stomach content analysis from a small number of stranded sharks found along the Mozambique and South African coastlines. By identifying their main prey items, we improve our understanding of habitat use and can also attempt to mitigate conflict with local fishers; similar studies in Tanzania revealed that during daylight hours through the summer whale sharks feed almost solely on high-density patches of shrimp. This brings them into some conflict with fishers, who are targeting small fish that feed on the same shrimps. Recognising issues such as this may help to prevent conflict before it begins to undermine

management efforts in the BANP. This also presents opportunities to work and develop plans with fishermen, having the two-fold effect of not only resolving issues but also creating a sense of involvement and ownership within the park community.

### **1.2 Oceanographic influences on Mozambican whale sharks:**

Whale sharks are present in Mozambican waters in varying numbers throughout the year. It appears that shark presence here is strongly influenced by oceanographic dynamics, particularly the movements of the large eddies that spin southwards through the Mozambique Channel between Madagascar and the African mainland. We have identified the primary oceanographic drivers of whale shark presence at this site<sup>1</sup>. There were no clear inter-annual changes that explained the declining trend in sightings. We have been working under the assumption that the steep 79% decline we documented between 2005 and 2011 occurred too fast to be caused by human pressures. However, at this stage, neither changes in local nor regional environmental / oceanographic factors explain the decrease in whale shark sightings, so human factors remain a concern.

## **2. IDENTIFY PRIORITY THREATS, AND AREAS FOR PROTECTION;**

*We have noted a long-term decline in whale shark sightings in Mozambique since 2005. Identify the most threatened whale shark hotspots, areas where conservation efforts will have the largest benefits for species recovery, and sites that may be particularly important to the life cycle of whale sharks, such as breeding locations.*

### **2.1 Movements of whale sharks in Mozambique:**

Fifteen sharks have been tagged with tethered satellite tags from Mozambique. We investigated the population structure of sharks along the coast and documented that the majority of sharks present are juvenile males, indicating that Mozambique is most important as a feeding area. This study was designed to identify the most-used areas by whale sharks in Mozambique<sup>1</sup>. All 15 sharks spent the majority of

---

<sup>1</sup> Rohner CA, Jaine FRA, Pierce SJ, Bennett MB, Weeks SJ & AJ Richardson (In revision). Movement ecology of whale sharks in the southern Mozambican Channel. PLOS ONE.

their time in the coastal waters of Inhambane province, where we have now documented a distinct movement corridor close to shore, over a ~200 km strip of coast. We now have a clear outline of the coastal area that is most important to the sharks, allowing future work to focus on removing the threats

(particularly large-mesh gillnets) along this coast. We are following up on this work by surveying this particular strip of coast for threats, such as communities that routinely use large-mesh gillnets, so that we can target these villages for education and conservation interventions. The government department responsible for managing protected areas in Mozambique is now incorporating these results into their 2015-2020 strategic plan for protecting critical marine habitats along the Mozambican coastline, and the environmental ministry has asked us to prepare our recommendations for enhanced species-level protection.

### 3. PROMOTE SUSTAINABLE TOURISM

*Develop and promote science-based best-practice standards for global whale shark tourism.*

#### **1. Whale shark guiding course:**

This course was composed of video and poster briefing materials, and a half-day course in whale shark ecology and tourism. We have delivered full training workshops to guides in both Mozambique and Tanzania, covering aspects of biology, threats, guiding technique, codes of conduct and other species guides. Further workshops have been requested for 2015. Dissipating knowledge and including staff in this way promotes a sense of inclusion and provides a concept of exactly what they are protecting.

#### **2. Behavioural impacts of tourism on whale sharks:**

This work is focused on monitoring the short- to medium-term behavioural responses of whale sharks to tourists. A key result of this work will be the development of an easy-to-follow monitoring protocol for whale shark tourism. We

found that whale shark tourism had no short- to medium-term impact on whale shark behaviour in Mozambique<sup>1</sup>. This is a very positive result, as it indicates that whale shark tourism can provide a sustainable income- generating activity in the countries where they aggregate, providing the industry is managed appropriately. To aid with that aspect, we also published a template for evaluating whale shark behaviour with regard to swimmers and boats. This template will be a useful starting point for similar work taking place in other areas, and is already in use in multiple countries.

---

<sup>1</sup> Haskell PJ, McGowan A, Westling A, Méndez-Jiménez, Rohner CA, Collins K, Rosero-Caicedo M, Salmond J, Monadjem A, Marshall AD & SJ Pierce (2014) Monitoring the effects of tourism on whale shark *Rhincodon typus* behaviour in Mozambique. *Oryx*

### **3. Mitigating Impacts of Whale Shark Tourism**

MMF investigated the medium-term behavioural response of sharks to swimmers and boats, to test whether tourism has a negative impact on whale sharks. We found no evidence of increasing avoidance behaviour over time, indicating that tourism can indeed be sustainable. A key additional output of this work was a global monitoring template for assessing the impacts of tourism on whale sharks, which is already in use in multiple countries. Continuing our focus on ensuring the sustainability of whale shark tourism, we also delivered training sessions to all provincial dive and marine tourism staff within the country. This included Codes of Conduct which were developed applicable to vessels and personnel involved in whale shark tourism and these have been propagated regionally.

## **FUTURE OBJECTIVES AND PLANS**

### **1. BUILDING ECOLOGICAL KNOWLEDGE**

#### **1.1 Biochemical analysis**

This is a method that can be used to assess diet. By comparing biochemical signatures of whale shark to the signature of different food items, it can be established where and what they are likely to be feeding on and also to identify important feeding habitat. Analysis of the stable isotopes of carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) are useful in movement and feeding studies. The concentration of these isotopes differs fairly predictably between environments, across latitudes, undergoes a predictable change as they are passed up the food chain. So the stable isotope composition of an animal is a reflection of its food and the place where they ate it. At this stage our knowledge of whale sharks is largely restricted to juvenile males, so this work will also dramatically expand our ability to locate and protect areas that are important for other life stages.

### **1.2. Genomic analysis**

Analysing DNA can help determine how closely related whale sharks from one region are with those from another. Global studies have already shown that sharks likely mix throughout all oceans, but how and where mating and breeding is occurring is vital knowledge for management purposes. This is important to be able to determine which sharks from which regions are actually mixing and mating then they might be able to narrow down their search for where this might be occurring. To correctly assign areas where they are protected we need information on the breeding portion of the population.

## **2. IDENTIFY PRIORITY THREATS AND AREAS FOR PROTECTION.**

### **2.1 Identifying and mitigating threats from fishers in the Inhambane Province.**

There is no formal protection in place for either whale sharks or its key habitat. The increasing use of large gillnets inshore is a documented threat to both whale sharks and the other threatened marine species that share these coastal waters. Aerial transects will map all human activities within one kilometre of the shore down the majority of the Inhambane coastline. Twelve hours of flight time over three days will provide independent verification of gear use and fishing strategies employed, and identify any human threats that surveys fail to highlight. Interview-based surveys will

be conducted in each of the 12 fishing communities (represented by collectives, known as CCPs) within Inhambane Province. The surveys will focus on (a) what fishing gear and techniques are employed by that community; (b) if whale sharks and other threatened fauna are being targeted, or accidentally caught as by-catch; (c) if there is an established market for these species; (d) the number caught and any trends in catches; and (e) fisher perceptions towards these species. Each of the 12 surveyed communities will be scored according to the size of the area in question, gear types in use, and relative impact on threatened marine fauna. The upper half will then be prioritised for follow-up engagement activities.

Potential mitigation strategies will be discussed with fishers, including placement of gear away from high-use animal movement corridors, incorporation of ‘weak links’ in nets to enable easy release of large entangled animals, or the use of alternative fishing techniques. Our primary outcome will be a quantitative reduction in whale sharks caught within artisanal fisheries. The baseline data on catch numbers will also allow us to calculate whether this source of mortality has been the primary force behind decreasing sightings. Similarly, the catches of other species that have likely been affected, such as reef manta rays, which had an observed decline of 88% between 2003 and 2011, will be quantified and reduced.

### 3. PROMOTE SUSTAINABLE TOURISM

#### **3.1. *Valuation of whale shark tourism in Mozambique:***

This project will use diver interviews to deliver key information on tourist numbers, demographics and spending to demonstrate the economic footprint of whale shark tourism in Mozambique. This will allow us to emphasise the economic benefits of whale shark preservation to the provincial and national government. Evidence of direct revenue from tourism can – as long as it is ensured that this revenue is distributed correctly within the park – deter illegal fishing activities, motivate regulation compliance and incentivise further capacity building.

#### **3.1. *Staff and Ranger training in BANP***

**Marine Megafauna Association** Tofo Beach, Inhambane, Mozambique

*MMF is a tax-exempt non-profit charitable organization under section 501(c)(3) of the US tax code (Tax ID #46-0645082).*

MMF will continue to supply training events to promote significant research and themes. Via several workshops, MMF was able to provide information for locals and park rangers which motivated them to support these animals and the area through their jobs – they were personally negatively affected by the issues affecting the marine life and were motivated to help however they could. They were also trained in snorkelling and diving to help them in aspects of their work. This training will hope to continue at least annually if not bi-annually, incorporating local staff and stakeholders to promote sustainable tourism.