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RATIONALE FOR PROTECTING MANTA RAYS (*Manta birostris* & *Manta alfredi*) IN MOZAMBIQUE

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SUMMARY

Manta rays are iconic species important for global marine heritage. They are also recognized as globally threatened species by the IUCN- listed as vulnerable to extinction. The coast of southern Mozambique has been identified as the most important aggregation site for both recognized species of manta rays in Africa. These gentle giants represent economically important drawcards for coastal tourism with a current estimated value of the US\$12.7 million per year in direct revenue to dive operators in the Inhambane Province and an overall direct economic impact (including associated tourism expenditures) of US\$39.5 million annually. Over the last decade, the resident reef manta ray population has dropped by over 88%- a result of unsustainable fishing pressure and other anthropogenic threats. In order to safeguard local populations of *Manta* species and secure this resource for future generations manta rays need to receive immediate legislative protection in accordance with recommendations from the IUCN and their respective CMS appendices listings, vigilant enforcement of fishing bans and CITES export restrictions need to be imposed, critical habitats adequately protected, anthropogenic threats reduced and remaining populations monitored and studied appropriately.

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GENERAL DESCRIPTION & DISTRIBUTION

Manta rays, genus *Manta* (Bancroft) are the largest rays in the world. The genus currently comprises two species *Manta birostris*, the giant manta, and *Manta alfredi*, the reef manta which were only differentiated recently in 2009 (Marshall *et al.* 2009). These massive rays reach a maximum-recorded disc width of 8 meters (Couturier *et al.* 2012). Similar to other massive planktivorous elasmobranchs, like whale sharks and basking sharks, manta rays feed primarily on zooplankton suspended in the water column. Manta rays evolved from the stingray family (Dasyatidae) but they no longer possess a functional stinger on their tails. While they have small teeth (less 2mm in size) embedded in their lower jaw, they do not use these teeth to feed or for defence and thus present no threat to humans.

Manta rays are circum-globally distributed and are broadly distributed throughout all three major oceans (Kashiwagi *et al.* 2011) although they are most commonly found in the tropics or along productive coastlines in temperate areas. Populations can be wide ranging often migrating from location to location to exploit plankton blooms or spawning events (Graham *et al.* 2012). Often large numbers of individuals can be found targeting these ephemeral bursts in local productivity (Sleeman *et al.* 2007; Jaine *et al.* 2012). There are often distinct seasonal patterns to their movements (Duffy and Abbott 2003; Dewar *et al.* 2008; Luiz Jr *et al.* 2008; Kitchen-Wheeler 2010; Anderson *et al.* 2011) and they have been noted in a variety of locations to be philopatric to specific localities over time (Homma *et al.* 1999; Dewar *et al.* 2008; Marshall *et al.* 2011a; Couturier *et al.* 2012). At these aggregation sites hundreds of individuals can sometimes be seen feeding together in relatively small areas. Manta rays also often frequent predictable areas, such as shallow water reefs, to be cleaned by reef fish (Dewar *et al.* 2008; O'shea *et al.* 2010) or to mate or give birth (Marshall and Bennett



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2010; Deakos 2011). Dozens of major aggregation sites for both species of manta rays have been identified worldwide, although the numbers of mantas frequenting these different regions can vary dramatically (by multiple orders of magnitude).

INTERNATIONAL CONSERVATION STATUS

Populations of *Manta alfredi* appear to be small and fragmented, and the degree of interchange between populations is unclear. *Manta birostris* is a relatively elusive species and is thought to be highly migratory (although the degree of interchange between populations remains unclear). On a whole, populations of *Manta birostris* appear to be smaller than those of *Manta alfredi*, however certain regions like Ecuador/Peru, India and Indonesia support, or have supported, very large populations of *Manta birostris* (Couturier *et al.* 2012). Both *Manta alfredi* and *Manta birostris* have very conservative life histories and are considered to be some of the last fecund of all elasmobranch species, with extremely low reproductive outputs (Marshall and Bennett 2010) making them vulnerable to fishing pressures (Dulvy *et al.* 2014).

Both species have a high value in international trade and direct fisheries exists that target these species in unsustainable numbers (Heinrichs *et al.* 2011; Couturier *et al.* 2012; Croll *et al.* 2015). Locations where they were previously fished have seen classic 'boom and bust' patterns of exploitation. Globally, the extent of population reduction for both *M. birostris* and *M. alfredi* appears high in several regions, to less than 15% of baseline numbers (Marshall *et al.* 2011b,c). Local declines, as high as 50% to 86% over one generation or less, in areas with targeted fisheries are being reported (Couturier *et al.* 2012; Rohner *et al.* 2013; Croll *et al.* 2015). Sustained pressure from fishing (both directed and incidental) has been isolated as the main cause of some of these declines (Rohner *et al.* 2013). In contrast, some subpopulations that are not



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fished or are within protected areas such as those in the Maldives, Yap, Palau, and Hawaii appear stable (Marshall *et al.* 2011b,c).

Due to the highly migratory habits of manta rays, targeted fisheries may be having broader repercussions throughout the regional distributions of both *Manta* species. Where they are targeted manta ray meat is often sold as food, the liver for bait and oil and branchial filter plates fetch high prices for use in specific Chinese tonics (Alava *et al.* 2002; White *et al.* 2006; Heinrichs *et al.* 2011). Limited use of epidermis for leather products (shoes, wallets, knife handles) occurs as well. Individuals are also taken as by-catch in everything from large-scale fisheries to shark protection nets (Cliff and Dudley 2011; Heinrichs *et al.* 2011). They are also victims of boat strikes, ‘ghostnet’ entanglements, and fishing tackle injuries. As a direct result to these broad anthropogenic threats, populations appear to have been depleted in several historically important aggregation areas such as in the Gulf of California (Mexico), Indonesia and the Philippines. Other populations at major aggregation sites that are currently being exploited are believed to be decreasing steadily (Couturier *et al.* 2012; Croll *et al.* 2015).

Limited data from long-term studies suggesting dramatic declines in the abundance of both species at well known aggregation sites resulted in both species being listed as “Vulnerable to Extinction” on the IUCN Red List of Threatened Species in 2011 (Marshall *et al.* 2011b,c). The elevation in their conservation status may have been precautionary but was deemed necessary due to their reportedly small population sizes, fragmentation of populations, their conservative life histories and low levels of natural mortality, and the escalation of direct and indirect fisheries for them worldwide.

As an oceanic species, giant manta rays are particularly vulnerable to capture in large-scale fisheries that are operating along continental shelves, in major waterways, or in



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international waters. Due to their highly migratory nature, concerns exist for national management strategies of *M. birostris*, which only provide protection when individuals visit their waters. These rays are easy to target because of their large size, slow swimming speed, aggregative behaviour, predictable habitat use, and lack of human avoidance. Targeting giant mantas at critical habitats or aggregation sites, where individuals can be caught in large numbers in a short time frame, is also of particular concern. Even the small species of *Manta*, *Manta alfredi*, is known to undertake large migrations along coastlines and into offshore habitats to feed. Recent migrations of *Manta alfredi* from the Inhambane Province to the border of South Africa have been recorded (Van Duinkerken & Marshall, unpublished data), suggesting that Mozambique and South Africa may share a population of this *Manta* species as well as *Manta birostris*.

In 2011 Ecuador proposed that *Manta birostris* be eligible for listing on Appendix I & II of CMS (the Convention for Migratory Species Act). On November 25th, 2011 this species received overwhelming support for this listing, marking the first international agreement to protect the giant manta ray. Consequentially, *Manta birostris* is the first ray ever to be listed on CMS and is also one of the only shark or ray species to have been approved for both Appendix I and Appendix II level protection. Appendix I, reserved for species that are threatened with extinction, obligates CMS Parties (currently numbering 116) to strictly protect the animals, conserve and restore their habitats, mitigate obstacles to their migration, and control other factors that might endanger them. CMS Appendix II includes migratory species that would significantly benefit from international co-operation for which CMS encourages global and/or regional agreements and concerted action. This recent listing obligates CMS member countries to provide strict national protections for giant manta rays and their key habitats. The listing also promotes regional conservation action amongst all Range



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States, many of which have directed fisheries currently operating within their borders. While the listing of *Manta birostris* was proposed by Ecuador. The European Union, Senegal, Madagascar, Australia, United States, Chile, Uruguay and most importantly Mozambique took the floor to convey their support for the proposal. Recently at CMS CoP11 in Quito Ecuador *Manta alfredi* also received support for an Appendix I & II listing on CMS. This proposal was put forward by the country of Fiji and was unanimously supported by Parties, including Mozambique.

ECO-TOURISM & CONSERVATION

Many countries have now realised the economic benefit of using iconic marine megafauna species from cetaceans to sharks to bolster marine tourism. As the world's largest ray species, manta rays are significant drawcards for tourism and as long-lived species they have the ability to generate far more substantial and sustainable incomes for regions via eco-friendly tourism over their lifespans than the small, 'one-time' financial gain from fishery harvests. The advent of viable tourism for manta rays therefore allows these countries to manage and preserve this resource while providing a financially lucrative and preferable alternative to targeted fisheries. A focal economic survey in 2013 evaluated manta ray tourism to be worth upwards of \$140 million dollars annually to local economies around the world (O'Malley *et al.* 2013).

Despite this fact, there are few, if any, comprehensive management programs for manta rays. Officially manta rays are only protected in a handful of locations worldwide, but slowly more and more countries are choosing to protect these species. In Yap, a marine protected area for manta rays has been created which covers 8,234 square miles and covers 16 islands and 145 islets and atolls. Over the years, manta rays have started to receive more attention and protection within Mexican waters,



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primarily in the Revillagigedo biosphere and along the Yucatan Peninsula. In the Philippines, the fishing of manta rays has been banned since 1998. In 2009, the governor of Hawaii signed House Bill 366 creating Act 092(09) establishing criminal penalties and administrative fines for knowingly killing or capturing manta rays within State waters- a move which made Hawaii the first state in the US union to protect manta rays from targeted fishing pressure. Also in 2009, the Environmental Minister of the Maldives announced the protection of coral reefs and waters in and around Baa atoll, Hanifaru, An'gafaru and South Ari atoll Maamigili, which are aggregation sites and critical habitats for manta rays including a major population of *Manta alfredi*. In 2010, after learning that one of the largest populations of manta rays in the world had been identified off their coastline, Ecuador chose to protect all Mobulid rays nationally with strict regulations on fishing and capture. Perhaps most notably, manta rays were protected throughout the entire economic exclusive zone of Indonesia in early 2014, a nation that historically boasted the largest fisheries for manta rays in the world.

MOZAMBIQUE

Mozambique, particularly the Inhambane coast from Zavora in the south to the Bazaruto Archipelago in the north, has emerged as one of the most important areas in the world for whale sharks and manta rays. This small stretch of coastline has also been identified as an extremely critical habitat for *Manta alfredi* as both a mating ground and birthing ground (Marshall and Bennett 2010). The Inhambane Province boasts one of the largest documented aggregation areas for *Manta alfredi* in the world, with almost 1000 individuals having been identified in this region, and the second largest identified population of *Manta birostris*. In 2011, it was estimated that over 1400 individual manta rays use this coastline, with many of these individuals showing permanent residence to the area or at least using this coastline as a major part of their



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home range (Marshall *et al.* 2011a). As a result the coastline of this province likely represents the most important habitat for manta rays along the eastern coast of Africa.



Figure 1. Manta rays killed in directed and indirect fisheries in the Inhambane Province.

In Mozambique, it is estimated that 20 to 50 reef manta rays (*M. alfredi*) are taken per annum by artisanal fishermen along a ~100 km area/length of coast from the Inhambane Estuary to Zavora (roughly <5% of the total coastline and <1/3 of their primary habitat in the south of the country) (Marshall *et al.* 2011a). As observational sighting records of this species declined Rohner *et al.* (2013) aimed to distinguish true population trends from short-term environmental fluctuations over an eight-year period

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in Mozambique. The study's data indicate a pronounced decrease in abundance of *M. alfredi*, with an 88% decline in their sightings over time. The model used in this study included various temporal and environmental variables and the observed decline is therefore not likely to be driven by local parameters but rather is indicative of a true population trend. Although other local biophysical predictors may also influence sightings, external anthropogenic pressures are likely to be the primary factor in the decline with the fishery for *M. alfredi* being implicated as the main cause. In contrast, the abundance of the relatively un-targeted giant manta ray (*M. birostris*) remained stable over the same examined eight-year period.

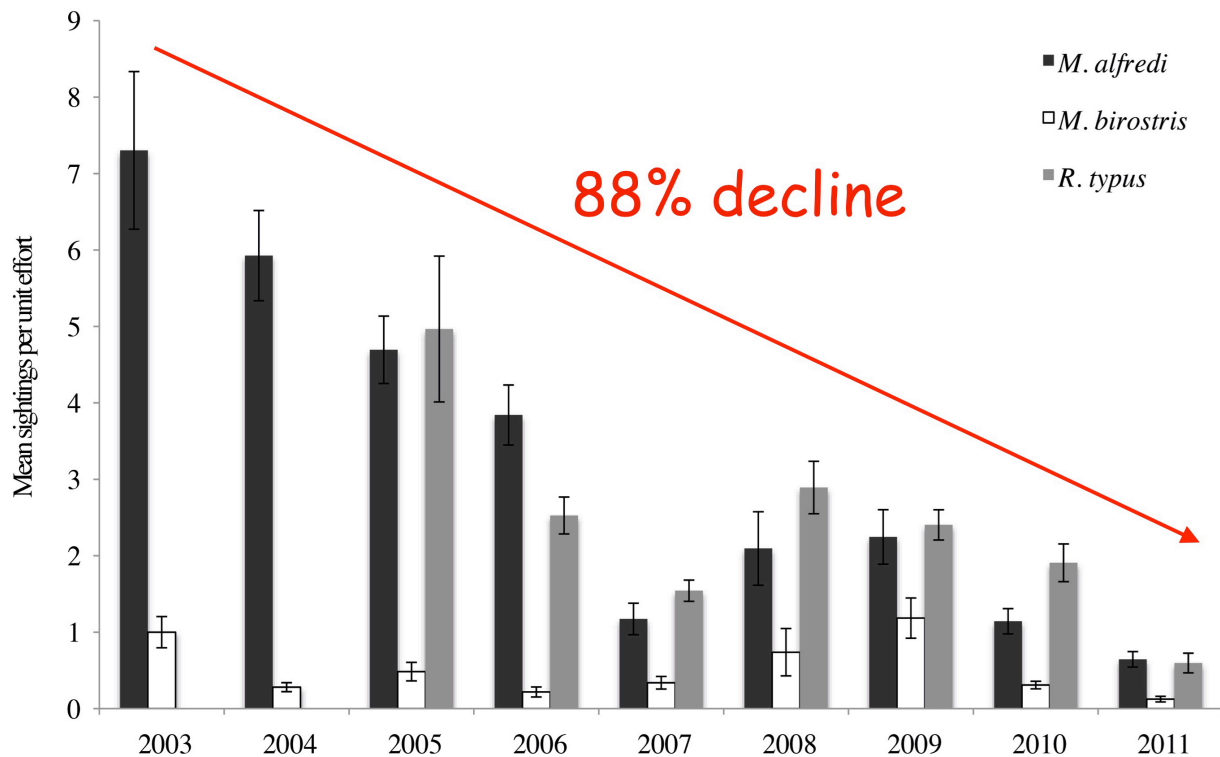


Figure 2. Decline in observational sightings records of *Manta alfredi* in Mozambique from 2003-2011 taken from Rohner et al. 2013



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To prevent an increase in unsustainable fisheries for this species in Mozambique, particularly shifts from subsistence to trade fisheries, it is imperative that manta rays be protected on a national level and remaining populations be managed carefully to ensure their future viability. The recent listing of all species within the genus *Manta* on Appendix I & II of CMS and Appendix II of CITES provides the framework for increased protection for remaining *Manta* populations in Mozambique. The CITES Appendix II listing for *Manta sp.* calls for exports to be derived from sustainably managed fisheries that are not detrimental to the status of the wild populations that they exploit. It is apparent that even at low levels of extraction, local sub-populations in Mozambique have declined rapidly (Rohner *et al.* 2013). The unsustainable nature of these small artisanal fisheries indicates that trade fisheries cannot be supported under the guidelines of CITES. Enforceable controls will now need to be put into place in Mozambique to regulate fishing and prevent international trade in these species. While some manta rays will most likely still be landed as by-catch or opportunistically for local consumption, unnatural mortality should be greatly reduced by the restriction of international trade. It is recommended, however, that national legislation be put in place that creates full coverage protection for these species in Mozambique, allowing depleted populations to rejuvenate.

MOZAMBICAN TOURISM & BENEFITS OF NATIONAL PROTECTION

With Mozambique hoping to host four million tourists annually by 2020 (Ministério do Turismo, 2004), attractions of international standard are needed to fuel interest levels in this region of Africa. As a result of hunting and war, large land animals are scarce in Mozambique. This costs the country millions in lost tourism revenue each year, as it is bypassed by tourists on the 'safari circuit'. However, the marine life in the country is outstanding. Mozambique's reputation for abundant marine megafauna has begun to



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shape its image as an ‘Ocean Safari’ destination that could rival terrestrial ‘Big Game’ destinations. These massive fish (and mammals if you include cetaceans like dolphins, whales and dugongs) are now the focus of a burgeoning tourism industry in the south of the country. The influx of international tourists over recent years has triggered substantial coastal development, including tourist lodges, dive operators and restaurants. As Mozambique’s marine tourism industry expands in the next decade it will also bring indirect benefits, such as job creation within the service sector, as well as secondary expenditure on Mozambican products.

As a large iconic species, both the giant manta and the reef manta are high interest animals for marine tourism. Their placid disposition and their curious nature make them perfect candidates for safe and enjoyable marine megafauna interactions. The predictable aggregation behaviour of manta rays and their tendency to utilize shallow, inshore areas has led to the development of successful dive and snorkel tourism industries across the world. Southern Mozambique, particularly the region from Vilanculos to Zavora, is one of the only known locations in the world with year-round aggregations of BOTH species of manta rays (Kashawagi *et al.* 2011). Aside from having one of the largest documented populations of either species in the world, these waters provide one of the only known locations in Africa where encounters with these rays are reasonably predictable. For species that are notoriously elusive and that can be difficult to access, southern Mozambique is quickly gaining an international reputation as one of the ‘manta ray capitals of the world’. High trip success rates and high mean numbers of animals observed per dive or trip suggests that Mozambique has a ‘product’ that rivals many manta ray tourism destinations, particularly in the Indian Ocean.



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All of these factors have resulted in a burgeoning dive tourism industry in the region. International tourists now flock to this coastline specifically to have encounters with these giant rays, with Mozambique ranking as the 4th highest grossing country for manta ray tourism in the world (O'Malley *et al.* 2013). Specifically, a new study by the Marine Megafauna Foundation has estimated the localised economic benefits of manta ray tourism in the Inhambane Province of Mozambique to be worth upwards of US\$12.7 million per year in direct revenue to dive operators in the province and an estimated direct economic impact (including associated tourism expenditures) of US\$39.5 million annually.

Despite this flourishing tourism industry, which promises to be extremely lucrative while also promoting job creation and infrastructure development, manta rays remain an unprotected species in Mozambique. Additionally, no comprehensive programs exist to manage existing populations of these rays or their primary habitats. As such, there currently are no legal safeguards to protect this developing industry or the employment it provides. In addition to evaluating the net worth of the manta ray tourism industry in the Inhambane Province, our recent economic study allowed us to calculate a 'substitution value' to estimate the expenditure that would be lost if manta rays were no longer present or if numbers were low enough to prevent viable tourism options. It was estimated that in the Inhambane Province alone between \$18,760,425 and \$29,844,067 USD in tourism revenue would be lost per annum, a figure that would be devastating to the local tourism economy.

Realising the non-consumptive and perpetual economic value of manta rays is of critical importance. However, the steady growth of tourism will make introducing active management for Mozambique's marine tourism industry a high priority. This management is vital to ensuring high quality experiences for tourists while minimising



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detrimental impacts to Mozambique's coastal environment and resources. Specifically for manta rays, it will mean the slow and sustainable expansion of the diving industry. The development of codes of conduct for interactions with animals in the wild (to prevent the alteration of natural behaviour or worse still, emigration from the region) are also essential since preliminary research indicates that tourism can heavily impact the behaviour of manta ray species at both cleaning stations and feeding areas (Marshall *et al.* unpublished data).



Figure 3. Species-specific codes of conduct- disruptive versus sustainable diving practices



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Since manta rays do not represent a current or a viable fishery in Mozambique nor do any known coastal populations solely rely upon them for resources or income, there are no real reasons to delay in protecting these populations for marine heritage and local tourism. First and foremost, legislative protection in Mozambique is needed to prevent the targeting of these species by both artisanal and commercial fishermen. Monitoring and enforcement of fishing bans/trade restrictions need to be both efficient and unrelenting. This step would help to satisfy Mozambique's responsibility as a signatory on international conventions like CMS and CITES. The next step toward safeguarding and rehabilitating remaining populations of manta rays in the country is to provide more comprehensive protection for key critical habitats in the south of the country. Once protected areas have been established, e.g. the Bazaruto Archipelago National Park, species-specific management strategies, based on adequate research, should be developed to stringently protect animals from anthropogenic pressures allow local populations to be continuously monitored and evaluated. In areas without formal protection, major anthropogenic threats for these species need to be identified and addressed as well as potential areas of high human conflict. For instance, the use of gillnets, which have been identified as the largest non-targeted threat to manta rays in the country, need to be controlled or banned in the province or in key areas where they manta rays are being incidentally captured in unsustainable numbers (e.g. in movement corridors). While these steps are varied, complex, and may require both significant periods of time and/or financial support to develop, they will help to ensure that this iconic species can be adequately safeguarded as part of the coastal heritage of Mozambique and used sustainably for the economic benefit of coastal communities.



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