

The Impacts and Implications of Whale Shark Ecotourism:
A Case Study of Three Ecotourism Sites

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Abstract

The biggest fish in the sea the whale shark, *Rhincodon typus*, still remains one of the biggest mysteries. This species named the whale shark, after it's size, is one of the most charismatic shark species in the world. This colossal, yet harmless shark surfaces in certain areas across the globe. The sites where these sharks surface and aggregate are transforming into ecotourism hotspots. Globally, these ecotourism sites are valued at US\$ 66 million (Higman, Luck, & CABI, 2008). However, a growing problem with these sites is the absence of positive management strategies that protect the sharks, and allow humans to benefit from interacting with them. This study, through the use of a literature review and a policy analysis provides suggestions for future management strategies. This study analyses the positive tourism management strategies at three ecotourism sites. Overall, this industry is growing at a rapid rate, and the need for protection of this elusive species is essential. This study has the potential to benefit and provide suggestions for upcoming *R. typus* ecotourism sites that aim to have a well-managed site.

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Preface

My love for the whale shark species began while I was studying abroad in Australia. A portion of my time was spent conducting research abroad. I was lucky enough to join the Oceanwise Expeditions team in Ningaloo Reef, Western Australia. I traveled by myself from Far North Queensland to Exmouth, Western Australia—an almost two-day long journey.

For five weeks, I worked on an ecotourism vessel, showing tourists this incredible species. In addition to swimming with whale sharks, and educating tourists; I conducted research on the scarring of whale sharks. I used photography, videography, and observations to collected data on this species. I was interested in learning about the impacts this industry was physically having on this species.

When I returned to the United States, I wanted to do my part to help continue to conserve this species. I thought if I continued research on this species, in some small way I might be able to help whale sharks—even from landlocked Colorado.

Today, I have found that my passion lies in the education of others. I am currently working for Ocean Classrooms, a company based here in Boulder, that promotes marine science education. I want to continue to do my part to help preserve the wonderful planet we live on. In doing so, I want to spread my knowledge, and educate others about why our oceans, and the species living in them are so amazing.

This paper has been an integral part of my senior year, and is the product of my passion and dedication for the conservation of the environment

Introduction

The whale shark, *Rhincodon typus* is the largest fish in the sea, but remains one of the most elusive species to date. Today, biological and ecological knowledge about this species remains limited. Due to *R. typus*' deep-diving behavior, and global migration patterns it remains difficult to obtain knowledge about this species. While information is limited, this species is known to surface and aggregate, in certain geographic locations across the globe. Some of these aggregation sites have transformed into ecotourism hot spots, where tourists can pay money to swim with these fish. The development of these industries has lead to the formation of policy to manage the interaction between humans, and *R. typus*.

Within this study, I have conducted a literature review of three ecotourism sites: Ningaloo Reef, Holbox Island, and Tofo Beach, which serve as my case studies. The following criteria are examined at each case study: Management of The Industry, Code of Conduct, Education, Conservation Implications, and Socio-Economic Implications. The three study sites were chosen because each site possesses unique characteristics that make it valuable to study. In addition to conducting a literature review, and analyzing these sites, I have conducted a policy analysis of the management strategies at each site. These three ecotourism sites were evaluated based on a criterion to measure the positive and negative implications of these industries. This research allowed me to find the most beneficial practices of *R. typus* ecotourism management at each site. The end product of this study is management suggestions, which could be implemented at future *R. typus* ecotourism sites. The purpose of this study was to support communities that lack the

resources or knowledge about positive whale shark management practices, in order to help preserve this vulnerable species. The preservation of this species is vital to not only preserve this intrinsically incredible species, but to safeguard the ecotourism industries that form due to shark aggregations.

Background

In order to examine these ecotourism sites, it is necessary to understand background information about the study species. This species has particular unique biological characteristics. In addition, there is still a great deal of information that is unknown about this species. This background section sheds light on the some the known, and unknown biological, and ecological knowledge of this species. This section also provides information on anthropogenic threats that *R. typus* face. Furthermore, this section includes information about the formation of the ecotourism industries the result from shark aggregations. In addition, this section discusses the benefits, and disadvantages of wildlife tourism. The last portion of this background section entails why *R. typus* is a valuable species to save, and why there is a need to promote conservation of this species.



Figure 1 - Whale Shark Swimming with Human

Current Biological Knowledge of *Rhincodon typus*

The whale shark or *Rhincodon typus* is the largest fish in the sea. It is the sole member of its' monotypic family, Rhincodontidae (Rowat & Brooks, 2012). Despite its' name, *R. typus* is indeed a shark, not a whale (Rowat & Brooks, 2012). It is often noted for its' flattened head, terminal mouth, and coloration of a unique pattern of stripes and spots (Colman, 1997). The spot and stripe pattern located behind the fifth gill slit was determined to remain unchanged throughout the lifetime of the shark; therefore it can be photographed, and used as a method of identification (Rowat & Brooks, 2012). Similar to sampling the fingerprint on a human, this spot and strip pattern provides an easily observed method of identification. Previously, the photos of *R. typus* were manually examined, in order to differentiate sharks. Today, the computer pattern recognition program Interactive Individual Identification System, I³S, is used to analyze photos (Pierce, 2006). This method of identification provides a non-invasive, and more accurate measure (Pierce, 2006).

Andrew Smith who observed an individual shark off the coast of South Africa was the first to describe the species in 1828 (Hermann, Hermann, & Affin, 1998; Smith, 1828). Smith observed a 4.6 m shark; although, these sharks have to ability to reach up to 20 m in length, and 34 t in mass (Rowat & Brooks, 2012). In addition to being the largest fish in the sea, these sharks also have the thickest skin on any animal. *R. typus* skin can measure up to 14 cm thick on its' back (Martin, 2007). This thick skin acts as armor for this species; when threatened *R. typus* will display its' back to a predator to mitigate the amount of potential damage inflicted (Martin, 2007).

While these sharks are massive, they are almost entirely harmless to humans. The docile nature of these sharks, in accordance with their biological attributes allows this species to be considered a gentle giant. The whale shark, like the megamouth shark, *Megacasma pelagios*, and the basking shark, *Cetorhinus maximus*, is a filter feeder. *R. typus* mouths are filled with approximately 3,000 very small teeth, which are used to sieve prey items from the water (Norman, 2005). While these other two shark species are filter feeders, the biological variation of *R. typus* suggests this species feeds in short suction intakes, as opposed to a more passive feeding method (Stevens, 2007). This feeding variation makes *R. typus* more dependent on dense aggregations of food sources, which include plankton, nektonic prey, and on occasion larger prey such as small fish (Colman, 1997). In some geographic areas where these food source pulses occur, *R. typus* is known to aggregate and come to the surface to feed.

Unknown Biological and Ecological Information

While *R. typus* may appear to be a conspicuous species, this species remains poorly understood biologically (Martin, 2007). There are many contributing factors as to why this species is still poorly understood these factors are detailed below. From *R. typus*' elusive behavior, to its' sheer size; this species proves hard to study.

Growth Rates and Life History Traits

This fish is the largest in the sea and its' size makes it more difficult to study. Due to this shark's large size, it is difficult to obtain growth measurements. Determining life history traits also proves extremely difficult. Stereo-video footage using two angled cameras, and computer software can be used to generate three-dimensional images of sharks; which provide accurate measurements (Rowat & Brooks, 2012). Collecting

stereo-video footage of *R. typus* can be difficult, and the sample size of sharks may only be a small population subset.

In the case of most aggregation sites, the sex ratio, and age of the population of *R. typus* is generally unbalanced. Most aggregation sites exhibit populations of sharks ranging from 2-10 m in length, and approximately 82% males (Rowat & Brooks, 2012). Therefore, these sites only provide information about young, sexually immature, male sharks.

Sensory System

In addition to poorly understanding growth rates, the biological understanding of *R. typus*' senses is potentially the least

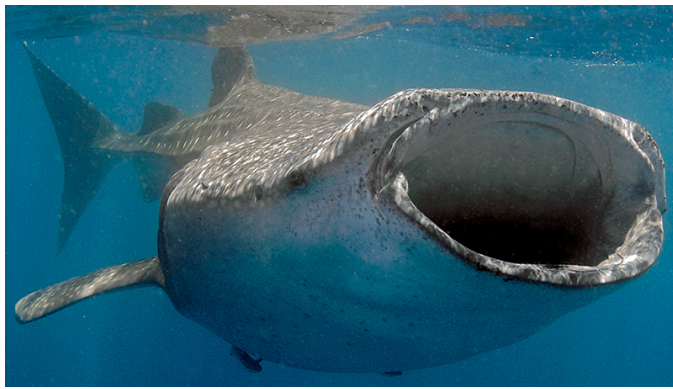


Figure 2 - Whale Shark with Mouth Open

understood biological aspect about this species (Rowat & Brooks, 2012). While predicting aggregation sites, it is hypothesized that these sharks may use their sense of smell to detect food sources pulses; although no research has been conducted in this field (A. Sequeira, Mellin, Rowat, Meekan, & Bradshaw, 2012). It is clear that much more research, and lab work is needed to understand this biological aspect of *R. typus*.

While scent may be a vital sense that is poorly understood, more information is known about the sight of these animals. *R. typus* has small circular eyes on the lateral sides of its' head, creating a large blind sport in the center of it's vision (Rowat & Brooks, 2012). *R. typus* has highly developed muscles that allow it to roll its' eyes into the back of their socket (Rowat & Brooks, 2012). This behavior has been observed when

people use flash photography to capture images of *R. typus*. Overall, it is thought that *R. typus*' vision is best adapted for short range sight around 3-5 m, as sharks have been observed following swimmers with their eye movements (Rowat & Brooks, 2012).

R. typus' sense of hearing is also greatly undiscovered. This species has the largest known inner ear of any animal; although it remains unknown how this affects their detection of low wave frequencies, and their perception of balance (Rowat & Brooks, 2012).

Reproduction

Little information is known about their reproduction, as pregnant females are rarely encountered (Colman, 1997). One

pregnant female shark was commercially caught by harpoon off the coast of Taiwan in 1995 (Joung, Chen, Clark, Uchida, & Huang, 1996). This female shark was 10.6 m in length and 16 t in mass. This shark provided great insight into the reproduction of this species, as this one female was found with over 300



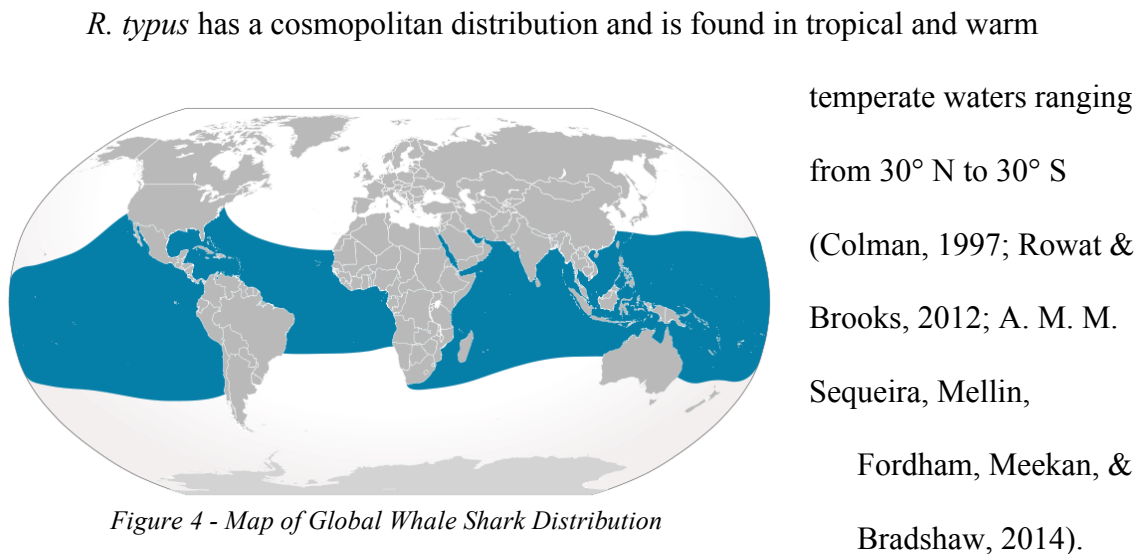
Figure 3 - Photo of Over 300 Pups Found From Pregnant Female Shark

embryos inside of her—the largest known litter of any shark species (Joung et al., 1996).

While 304 embryos were found, the embryos were all at different stages of development. These embryos ranged in development from the majority—which had a yolk sac, and were in eggs, to free swimming young inside of the female (Joung et al., 1996). Additionally an unrelated discovery was made when a 46 cm pup was found in the

Philippines, suggesting that *R. typus* pups may greatly vary in size at birth (Rowat & Brooks, 2012). It is hypothesized that fertilized eggs may remain in a state of embryonic diapause, until conditions are optimal for a healthy pregnancy; suggesting that *R. typus* has a k-selected life history (Rowat & Brooks, 2012; Wilson, Polovina, Stewart, & Meekan, 2005). Overall, the reproduction of this species remains largely unknown. Further research is needed to have a greater, and more comprehensive understanding of *R. typus* reproduction.

Distribution and Movement



They are found in oceanic, and coastal waters (Rowat & Brooks, 2012). *R. typus* populations occur at the ocean surface to feed, and possibly to assist with thermoregulation (A. M. M. Sequeira et al., 2014). The geographic locations where multiple sharks are known to surface are referred to as aggregation sites.

Aggregations

Aggregation is the term used to describe areas where multiple sharks are found, or seasonal occurrences of sharks are observed (Rowat & Brooks, 2012). *R. typus* is known

to aggregate in the waters off the coasts of: Belize, Ningaloo Reef, the Sea of Cortez, the Philippines, the Maldives, the Seychelles, Mozambique, Djibouti, KwaZula-Natal, Kenya, the Galapagos, India, and Mexico (Colman, 1997; Rowat & Brooks, 2012). This list of aggregation sites continues to grow, as more sites are discovered.

These aggregation sites provide an insight into population dynamics. *R. typus* population estimates are ultimately constrained due to the unique population dynamics at these aggregation sites. At these sites the majority of observed *R. typus* are immature males, with few immature females sighted, and very rarely mature sharks of either sex (Rowat & Brooks, 2012).

In addition to the use of photo-identification to estimate shark populations, aerial surveys are conducted to establish estimates, although both methodologies have

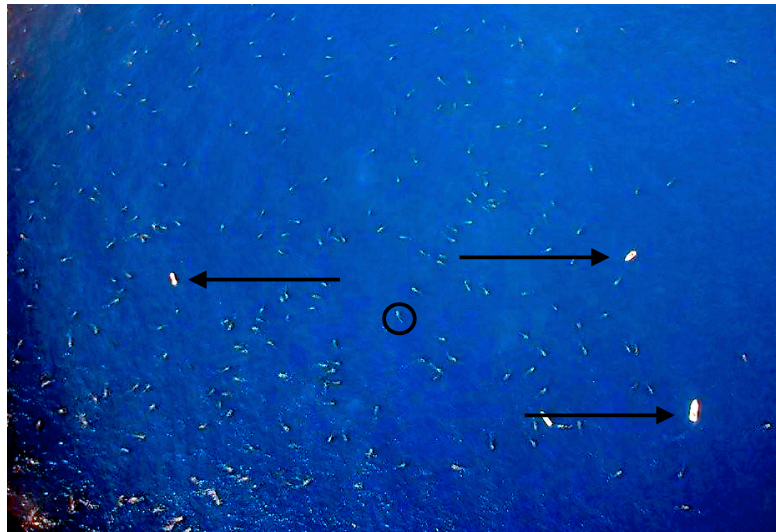


Figure 5 - Aerial View of Holbox Island Aggregation Site

- Black Arrows Indicate Three Ecotourism Boats -

- Black Circle Indicates the Size of a Single Whale Shark -

is the amount of time these

sharks spend below the surface (Rowat & Brooks, 2012).

Diving Behavior, and Movement

Today, research is being conducted to gain a more complete understanding of *R. typus* diving behavior, and movement. Through the use of pop-up archival tags (PATs)

recording information on movement, and diving information has become more accessible. PAT recorded data has revealed that *R. typus* dive in epipelagic, mesopelagic, and bathypelagic zones; exploiting prey in the epipelagic, and mesopelagic zones (Rowat & Brooks, 2012). *R. typus* has been recorded to dive to depths of over 1,000 m; proving it to possibly be the deepest diving fish in the sea (Wilson et al., 2005). This creates some problems when it comes to conducting research on this species. While tagging technology is extraordinarily developed, these tags cannot withstand the depths in which these sharks dive. Therefore, tags are often broken, or lost while trying to collect data about this species.

The deepest dive was recorded by PAT data from a shark off the coast of Holbox Island, an individual was recorded diving to a depth of 1,720 m (Colman, 1997). *R. typus*' vertical movement still remains not entirely understood, and *R. typus*' horizontal movement is still being explored. PAT data has provided some insight into migration patterns of these sharks. PAT data revealed that *R. typus* migrate through Indonesian waters, where current hunting still occurs (Wilson et al., 2005).

Early studies indicated that *R. typus* can migrate great distances. Satellite data indicates that *R. typus* has the ability to migrate over 13,000 km in 37 months (Rowat & Brooks, 2012). In addition, satellite data showed that *R. typus* moved through international waters, all under different jurisdictions (Rowat & Brooks, 2012). Overall, *R. typus* may be at a greater risk for overexploitation, due to its' migratory movement, and behavioral vulnerability (Wilson et al., 2005).

Current Threats

According to the International Union for Conservation of Nature (IUCN) Red List, *R. typus* is currently listed as a vulnerable species, with a decreasing population (Norman, 2005). In addition, the population measurements are potentially skewed because few surveys have accounted for those individuals who spend much of their time at extraordinarily deep-depths (Rowat & Brooks, 2012). Therefore, this species could have the potential to be at an even greater risk than what is currently estimated.

R. typus are legally protected in the waters off the coasts of: Australia, the Maldives, the Philippines, India, Thailand, Malaysia, Honduras, Mexico, US Atlantic waters, and Belize. This species was also added to Appendix II of the Bonn Convention for the Conservation of Migratory Species of Wild Animals (CMS); this identifies species whose conservation would benefit from international cooperative agreements (Norman, 2005).

In 2002, *R. typus* was added to Appendix II of the Convention on International Trade in Endangered Species (CITES) (Norman, 2005). Species listed under Appendix II of CITES, are species that are not necessarily threatened with immediate extinction, but may face extinction pressure if trade is not closely monitored (Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2015). The addition of *R. typus* to Appendix II of CITES states that any exports of *R. typus* must have come from a sustainably managed population (Norman, 2005).

Finally, *R. typus* is included in Annex I of the United Nations Convention on the Law of the Sea (UNCLOS), this recognizes that this species must be managed accordingly to its unique migratory patterns (Department of the Environment and

Heritage, 2005). According to the ICUN, *R. typus* is listed as a vulnerable species due to the multitude of threats that harm this species, one of which is hunting (Norman, 2005).

Hunting

As a result of the combination of the migratory patterns of this species, and the amount of time this species spends near the surface of the water; they are vulnerable to interactions with fishing vessels (Li, Wang, & Norman, 2012). Although Appendix II of CITES protects this species; illegal hunting still occurs due to the demand for this shark's fins, body parts, and meat.

According to fishermen in China, *R. typus* captures mostly occur as a result of by-catch (Li et al., 2012). Often times *R. typus* swims into trawl nets, set nets, purse seine nets, stow nets, and drift gill nets (Li et al., 2012).



Figure 6 - Image of Whale Shark Meat Being Cut for Distribution in Local Market

Unfortunately, the only geographic location where *R. typus* have been confirmed to breed is off the coast of China, where hunting has declined, but still occurs (Conservation, Overview, & Proceedings, 2005; Norman & Catlin, 2007b). This can inherently harm this species, as breeding grounds appear to coincide with hunting grounds.

One reason this species is an easy target for hunters is their symbiotic relationship with a multitude of commercially valuable fish species. As *R. typus* aggregate in areas of high productivity, they can often be found with other



Figure 7 - Image of Whale Shark Caught in a Purse Seine Net

commercially valuable species, such as tuna species (Rowat & Brooks, 2012). Therefore, some fishermen use *R. typus* to target other species, and simultaneously capture *R. typus*.

While hunting *R. typus* inflicts direct harm to the species, it can indirectly affect many other species, and have a trickle-down effect on the ecosystem. It has been discovered that over 200 different fish species travel along side *R. typus*, using the shark as a source of refuge (Rowat & Brooks, 2012). *R. typus* has been found to act as a fish aggregating device (FAD). Therefore, this species can be categorized as an “umbrella species”. As defined by Roberge, and Angelstam an, “umbrella species is a species whose conservation confers protection to a large number of naturally co-occurring species” (Roberge & Angelstam, 2004). For example, as observed at the aggregation off of Holbox Island, giant manta rays, large sea turtles, a variety of tuna species, sea birds, and other marine mammals were spotted amongst the *R. typus* aggregation (Hueter &

Tyminski, 2012). Therefore, by providing greater protection for *R. typus*, indirectly many other species would be protected.

Further protection is needed, due to the demand for *R. typus* fins, meat, and other products on the commercial market. *R. typus* fins are massive in size and along with the basking shark, *Carcharodon maximus*, are the most highly demanded on the market (Li et al., 2012). These fins are demanded by the lucrative shark-fin soup industry. A single *R. typus* fin has been found to sell for upwards of US\$ 57,000 (Hueter & Tyminski, 2012). Other body parts are taken from the shark and sold on the market including the liver oil, and meat; although, the fins are generally the most valuable body part (Li et al., 2012).

R. typus is referred to the ‘tofu shark’, as the consumers of its’ meat find resemblance to that of tofu (Joung et al., 1996). This shark’s meat remains some of the most expensive shark meat in the commercial market (Joung et al., 1996). *R. typus* meat has been found to sell on the market for \$2.56-\$7.0 per 1 kg (Fowler, Reed, & Dipper, 1997). Recent images of *R. typus* have appeared to surface on the Internet, showing sharks being transported to fish markets. In addition, recent video footage has shown illegal fishing operations transporting *R. typus* fins, and other by-products to other importing nations. Previously research conducted by Li, suggests that annually catch rates are most likely much higher than recorded and that if this hunting persists it could lead to an ecologically unsustainable industry.

Boat Collisions

R. typus can be found at the ocean surface, exposing them to many threats. Collision with boat traffic can result in significant injury, or death for the sharks. Injury can be inflicted by ecotourism boat operators; in 1999 Brad Norman concluded that a

number of sharks in Ningaloo Reef exhibited fresh scars from what appeared to be a boat's propeller (Mau, 2008). Two previous studies (Hillcoat; Korman) on scarring of *R. typus* have been conducted in Ningaloo Reef. These studies provided insight into the number of sharks that exhibited some form of scarring. A majority of sharks exhibited scars; although the cause of the scar was not always clear (Korman, 2014). Often times it was hypothesized that the scars were caused by natural occurrences, such as the shark swimming into benthos, or being the victim of predation from other shark species

(Fitzpatrick, Meekan, & Richards, 2006; Korman, 2014). Although, some sharks were observed with major lacerations that were clearly induced from boat propellers. These sharks suffered major wounds, or in some cases partial or full

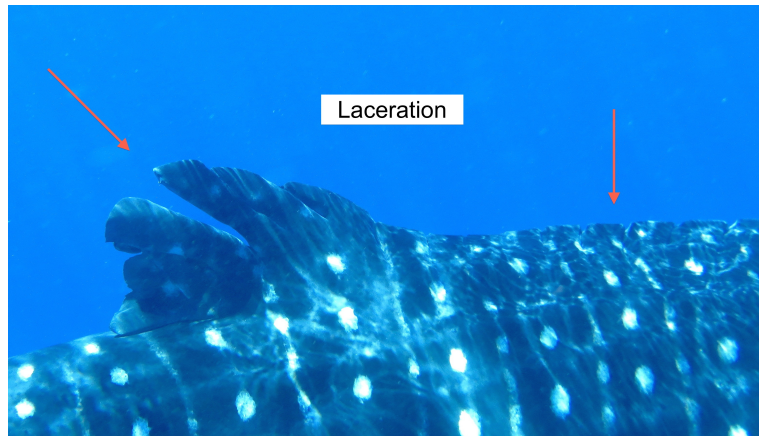


Figure 8 – Laceration on Dorsal Fin From Boat Propeller Found on a Shark in Ningaloo Reef, WA

amputations, the overall health of these individuals did not appear greatly reduced (Korman, 2014). It still remains unclear how well these sharks can heal, or the rates in which they heal, although observations suggest this species is resilient to harm (Korman, 2014). In addition to ecotourism operators, *R. typus* can face threats from commercial shipping.

A possible death from boat collision was recorded using a PAT (Speed et al., 2008). A PAT was deployed on a shark in Ningaloo Reef, the tag then showed the shark

swimming out of the reef, through some the busiest shipping waters off the coast of Australia. The tag followed the shark along the ocean surface, when suddenly it descended to a depth of 900 m for 12 hours, when the tag then floated to the surface (Speed et al., 2008). While this evidence suggests a mortality induced from a boat collision, other causes of sudden diving cannot be excluded (Speed et al., 2008). In addition, the extent of mortality induced from boat strikes can be more difficult to gather; as *R. typus* bodies may rapidly sink to the ocean floor, where their deaths go uncounted for (Speed et al., 2008).

Ecotourism Sites

Currently, there is a multitude of ecotourism sites located in accordance with *R. typus* aggregations. Some of these sites include: Ningaloo Reef, The Galapagos Islands, Thailand, Sea of Cortez, Philippines, Mozambique, Seychelles, Maldives, Djibouti, Belize, Holbox, North Gulf of California, South Gulf of California, and the North Gulf of Mexico (Rowat & Brooks, 2012). These sites can provide important conservation benefits for *R. typus*. These ecotourism sites can transform local economies from unsustainable natural resource use, to a more sustainable, and non-consumptive use of natural resources (Hueter & Tyminski, 2012).

For the purpose of the study I have chosen to use the definition of ecotourism that is stated by Weaver,

“Ecotourism is a form of tourism that fosters learning experiences and appreciation of the natural environment, or some component thereof, within its associated cultural context. It has the appearance (in concert with best practice) of being environmentally, and socio-culturally sustainable, preferably in a way that

enhances the natural and cultural resources base of the destination and promotes the viability of the operation.” (Dowling & Fennell, 2003)

Inevitable Growth of Industry

The *R. typus* watching industry has been growing since its start in the 1980s. In addition, there has been a trend with marine wildlife tours to move from simply viewing the wildlife from the boat, to a more interactive experience, like swimming along side *R. typus* in the water (Higman et al., 2008). In the case of most ecotourism operations, tourists are taken out to shark aggregations sites, where they snorkel along side the sharks. The temperament of *R. typus*, and aggregation at the ocean surface, makes this species an ideal shark for ecotourism encounters (Hueter & Tyminski, 2012).

Creating this interaction has elicited strong emotional responses from tourists. Some tourists who swam with *R. typus* remarked feeling emotions such as ‘peace’, ‘calm’, ‘grace’, and ‘beauty’ (Higman et al., 2008). Studies have found that for tourists interacting with *R. typus* there are many psychological benefits; a key benefit is centered around finding the shark, and interacting with the shark (Higman et al., 2008).

The shark-watching industry was not always on the forefront of marine wildlife tourism. In 1975 Peter Benchley released his film *Jaws*. The release of this film changed the public’s perception of sharks for decades—and still influences many today. In addition to instilling fear in the public, this film also created an incentive to hunt sharks. After around a decade, and a half there was a shift to capture sharks on film, and not hunt them (Higman et al., 2008).

As another decade passed, there was a movement towards the concern for sharks’ well-being (Higman et al., 2008). Thus, the desire to swim amongst sharks blossomed,

and marine tourism began to boom. Now the growth of the shark-watching industry is of interest to conservations, as most shark species are facing extreme pressure from commercial fisheries, due to the value of their fins (Higman et al., 2008).

The Importance of the Study

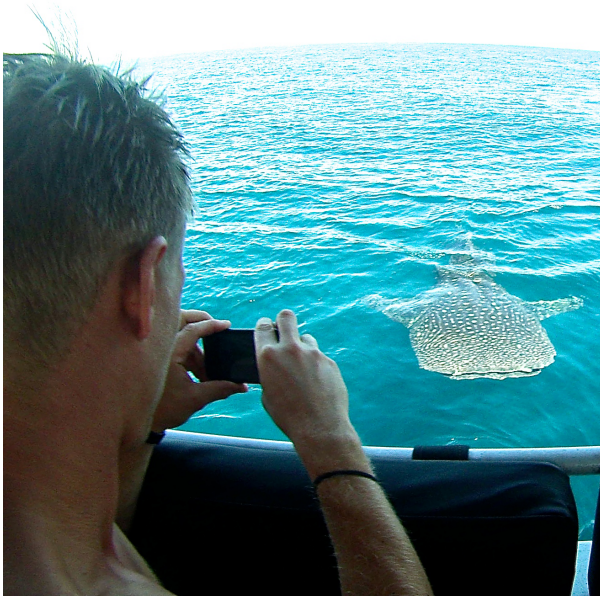
With a species like *R. typus* where little information is understood about the species, it is important to continue to examine the implications human interaction is having. It is vital to exhibit the precautionary principle when dealing with this species, whether it is tourism, or management. Due to the limited information that is known about *R. typus*, it is difficult to comprehend the damage that is being inflicted on this species, and what implications this damage can have on the future of this species.

While the intrinsic value of this species should be enough to protect it, it is not. Therefore, I wanted to conduct this study to provide additional evidence to support the idea that *R. typus* is a valuable species, in need of protection, and conservation. As an undergraduate Environmental Studies student, I have studied humans' interaction with the natural world for almost four years. I believe studying how humans interact with sharks for profit is an ideal case study in the Environmental Studies field.

In addition, I have a personal connection to this species. I worked on an ecotourism boat in Ningaloo Reef, swimming with these sharks almost everyday, for five weeks. I got to observe the grandeur of this species, and the experience tourists had when interacting with this species. After this experience, I decided I needed to study this species further, in order to help protect it. It became clear to me that in order to mitigate harm inflicted on this species, additional studies needed to take place to evaluate how the ecotourism industry was affecting these sharks.

Benefits of Marine Wildlife Tourism

A few benefits from wildlife tourism include: wildlife management, wildlife research, fundraising for the conservation of the species, socio-economic benefits for the surrounding community, and the education of tourists which can lead to further support for conservation (Higman et al., 2008). Some studies indicate that wildlife tourism experiences can even lead to a fundamental change in the tourists' beliefs. Studies have suggested that marine wildlife tours, which focus on education can create behavioral



*Figure 9 - Tourist Viewing Whale Shark from
Ecotourism Boat in Ningaloo Reef, WA*

changes in tourists, including reducing impacts, giving money, and creating direct actions to support environmental issues (Higman et al., 2008). It is clear that the formation of tourism hotspots can produce beneficial outcomes for the surrounding community; therefore, leading to a growing demand to start ecotourism businesses.

Ecotourism experiences can also create multiple forms of psychological benefits for the tourists involved, and are often found to promote well-being, and improve the overall quality of life of tourists (Higman et al., 2008). Ecotourism experiences with an interaction component are found to promote happier moods, greater environmental sensitivity, help solidify a sense of place, and aid with interactive learning (Higman et al., 2008). Overall, research has found that the

experience tourists have can change the way they feel. These emotional changes can be very powerful, and potentially change how tourists act later in life.

As stated previously, humans' interaction with marine wildlife can elicit emotional responses (Curtin, 2005). In the case of swimming with *R. typus*, due to the perceived lack of mediation of the tourist experience, there appears to be a “greater congruence of mind and body, coupled with a sense of discovery, fantasy, imagination and immense enjoyment” (Curtin, 2005). The emotional responses from tourists demonstrate why this industry has immense potential for growth. A few factors were found to be vital in order to improve the overall experience for the tourists: “viewing animals in their natural setting, seeing a wide range of species, interacting with wildlife in close proximity, experiencing the sense of place, and sharing experiences with like-minded people” (Curtin, 2005). While viewing *R. typus* in the wild was a key factor to improve tourist enjoyment, tourists can view these sharks outside of their natural environment.

The only alternative to viewing *R. typus* in their natural setting, is viewing these sharks in captivity. *R. typus* have been kept in captivity in Japan, and Taiwan (Hermann et al., 1998), and today *R. typus* can be observed in the United States at the Georgia Aquarium. Overall, thirteen *R. typus* individuals are held in captivity amongst these three nations (Hueter & Tyminski, 2012). This species has proven difficult to care for in captivity.

Disadvantages of Marine Wildlife Tourism

While wildlife tourism can have some clear benefits, without proper management the negative effects on the wildlife can include: disruption of natural behavior, inducing

injury, habitat modification, and the ultimate destruction of the wildlife that is in need of protection (Cagua, Collins, Hancock, & Rees, 2014). These threats can lead to the long-term benefits being endangered (Cagua et al., 2014).

Disruption of natural behavior has already been observed of *R. typus*. *R. typus* has been observed to avoid tourists when encountering the bubbles produced from SCUBA divers, and when tourists ‘duck-dive’ too close to the shark (Department of the Environment and Heritage, 2005). In these situations *R. typus* has been observed to avoid the tourist, or dive out of sight.

From my personal experience, *R. typus* has been



observed to react in an opposing manner as well. While swimming with an approximately 3.5 m female *R. typus* in Ningaloo Reef, an individual shark exhibited signs of curiosity. The lower lobe of this shark’s caudal fin had been amputated from what appeared to be rope entanglement, as the remnant scars were non-linear, and the healed wound had jagged edges. While this shark had endured a major amputation, which was most likely inflicted by humans; this individual still appeared to be very curious about humans. This shark followed snorkelers around in the tour group.

After the tourists had exited the water, the shark swam around the hull of the boat, occasionally rubbing against it. After this behavior, the shark then swam to the back of the boat to examine the bubbles being produced from the vessel. This individual *R. typus*

Figure 10 - Tourist 'Surfing' a Whale Shark in The Philippines

displayed unique curious behavior, which needs to be studied further. The knowledge of this species' behavioral ecology is greatly unknown, and further research needs to be conducted in order to determine the implications of this interaction, and ecotourism interactions in general.

Flagship Species

R. typus can be a very valuable species to study, this species has been referred to as the 'Ambassador of Sharks' (Higman et al., 2008), as it's unique behavior makes it sought out by tourists worldwide. *R. typus* has the potential to act as a flagship species. A flagship species is generally an iconic species, which has the potential of generating public interest. This species holds serious potential for promoting the health of other species, and gaining additional protection for other species. As stated by Sonja Fordham, *R. typus* is the first shark species to be listed under the CMS, and CITES (Conservation et al., 2005).

In addition to generating public interest a flagship species is often capable of raising conservation awareness, and conservation funding (Higman et al., 2008).

Globally, *R. typus* creates US \$66 million from ecotourism, the majority of which is generated by developing countries (Higman et al., 2008). This financial revenue creates incentive to protect these sharks, as opposed to hunting them.

Need for Conservation Management

There is a need for conservation, enforcement of regulation, and management at the all levels—including the international level (Wilson et al., 2005). It is clear that a tremendous amount of ecological, and biological information remains unknown. In order to better understand this species, we need to be able to protect it from harm. In addition,

if we continue to hunt this species, or even indirectly harm it—there could be unknown damage inflicted. Due to the fact that so little is known about *R. typus*, humans could be inflicting more damage than we are even aware of. Fordham states, that despite *R. typus*' current legislative protection this species remains at serious risk for overexploitation (Conservation et al., 2005).

Materials and Methods

This study was conducted through the use of a variety of methodology. The primary source of information was gathered from literature review, which is explained below. The policy analysis was conducted by methodology adapted from Eugene Bardach. The detailed steps of Bardach's analysis are outline below. Finally, in order to compare the sites; a matrix of evaluative criteria was developed. This matrix can be found at the start of Chapter Four in this document. This matrix was used to evaluate each site, and determine what attributes of management can be adapted to create management suggestions that can be implemented at new *R. typus* ecotourism sites.

Literature Review

The research in this study was conducted by reviewing primary literature on *R. typus* biology, ecology, conservation status, and protective measures. This study is predominantly a collection of qualitative data on three ecotourism sites. The documents used to collect this data are chiefly journal articles. In addition to journal articles, reports of *R. typus* were used, news articles, and multiple government produced documents.

In addition, a few personal experiences were added to supplement known information about the species. A comprehensive analysis was completed in order to

present information on the multifaceted implications of the ecotourism industry associated with the global aggregations of *R. typus*. The literature review includes information on the current policies in place at these locations. Therefore, the information about policy was gathered from these documents as well.

Selection of Case Studies

The three case studies in this comprehensive study are: Ningaloo Reef, Holbox Island, and Tofo Beach. I choose these locations for a multitude of reasons. Firstly, a study of only these three sites has not been conducted, creating novel research in the field of whale shark ecotourism research. In addition, each of these sites provides a unique insight into the topic of *R. typus* ecotourism.

Ningaloo Reef, Western Australia was included as it is the foundational site of *R. typus* ecotourism. Therefore, this site provides a good baseline, when comparing these sites. In addition, most of the current codes of conducts are adapted from the model that was established in Ningaloo Reef. This site was important to include, because when comparing the codes of conduct—Ningaloo Reef can once again act as a baseline.

Holbox Island off the coast of Mexico was included because this ecotourism location is the fastest growing *R. typus* ecotourism site on the globe. In addition this site is vital to study, as it coincides with the largest known *R. typus* aggregation site. The potential exponential growth of this industry is vital to study, in order to safeguard *R. typus*.

Finally, I examined the Tofo Beach, Mozambique ecotourism site. This *R. typus* aggregation was important to study because, it is one of the few aggregation sites where *R. typus* have been observed year-round, and currently has no protection (Pierce,

Méndez-Jiménez, Collins, Rosero-Caicedo, & Monadjem, 2010). In addition, this site is on the cusp of developing a code of conduct to swim with *R. typus*, creating a unique case study. This site provides insight into the development of a code of conduct, particularly in a developing nation.

Policy and Code of Conduct Analysis Methodology

The particular form of policy analysis used in this study was adopted from Eugene Bardach's Practical Guide for Policy Analysis. As stated previously, the information about the policies that are examined in this study were gathered from the documents used in the literature review. In order to analyze the policy at these ecotourism sites, I will later use Bardach's methodology as a guide for the policy analysis portion of this study (Bardach, 2000). Below I have outlined Bardach's methodology to serve as an indicator of the breadth, and depth in which I will be analyzing the policies at these sites. This outlined methodology acts as a simple guide to follow in order to understand the way in which my suggestions for management were formed.

Finally, as found in Chapter Four of this document, I will use an evaluative matrix as a tool to evaluate the three study sites. The criteria used to evaluate each site include: Management of The Industry, Code of Conduct, Education, Conservation Implications, and Socio-Economic Implications. These criteria are described in depth in Chapter Four of this document.

This matrix was used in the final portion of this study to help determine suggestions, and possible future management strategies. The higher a site score in each category, the better the site performed in that area of management. Therefore, this matrix was used as a tool to extrapolate the beneficial aspects of management at each site. While

creating suggestions for management, Bardach's guide was also used as a tool for crating suggestions. The steps of Baradach's methodology are detailed below in the following section.

Bardach's Practical Guide for Policy Analysis

The first step in order to conduct a policy analysis is to examine, and define the current problem with the policy you are examining. Once the problem is identified, quantifying the problem is the next vital step. The quantification of the problem is simply the articulation of the problem to your audience. The problem must clearly be stated, so that your audience understands why you are examining the policy in the first place.

The second step of a policy analysis is to assemble evidence (Bardach, 2000). In order to create a valuable analysis, and argument—you need to produce valuable evidence. While collecting evidence, it is important to think about the application of this evidence in your research.

It is important to consider how the use of this evidence will further your argument. In addition to contemplating the application of your evidence; the use of analogies can be helpful when addressing problems with the policy you are examining (Bardach, 2000). For example, while the implications of whale shark ecotourism policy may be less explored; policy based on sea turtle, or dolphin ecotourism may provide some useful analogies. The use of analogies can strengthen your argument later on in your policy analysis.

The third step of policy analysis according to Bardach is, constructing alternatives for the policy under examination. While undertaking this process, it is best to start broad, and then eventually narrow the alternatives. If providing alternatives does not seem to be

solving the problem with the policy; then you can provide suggestions for an entirely new policy. The formation of a new policy may be ambitious, but in some cases total policy reform can be necessary. For the case of Ningaloo Reef's code of conduct, it has been accepted as the baseline for whale shark ecotourism policy globally; therefore, establishing an entirely new policy appears unwarranted.

In this study, as opposed to forming an entirely new management strategy, I will be analyzing the preexisting strategies, and offering my suggestions for reforms. Below I will analyze the existing policy at three ecotourism sites: Ningaloo Reef, Holbox Island, and Tofo Beach. In order to help make predictions about the outcomes of this study, I have created a matrix as a tool for analyzing policy. The matrix can be found in Chapter Four, where it, and the evaluative criteria are explained in depth.

The fourth step in conducting a policy analysis is selecting the criteria in which you will be evaluating the policy (Bardach, 2000). While selecting the criteria, you must critically think about how this evidence will be interpreted by your audience. This step in the analysis can prove to be the most difficult. There is a great range of topics in which you can evaluate a policy. Some important topics to think about when crafting your criteria are: feasibility, economic evaluation, legality, political acceptability, justice, and robustness (Bardach, 2000).

While analyzing whale shark ecotourism policy I believe it important to consider: management of the industry, code of conducts, education, conservation implications, and socio-economic implications. I have found that the above stated criteria are essential factors to consider in relation to *R. typus* management.

The fifth step in a policy analysis according Bardach is projecting the outcomes of the alternatives you have provided. This portion of analysis can prove to be most difficult, because it is hard to predict how the policy will transform from theory to practice (Bardach, 2000). While predicting the outcome of your policy reform, it is important to include the magnitude of change this policy will create.

As a general rule of thumb, it is very important to be realistic, not optimistic when stating your predictions (Bardach, 2000). In addition to being realistic, it is important to state the unintended side effects of your policy reform. If you state the possible negative implications of your policy reform, your policy analysis will be more robust, and based in practical thought. In order to accomplish this task when it comes to whale shark ecotourism policy, I believe it would be beneficial to examine the history of the current policy. Therefore, when you state your recommendations you can state that your recommendations would be positive, as you have examined where, and why the policy was originally crafted.

The sixth step of policy analysis according to Bardach is to confront the trade-offs (Bardach, 2000). If you frame your trade-offs as alternatives, your argument in favor of your policy reform will appear to be much stronger. By rephrasing the negative effects of your policy reform as trade offs, you will have positively addressed your critics' arguments. This step will be vital when addressing whale shark ecotourism policy. As often the case with conservation-based legislation, there are generally complaints about the economic costs, or losses that will be endured due to policy reform. If these economic trade-offs are addressed in a positive manner, the reception of your policy reform could be much more positive.

The seventh step to policy analysis is deciding between the existing policy and your suggested policy reform, or new policy. According to Bardach, if you find this decision difficult you must retrace your steps, and improve your argument. Bardach suggests running the “twenty-dollar-bill-test” against your policy. This test is named after an analogy, simply inferring if your policy is indeed better; why isn’t it already in place? If you cannot answer this question, it is best to backtrack, and strengthen your analysis. Running this test against your own work will only improve the validity of its’ practical application.

Finally the eighth and final step of policy analysis is to tell your story (Bardach, 2000). If you can simply, logically, and concisely explain your policy analysis to someone who has no prior background knowledge on the topic, without a gap in logic, then you have successfully completed a policy analysis. If you struggle with providing clear evidence, this can be an indicator to gain a better grasp of your argument. Additionally, if you find that while explaining your policy reform to an outsider leaves them confused, and with many questions—take another look at your work.

Overall, this methodology is a simple way to tackle a policy analysis. This simple format can be applied to the analysis of *R. typus* ecotourism policy. In order to determine the effectiveness of the current policy, in my study I will conduct an analysis of the policy that is currently in place at these different ecotourism locations. In addition, I intend to examine how this policy can be applied to other whale shark aggregation locations.

The aim of this study is to construct a baseline universal management strategy for *R. typus* ecotourism that can be implemented across the globe at upcoming ecotourism

sites. In order to do this I will examine, and analyze the management strategies at these three sites, to determine what practices have been most beneficial, and which have not.

Chapter 1 – Case Study: Ningaloo Reef - Western Australia

The *R. typus* ecotourism industry was spearheaded in Ningaloo Reef, Western Australia in the 1980s (Cagua et al., 2014). Soon after the foundation of this industry, research on this species began. The record keeping of this aggregation site has shown that there appears to be approximately 300-

500 individual sharks who return annually to Ningaloo Reef (C. J. A. Bradshaw, Fitzpatrick, Steinberg, Brook, & Meekan, 2008). The sharks in this area generally being to aggregate in April, and can be observed into July, although the number of sharks ranges from year-to-year (Catlin & Jones, 2010; Korman, 2014). Officially the *R. typus* season is April to May (Catlin & Jones, 2010). In addition, there has been over 4,000 sightings of *R. typus* at this aggregation site (C. J. A. Bradshaw et al., 2008).

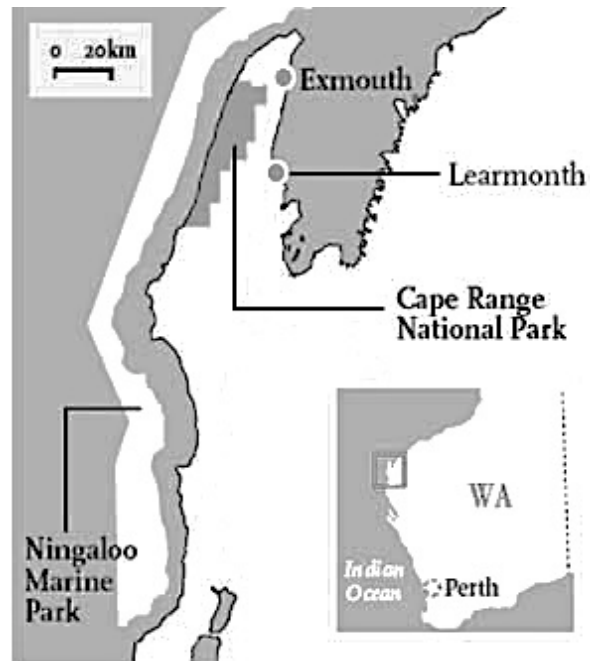


Figure 11 - Map of Ningaloo Reef, Western Australia

Although the cause of the aggregation is somewhat contended; it is generally accepted that these sharks aggregate in this area to feed. This geographic region off the Northwestern Cape of Western Australia is an area of high primary productivity. The

convergence of the Leeuwin Current, and the cold nutrient-rich Ningaloo Current creates an area of upwelling (C. J. A. Bradshaw et al., 2008). These currents form an area where food source pulses occur, and sharks are drawn into the reef to feed.

In addition to the unique current convergence, this area is also influenced by the geology of the ocean floor (Korman, 2014). As the former super-continent Pangaea separated from Gondwanaland, around 180-50 million years ago, the remaining landmass formed an extraordinarily small continental-shelf along this coastal margin (Korman, 2014; Norman, 2005). Therefore, this allows mega-fauna, such as *R. typus*, and giant oceanic manta rays, *Manta birostris*, to come very close to shore where tourists have fairly easy access to them. The confluence of all of these ideal conditions has led to the formation of a very prosperous ecotourism site.

Management of Industry – Limitations of Operators

In Western Australia, *R. typus* is protected under the Wildlife Conservation Act of 1950, which states that this species is in need of protection. *R. typus* is also protected under the Conservation, and Land Management Act of 1984 (Department of the Environment and Heritage, 2005). In addition, in Western Australia the Department of Conservation, and Land Management (CALM), is responsible for the day-to-day management of *R. typus* (Department of the Environment and Heritage, 2005). An important aspect of the management of this species is the regulation of the number of ecotourism operator licenses distributed.

According to Genter, the provisioning of licenses is a fundamental feature to a positive government-led regulation program, that will lead to environmental, and societal benefits (Catlin, Jones, & Jones, 2012). In Ningaloo Reef, the ecotourism operators have

been licensed by the Department of Environmental Conservation (DEC) since 1993 (Catlin et al., 2012). The DEC is primarily in charge of ensuring the sharks in this area remain undisturbed by ecotourism activities (Catlin & Jones, 2010). The DEC was subdivided into the Department of Parks and Wildlife (DPAW), and the Department of Environment Regulation (DER). Currently, the main governing agency over *R. typus* management is DPAW.

In Ningaloo Reef, the current number of licenses is set at 15 operators (Catlin et al., 2012). At the start of this process, licenses were given out for a period of 12 months, but are now given for a duration of five years (Catlin et al., 2012). In addition, a licensing fee is administered to cover costs of managing the industry, these costs were initiated in 1994, and have risen in price (CALM, Catlin et al., 2012). These licenses were then distributed to the candidates who best expressed how their practices were going to contribute to a sustainable industry (CALM, Catlin et al., 2012).

In order to define ‘sustainable tourism’, the DEC decided to use the following nine categories to evaluate the operators: sustainable equipment, environmental impacts, cultural/social impacts, safety/risk management, interpretation and education, quality of service, visitor satisfaction, contribution to park management, and responsible marketing (DEC, Catlin et al., 2012). While the current licensing procedure raises concerns for some operators, the potential lack of regulation could lead to destructive practices, as observed in other aggregation locations (Catlin et al., 2012).

Code of Conduct

The code of conduct (COC) in Ningaloo Reef was established in 1995 by the DEC (Catlin & Jones, 2010). The COC is a set of rules intended to manage the interaction humans create with sharks. The COC developed restrictions, such as



Figure 12 - Image of a Code of Conduct Poster

behaviors that are not allowed when swimming with *R. typus*. Today this code of conduct is multifaceted, and covers multiple aspects of *R. typus* protection, including how tourists are allowed to interact with the sharks.

Sharks in Ningaloo Reef are found by spotter planes, which are lightweight aircrafts that are sent out to locate sharks from above. In addition these planes take images of the sharks, and tourists to provide a method of

ensuring the code of conduct is being maintained. These spotter planes then give Global Positioning System coordinates to the boat operators, where boats then move to the location of the shark.

Once an ecotourism vessel locates a shark, they must reduce their boat speed to eight knots while in the Exclusive Contact Zone (ECZ), 250 m surrounding the shark

(Ningaloo Marine Park, 2013). All other ecotourism operators must remain 400 m from the ECZ, if one operator is interacting with a shark. Only one vessel is allowed in the ECZ, and for a maximum of 90 minutes. The vessel that is dropping off passengers in the water is allowed to get 30 m from the shark (Ningaloo Marine Park, 2013). The skipper is then supposed to stay in front of the head of the shark, and drop off passengers in the path of the shark. Prior to swimming with the shark, swimmers are briefed on the proper way to interact with *R. typus*.

They are instructed to abide by the following rules: do not touch the shark, do not restrict the normal behavior of the shark, do not get closer than three meters from the head/body of the shark, do not get closer than four meters from the tail, do not use flash photography, and do not use a camera on a pole that gets closer than three meters to the shark (Ningaloo Marine Park, 2013). The operators of the ecotourism vessel are responsible for enforcing the restriction stating that, only ten tourists are allowed in the water at a time, with the exception of two professionals. While a maximum of 20 tourists are allowed on one tour, the group must divide up to interact with the shark (Ningaloo Marine Park, 2013).

In order to ensure that the COC is being enforced, Ningaloo Marine Park takes multiple precautions. The Marine Park has regular inspections, boat patrols, and covert operations (Ningaloo Marine Park, 2013). These operations ensure that guides are providing information to tourists, and enforcing regulations in the water. In addition, as previously stated, the spotter planes also aerially patrol to observe the operation.

Education

One of the most important factors to have in order to create a successful ecotourism industry is education among the staff, and tourists. The Ningaloo Reef site has taken measures to prepare their staff to properly educate tourists. As a portion of the COC states, humans must not restrict the natural behavior of the shark when interacting with it. In order to understand what the natural behavior of *R. typus* is, the staff must have an education, which they can pass on to tourists.

Education of Staff and Trained Professionals

DPAW created an, “Interacting with Whale Sharks Course” for the professionals in their industry. This was developed in 2006 by the DEC to help improve the knowledge of the professionals (Ningaloo Marine Park, 2013). In addition, this course aimed to ease communication between the industry professionals, and the DEC. This course was also started to help mitigate the damage of the industry, and create a better understanding of the rules, and regulations (Ningaloo Marine Park, 2013). This course provides each staff member with reading material about *R. typus*, as well as an in-person presentation. Having an in-person presentation allows staff members to meet the local DEC professionals, and increases the level of communication between the operators, and the governing agency.

Education of Tourists

The tourists are provided handouts about *R. typus* biology, and ecology. In addition they are given information from the staff (Ningaloo Marine Park, 2013). The staff is required to complete a course to ensure that they are capable of providing correct

information about *R. typus* to tourists. This course includes behavioral ecology information, and well as general biological information on the species.

This information is then presented to tourists while they are on the bus to the boat ramp, and onboard the vessel. The staff presents a briefing of biological, and ecological information about the sharks. Overall, the staff members present correct, and pertinent information about *R. typus* to the tourists.

Conservation Implications

The existence of *R. typus* aggregation sites, like the one in Ningaloo Reef, allows studies of interactions with humans to occur. Studies in Ningaloo Reef have occurred for many years, providing a more comprehensive understand of the biological implications of the ecotourism industry.

The record keeping on this species was initiated in 1995 through the use of logbooks. Logbooks were distributed by CALM in order to record information about the sharks, and the tourists' interactions with sharks (Conservation et al., 2005). Most often the skipper of the vessel was responsible for recording data, such as length estimates, tourist interactions, and sex of the shark. The tourists provided the funds for this program. Originally operators were deducting AUS\$20 per adult, and AUS\$10 for children from ticket prices to cover the license fee (Conservation et al., 2005). The information collected from the logbooks provided insight about this *R. typus* aggregation. In 2009, as opposed to writing down this information in a logbook, skippers are given an electronic recording device in which the skipper puts in this data. Therefore, there are no physical logbooks, only the new electronic record devices (Ningaloo Marine Park, 2013).

One worry with the formation of this industry is the possible ecological implications this industry can have on *R. typus*. Brad Norman has observed the behavioral ecology of this species for decades. Norman has observed the growth of the ecotourism industry, and viewed potential negative behavior of *R. typus* that was induced from tourism practices.

Some of the direct impacts observed include: disruption in normal behavior, contact between swimmers and sharks, diving behaviors, and the rolling of eyes when flash photography is used (Catlin & Jones, 2010). Norman observed sharks diving away from tourists, and diving up-and-down; these behaviors could potentially reduce the sharks' time spent on the surface, where sharks feed, or possible undergo thermoregulation.

Norman also recorded sharks banking, which is a behavior exhibited when the sharks turn to expose their backs to swimmers (Catlin & Jones, 2010). The back of the shark is used as a protective measure, because the skin on the back of the shark is extremely thick. While all of these behaviors have been observed in the presence of tourists, sharks have also been observed displaying this behavior in the absence of tourists (Catlin & Jones, 2010). This once again suggests further behavioral studies need to be conducted, although the prevention of these behaviors should be taken into consideration at ecotourism sites.

Another negative implication for *R. typus* in this area is the high risk of boat collision. As stated previously, fresh and remnant scars have been observed on *R. typus* in Ningaloo Reef. As opposed to other sites, where the sharks can be found very easily offshore with small vessels, the sharks in Ningaloo Reef require high-power vessels to

access. Due to the fact that these sharks spend a majority of their time on the surface in this area, the chance of a boat collision is greatly increased as a result of the ecotourism industry. The possible use of propeller protectors could be a solution for this ecotourism site. A second alternative that could be considered is reducing boat speeds even further; allowing skippers to have more time to react if they see a shark appear. In addition to having a collision with a boat, sharks in Ningaloo are also in danger due to their migration path. While migrating, these sharks can encounter fatal threats.

It is hypothesized that in this geographic region *R. typus* migrate throughout Australian waters, Southeast Asian waters, and the Indian Ocean (C. Bradshaw, Fitzpatrick, Steinberg, Brook, & Meekan, 2008). With this information in mind over the past, studies have shown that there has been a decline in body size of *R. typus* individuals. A decline of 2 m in body size, and relative abundance of sharks has declined approximately 40% over the past decade (C. Bradshaw et al., 2008). This evidence suggests that unsustainable mortality of sharks is taking place outside of Australian waters where these fish remain unprotected, potentially supporting the hypothesis that these sharks are actively being hunted (C. Bradshaw et al., 2008). This evidence has been gathered by the observations of ecotourism operators, in conjunction with Australian scientists. Overall, this evidence suggests that a lack of enforcement of current regulation is occurring in waters off the coasts of other nations, which inadvertently impacts the ecotourism business in Ningaloo Reef. If the sharks in this area are viewed as in economic resource, and the resource is being depleted by other nations, this can create a source of conflict. Therefore, ensuring proper enforcement of protective legislation is essential, but often extremely difficult.

Although, viewing these sharks as an economic asset can prove to be a dangerous perspective. As noted by Huges and Carlsen, often times ecotourism operations are often most profitable when run by agencies with the main priority being environmental conservation (Catlin et al., 2012). Therefore, by focusing on environmental preservation, rather than an economic focus, the ecotourism industry will remain sustainable, and profitable for an increased duration of time. Although no current evidence suggests that this industry is harming *R. typus*, there is no evidence to support opposing claims (Catlin et al., 2012). Overall, there is a necessity to continue to observe, study, and preserve the aggregation of these sharks, as the annually aggregation can provide benefits for both sharks, and humans.

Socio-Economic Implications

The Ningaloo Reef aggregation site is located in a fairly remote part of Western Australia off the Northwestern Cape. The hub of *R. typus* ecotourism is Exmouth, which is the nearest town. This small town is over 1,000 km from the closest major city—Perth, WA (Catlin & Jones, 2010). Other than the long drive to this region of the country, the only alternative is flying into this small town. The cost to fly to the small town of Exmouth is very high. While these factors make accessibility to this location difficult, many tourists still come to this area.

Although this area is remote, it is reaping enormous monetary benefits from the ecotourism industry. Annually *R. typus* aggregates in this area from approximately March until May (Higman et al., 2008). During this period of time, the industry was valued to bring in between AU\$ 3.2-6.2 million in 2007, and continues to grow (Hueter & Tyminski, 2012; Norman & Catlin, 2007a). Included in these calculations was the worth

of one living shark in Ningaloo Reef, which was valued at AU\$ 282,000 (Hueter & Tyminski, 2012; Norman & Catlin, 2007a).

Conclusion

Overall the industry in Ningaloo Reef is well maintained, and intends to inflict minimal damage to *R. typus*. The local government at this site has proper regulations, and enforcement of regulations—including the COC. The COC in this location is appropriate for the environment, and is continually modified to remain modernized. In addition, the level of education provided to the operators, and public at this site is greatly benefiting the tourists, and the sharks. The economic benefits gained by the local economy are enormous, and this industry continues to support the local remote town of Exmouth. Overall, this industry provides a great baseline for other ecotourism industries, and offers insight into the development of a well-maintained industry.

Chapter 2- Case Study: Holbox Island - Quintana Roo, Mexico

The ecotourism industry located at Holbox Island is a much younger industry than the Ningaloo Reef site. Prior to 2002, Holbox Island was primarily a fishing village, but now has transformed into a booming ecotourism site (Ziegler, Dearden, & Rollins, 2012).

R. typus has been found to aggregate off this northeast portion of the Yucatán Peninsula



Figure 13 - Map of Holbox Island, Mexico

from May to September (Hueter & Tyminski, 2012). As the case with many other *R. typus* aggregation sites, in this geographic location; a cold nutrient-rich current upwells, creating a plankton bloom (Hueter & Tyminski, 2012). This

plankton bloom is a food source pulse that draws in *R. typus* to feed. While the sharks are feeding off the coast, the journey to reach the sharks off the coast on average is an hour-long boat ride.

There are two aggregations off this coast line; one off the shores of Holbox Island, and an additional aggregation further off the coast of Isla Contoy, and Isla Mujeres (Hueter & Tyminski, 2012; Ramírez-Macías et al., 2012). This second site is referred to as the “Afuera”, meaning “outside” in Spanish (Hueter & Tyminski, 2012).

This Afuera site appears to be the result of a large fish spawning location, where sharks are drawn in to feed on fish eggs. While the large plankton blooms located off the coast of Holbox Island draws *R. typus* to aggregate. These two aggregation sites combine to form the largest aggregation site of sharks in the world. This aggregation site's *R. typus* population ranges from 521-809 individuals (Hueter & Tyminski, 2012; Ramírez-Macías et al., 2012).

In addition, these two *R. typus* ecotourism sites appear to be the fastest growing *R. typus* ecotourism sites in the world (Hueter & Tyminski, 2012). This industry has been projected to grow 25% per year, and by 2008 alone brought in over 17,000 tourists (Ziegler et al., 2012). While this site is relatively new, the proximity of Holbox Island to major resort cities such as Cancun, and Playa del Carmen creates very easy access for tourists. The combination of factors, from the largest *R. typus* aggregation site, and the fastest growing *R. typus* tourism industry creates a case study that is necessary to study.

Management of Industry

In 2000, the hunting of *R. typus* was prohibited in Mexican waters (Department of the Environment and Heritage, 2005). The current governing agency in charge of regulating this industry is the Comision Nacional de Areas Naturales Protegidas (CONANP), which is struggling to keep this industry under control (Hueter & Tyminski, 2012). The transition from hunting *R. typus* to swimming with *R. typus* initially sounds like a beneficial transition, but if the industry is mishandled the consequences of this ecotourism site can lead to harmful implications for *R. typus*.

The once small fishing village of Holbox Island has now been transformed into a major site for *R. typus* ecotourism. Currently, in order to gain a permit for *R. typus*

tourism related activity the General Direction of Wildlife must be contacted, and the Commission of National Protected Areas (Francisco Remolina Suárez et al., 2005). It appears to be the case, that the number of permits distributed is too large, leading to serious issues. As with other ecotourism operators, such as whale watching operators based in Scotland, it was argued that a more effective approach was to regulate from the 'bottom-up' rather than 'top-down' (Catlin et al., 2012). As there appears to be many issues with the current government-led system of regulation; it might be beneficial to re-work the current system to let operators have more control.

At this site the rapid expansion of the industry has led to some issues. In the early 2000s, this industry was limited to a few individuals who took tourists out to see *R. typus*. In 2003, the number of operators was only 42 (Ziegler et al., 2012). By 2012, approximately 240 boat operators were permitted to take tourists out to the aggregation sites, this is a tremendous jump in licensed operators (Hueter & Tyminski, 2012). In addition, it is important to consider the number of operators that are taking tourists out without licenses. While this number is unclear, it is documented that individuals are doing this, and personal accounts of tourists have described operators' clear disregard of the COC. Estimates of industry professionals suggest that the number of licensed operators is much too high, and should be around 160, rather than 240 (Hueter & Tyminski, 2012). While it appears that there are too many operators in the water; many tourists stated they had a positive experience, and felt as though they could interact with the animal. Although, if there were too many people in the water, or the visibility was low, they did not enjoy the experience as much (Curtin, 2005).

A prevalent issue stated by tourists is the ‘perceived crowding’ of this ecotourism site (Ziegler et al., 2012). The regulation of this industry appears to be a serious issue. There is an uncontrolled amount of growth; this industry has grown from 1,500 tourists in 2002, to over 17,000 tourists in 2008 (Ziegler et al., 2012). The lack of government restrictions has caused a boom in the short term economic gains from this industry, but in the long term implications of this industry can inflict serious damage (Ziegler et al., 2012). The lack of regulation of this industry can lead to too many swimmers interacting with one shark at a time. This can also cause conflict among operators, and this requires sharing sharks with fellow operators (Ziegler et al., 2012). One extreme instance of overcrowding was record in 2009, when over 30 boats were surrounding one shark (Ziegler et al., 2012). The disregard of the regulations solidifies that there is a lack of enforcement of regulations at this site.

Code of Conduct

In 2003, a code of conduct was implemented to help promote the conservation of sharks, and the preservation of the ecotourism industry. As a result the following regulations were put in place:

“Tourism activities are only allowed during the daylight hours, Holbox Island operators, and Chiquila operators must leave from different beaches, vessels must remain less than 12 m in length, the maximum boat speed within a shark observation zone is 3 knots, a minimum distance of 100 m must be kept between vessels, the number of tourists on one boat is limited to six—with the addition of two crew, vessels must remain 10 m from the shark, one vessel is allowed to interact with one shark for a maximum of thirty minutes, only two tourists are allowed in the water with one guide at any given time, SCUBA is prohibited, swimmers must maintain a distance of 2 m around the shark, the use of safety vests is required, the use of non-biodegradable sunscreens is not permitted, the use of apparatuses that can create noise is prohibited, inspection and monitoring is required to ensure the code is followed, training is to be provided to improve the service given by tourists service providers, and guides and to certify them as specialized guides” (Conservation et al., 2005; Francisco Remolina Suárez et al., 2005).

After being put in place these regulations were evaluated, and some were altered. For example, the distance a tourist could remain from a shark was previously 5 m, but due to the low visibility that results from dense plankton blooms—the regulation was changed to 2 m (Francisco Remolina Suárez et al., 2005).

A survey was distributed at Holbox Island to tourists to determine what factors are most important for tourists. For instance, 96.2% stated they were satisfied by their proximity to *R. typus*, inferring that the above change to the COC was vital to ensure a positive experience for tourists (Ziegler et al., 2012). Although, the one factor that tourists were most dissatisfied with was the amount of boats in the water, therefore greater regulation of the number of operators might be necessary (Ziegler et al., 2012).

An Important-Performance Analysis was conducted, and determined that greater management is needed when it comes to the, “commitment to the environment of the boat crew” (Ziegler et al., 2012). This data suggests, that further education of staff may be in order to provide a better experience for tourists, and improve the overall quality of the experience. Overall, there seems to be a common connection between a tourist’s positive experience, and a focus on the importance of education, and environment. This same survey determined that the second most important factor when deciding to participate in a *R. typus* tour is overall expansion of knowledge (Ziegler et al., 2012). On most tours provided at Holbox Island many guides do not provide any additional information about the species, despite their certification qualifications (Ziegler et al., 2012). Therefore, these tourists are not given any information about the importance of the conservation of *R. typus*.

Education

Similar to Ningaloo Reef, this site has tried to implement an education plan. This plan includes educating guides, so that they can pass their knowledge on to tourists. Although, unlike Ningaloo Reef there appears to be a disconnect found between the education of the guides, and the tourists.

Education of Staff and Trained Professionals

In order to ensure the above stated regulations are enforced; the training of staff members began in 2002. This training includes: water safety procedures, biological and ecological information on *R. typus*, snorkeling techniques, and tourist guidance information (Francisco Remolina Suárez et al., 2005). When this program began in 2002, there were no permits distributed, and no guides certified. By 2005, there were 90 permits given out, and 71 guides certified (Francisco Remolina Suárez et al., 2005).

Education of Tourists

Education of tourists should be an important factor in this ecotourism industry for a multitude of reasons. Firstly, it is important to educate tourists so that they know how to properly interact with the species, and not educe harm. Secondly, as stated previously having a focus on sustainable practices benefits the industry overall. Finally, educating tourists should be a focus of this industry because it is a driving factor that benefits tourists on this excursion. According to a survey that was distributed at Holbox Island over three months, tourists top two reasons for swimming with *R. typus* were: interest in the species, and a desire to expand knowledge (Ziegler et al., 2012). Therefore, educating tourists not only benefits the industry, it caters to the needs of the tourists. In addition 88.9% of tourists shared that the staffs' commitment to the environment was an important factor (Ziegler et al., 2012). The tourists also found it was very important that the staff provide information about the experience to them, 87.6% stated that this was an important motivation to improve their experience.

While guides at this site are required to brief tourists about the COC, and interaction regulations; they are not required to present additional information about *R.*

typus to tourists. In this location, many guides do not present biological, or ecological information about *R. typus* to the tourists. This is hypothesized to be a result of the language barrier (Ziegler et al., 2012). Most of the guides in this area were previously fishermen, who do not have a high level of schooling; therefore limiting their language capabilities, or rendering them uncomfortable speaking in a second language to groups (Ziegler et al., 2012). Presenting this information to tourists is a vital component to instilling a conservation ethic amongst tourists, which can potentially lead to long-term participation in conservation programs (Ziegler et al., 2012).

Conservation Implications

Research conducted by MOTE Marine Laboratory suggests, that Holbox Island ecotourism operators may be disrupting the natural feeding behavior of these sharks. Allowing tourists to swim with *R. typus* in the early hours of the day could coincide with the feeding pattern of these sharks (Hueter & Tyminski, 2012). PAT data recorded off the coast of Holbox Island found that *R. typus* in this area spend around 43.9% of their time on the surface feeding (Colman, 1997). As observed at other aggregation sites, sharks may change their behavior, and choose to avoid certain sites where large numbers of boats are found. In Gladden Spit in Belize, there has been an observed decrease in *R. typus* sightings. On average in 2004, shark sightings were down to one or two sharks a day; previously, on an average day eight or nine sharks were observed (Higman et al., 2008; Quiros, 2005). Although Holbox Island is the location of the largest *R. typus* aggregation, it could have the potential to impact the number of observed sharks. Once again, precaution should be strongly exhibited when considering the negative conservation implications this industry could induce on the *R. typus* population.

In addition these sharks may be exposed to a higher chance of getting hit by a boat, due to the increased number of boats in the area. As stated previously, boat collisions can be potentially fatal for *R. typus*, but difficult to record as sharks bodies may sink. In the area off of Holbox Island a large portion of sharks have been observed with fresh scars. Reports have indicated that 25% of *R. typus* off the coast of Holbox Island have exhibited scars that suggest a collision with a boat (Hueter & Tyminski, 2012; Ramírez-Macías et al., 2012). While the *R. typus* population may exhibit scarring, the Mexican government in trying to implement policy to create greater protection for *R. typus*. In 2009, there was the creation of a Whale Shark Biosphere Reserve that includes the aggregation sites (Francisco Remolina Suárez et al., 2005; Hueter & Tyminski, 2012)

An additional beneficial practice of ecotourism that has carried over from Ningaloo Reef to Holbox Island is the use of logbooks. These logbooks help record data on the sharks that the operators encounter. The operator is required to record information such as: sex, length, and interaction information (Francisco Remolina Suárez et al., 2005). These logbooks were distributed to permit holders, and were required to be filled out.

In the case of Holbox Island, the industry appears to be unmanaged due to the economic gains that have been made at this site. As argued by Dobson, the formation of an ecotourism industry can lead operators to view the environment as a consumable commodity, which may be the case in Holbox Island (Catlin et al., 2012). A shift towards a more sustainable view may be in order if the industry in this location wants to persist.

As stated by Mckercher and Robbins in 1998, two integral aspects of ecotourism are the maximization of benefits to the surrounding community, and a focus on

environmental conservation (Catlin et al., 2012). Although they also stated that, these goals can only be reached when the business is economically sustainable (Catlin et al., 2012). The industry in Holbox Island has to evolve into a more sustainable, and ecological-based industry in order to reduce the negative impacts it is having on the *R. typus* species.

Socio-Economic Implications

The economic implications of this industry are not as clearly documented as with other industries. Although, calculations suggest this industry is valued at approximately US\$1 million (Hueter & Tyminski, 2012; Ziegler et al., 2012). Prior to the discovery of this *R. typus* aggregation, fishermen on Holbox Island were making approximately US\$25 per day of work (Higman et al., 2008). The shift towards an industry based on ecotourism appears to financially benefit the local population. According to recent reports, one tourist pays on average US\$250 per tour (Higman et al., 2008). Therefore, these former fishermen have the potential to make a much greater income based on the *R. typus* aggregation.

Conclusion

The industry based out of Holbox Island is in need of reform. This massive shark aggregation site is lacking in proper management. The need for operator reduction is necessary, in addition to greater enforcement of current regulations. While the COC has the potential to benefit the sharks, when not properly enforced can render meaningless. The local government needs to take a greater role at this site. This site is very important to the conservation of this species, as it is the largest aggregation in the world. The negative impacts this industry may be inflicting upon the biological, and ecological

health of this species may be detrimental. Overall, the immediate economic gains of this industry are blinding the local operators to the importance of the long-term health of this species.

Chapter 3-Case Study: Tofo Beach – Mozambique, Inhambane Province

The third and final case study is the aggregation site located at Tofo Beach in Mozambique, in Southeast Africa. This ecotourism site has just recently become a popular place to swim with *R. typus*. The civil war in this nation halted tourism until 1992, when a peace agreement was signed (Tibiriçá, Birtles, Valentine, & Miller, 2011).

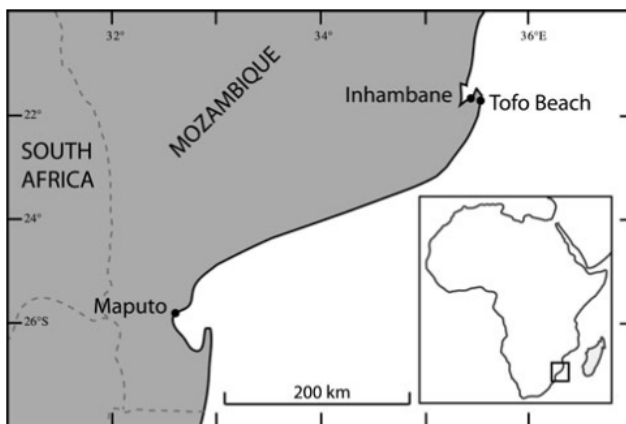


Figure 14 - Map of Tofo Beach, Mozambique

Due to the political turmoil, and lack of infrastructure, this location did not start developing until the late 1990s (Pierce et al., 2010). Although, the growth of marine tourism in this nation has lead people from multiple sectors to come together to improve

the tourism experience (Tibiriçá et al., 2011).

This site is very unique because it is one of the few *R. typus* aggregation sites where sharks have been recorded year-round (Pierce et al., 2010). There are a few factors, which could lead to the ultimate boom of the ecotourism industry in this location. For example, at this site more sharks were sighted per tour in comparison to other very popular locations.

One or more sharks were observed 87% of the time at Tofo Beach, while between 1996-2004 one or more sharks were observed only 81.6% of the time per tour in Ningaloo Reef (Pierce et al., 2010). While this percentage difference may seem minimal, the number of shark sightings per tour were continually declining in Ningaloo Reef at the time of this study (Conservation et al., 2005; Pierce et al., 2010). Moreover, the number of sharks observed by tourists is a very important factor, when increasing the tourists' experience.

In addition, tourism is expected to increase significantly in the coming years at this location. Mozambique plans to bring in approximately four million tourists by the year 2020 (Pierce et al., 2010). Therefore, there will be a growing need to properly manage this site, to ensure the protection of the sharks, and the industry. This site could serve as an example for future ecotourism sites, which will undoubtedly face extreme growth.

This site is located approximately 400 km from Maputo, the capital of Mozambique; prior to the discovery of the *R. typus* aggregation, this site was a remote fishing village (Haskell et al., 2012). The tours at this site are referred to as 'ocean safaris' and similar to other sites, the tours are run during daylight hours, where sharks were observed to be feeding 19.5% of the time (Haskell et al., 2012). Unlike Holbox Island, accessibility to the sharks appears to be easier at Tofo Beach. Although, the sharks at this site are identified in the same manner as they are in Holbox. The sharks are simply viewed on the surface by an observer, rather than by aircraft (Pierce et al., 2010).

The trips take place along a 6 km stretch of coastline, and go out only as far as 1,000 m from the shore (Haskell et al., 2012). The size of the vessels in this location

tends to be smaller than other locations as well. This industry mainly uses 8.2 m rigid-hull inflatable boats (Haskell et al., 2012). While these vessels are still large enough to inflict damage if they collide with sharks, they may run a lower risk of educing fatal injuries. As with other ecotourism sites, high numbers of sharks exhibited some from of scarring. At this site 53% of sharks had either a fresh or remnant scar, which could be the result of natural or anthropogenic causes (Haskell et al., 2012).

Management of Industry

At the present time, there is no official management strategy in place for the ecotourism site at Tofo Beach (Haskell et al., 2012). This is worrisome to the *R. typus* ecotourism community, as this lack of management could lead to an unsustainable industry. In addition, there is a lack of formal government species protection for *R. typus* in the waters off the coast of Mozambique. This is one of the few ecotourism sites that has no species, or habitat level protection management in place (Haskell et al., 2012, 2014).

This site, like other could consider implementing a tourism accreditation program, to certify operators. It has been suggested, that by proving a tourism accreditation, or a certification would provide operators with a complete edge; allowing them to have a greater focus on conservation, rather than promoting their business (Catlin et al., 2012). The potential management of this industry can draw from other successful management plans, at other aggregation sites.

Code of Conduct

Some operators have unofficially adopted a code of conduct in Tofo Beach that was adapted from the Ningaloo Reef COC (Ningaloo Marine Park, 2013). Officially,

there is no COC in place. Studies tried to determine factors that would be important to consider when crafting a COC in this location. While other sites have restrictions about the number of people in the water with one shark at a time, studies suggest this factor may not be as important as it appears initially. It may be more important to consider what behaviors should be restricted, and how far the tourists remain from the sharks (Pierce et al., 2010).

Overall, the implementation of a *R. typus* COC could be fairly easy, and produce positive results. Due to the small number of operators in this region, a plan to educate, and create accountability of operators could be very helpful when mitigating damage. The *R. typus* ecotourism industries in other countries suggest, that forcing operators, and staff members to be accountable for their actions is an important element to a successful industry (Pierce et al., 2010). The current lack of a formal COC has resulted in tourists regularly harassing sharks (Pierce et al., 2010; Richards et al., 2015).

Education

While there is no current education plan, local Non-Governmental Organizations (NGOs) are trying to educate the local population, and tourists. These are the same NGOs that are creating the voluntary COC (Richards et al., 2015). Dr. Simon Pierce the local expert on *R. typus* in this location is the head of the Marine Megafauna Foundation (MMF). MMF is an example of a local NGO, that is trying to education the local populace, and tourists about *R. typus*. This organization is also conducting active research at this aggregation site.

Conservation Implications

While this industry is new, there have been some observations indicating that these sharks may be at risk, due to the budding ecotourism industry. As observed at the other case studies, a certain number of sharks exhibited avoidance behaviors. The increased likelihood of avoidance behaviors leads to a reduction of normal foraging behaviors. This reduction could reduced the overall health of the sharks in this area (Haskell et al., 2012). The less time these sharks spend feeding; a greater reduction in overall health could be experienced.

One ecotourism vessel in this area served as a research vessel, which conducted research on the avoidance behavior of this shark aggregation population. This industry has the potential to easily support necessary research on this species. *R. typus* ecotourism boats are considered the ideal platform to collect data on this species (Higman et al., 2008). As is the case at other aggregation sites, ecotourism vessels are doubling as research vessels. This ecotourism industry has the potential to support research on a year-round aggregation of sharks, which could prove invaluable.

The findings collected from this research operation suggested sharks exhibited avoidance behaviors (listed in Chapter 1), and remained on the surface for a reduced period of time (Haskell et al., 2012). In the cases where sharks showed no avoidance behavior signs, the interaction time on average was 12 minutes, and 37 seconds (Haskell et al., 2012). Among the interactions where the shark exhibited avoidance behaviors, the average interaction time was reduced to 9 minutes and 46 seconds (Haskell et al., 2012). The above data was collected from 2008 to 2010 in Tofo Beach, during this time

approximately 67.5% of the recorded encounters caused sharks to exhibit avoidance signs (Haskell et al., 2012).

The large number of sharks exhibiting avoidance behaviors suggests this industry may be harming the sharks. If these sharks spend their time avoiding humans, rather than exhibiting their natural behavior, it could reduce their health, and alter their behavioral ecology. Although, it is important to keep in mind *R. typus* has been observed to exhibit some of these avoidance behaviors when they are not in the presence of tourists. Further research needs to be conducted to see if there is a direct correlation between the interaction of tourists, and the production of a stimulus that creates avoidance behaviors of the sharks.

While these sharks showed avoidance behaviors, one has to consider the trade-offs of moving towards an ecotourism-based society. While these sharks may face stress, they are not being actively hunted in this area. In addition, the above study did not find evidence to suggest that the above stated short-term avoidance behaviors, will later become long-term behavioral changes (Haskell et al., 2012). It is difficult to determine how much stress these sharks are enduring at this location, and this species' stress threshold. While these sharks may face stress, this may be a positive trade-off as the alternative is being hunted.

One negative practice that is not being conducted at this site is the feeding of sharks. The feeding of wildlife is used as a method to ensure that tourists get the chance to observe, or swim with the species that is the main attraction. This practice can alter natural feeding patterns amongst shark species, and potentially habituate these animals (Higman et al., 2008). While this issue is often associated with species like the white

shark, *Carcharodon carcharias*, it is now becoming an issue amongst *R. typus* tourism as well. This practice is taking place in the Philippines, but in this location this practice is not an issue.

Socio-Economic Implications

Governments of less developed nations, like Mozambique, have to tend to greater priorities such as health, welfare, education, and more—leaving resources limited when tending to environmental management (Hall, 2001). Therefore, the focus on environmental protection in this nation is minimal. This nation was officially the poorest nation on Earth during the mid-1990s (McNaughton, 2012). Now, the industry that has been created by *R. typus*, and the tourists is having a meaningful impact. *R. typus*, and other marine megafauna species are such iconic species, that they alone are responsible for bringing in hundreds of people to this location (Tibiriçá et al., 2011). While there has not been any estimates of the amount of money this species has brought to Mozambique, it is clear *R. typus* is bringing in a substantial amount as the government has increased habitat protection. In 2012, the government of Mozambique recognized the importance of preserving the marine natural capital of this area; and as of 2012, has agreed to create a marine park, which will protect *R. typus*' habitat. Although it is still legal to hunt *R. typus* off the waters of Mozambique, progress is being made in this developing nation.

Conclusion

Overall, this ecotourism site provides some great insight into the formation of an ecotourism industry in a developing nation. While the lack of governmental resources is a issue, local NGOs are taking a serious role in the protection of this species. Although

much work needs to be done to implement a COC, and education plan—this site is making positive strides in the right direction.

Chapter 4- Policy Analysis

The policy behind the management of the interaction between sharks, and humans is vital to ensure the longevity of the species, and the industry. There is a demand for ecotourism policy, as ecotourism is the fastest growing sector of the world's largest market (Dowling & Fennell, 2003). The global tourism industry is valued at \$US 2.5 trillion, and proves to be an immensely powerful industry (Doan, 2000). In order to achieve the best results from implementing ecotourism policy, it has been suggested that the most advantageous results are observed when the policy is implemented at a regional level (Dowling & Fennell, 2003). The most benefits from ecotourism policy can be witnessed when the local community, and the natural environment are top priority (Dowling & Fennell, 2003). The policy analysis conducted below is organized in a manner, in which the management suggestions could be potentially implemented at a regional level at a new *R. typus* ecotourism site.

Method of Comparing and Analyzing Ecotourism Sites

In order to compare the ecotourism sites, a matrix was created to evaluate the stated criteria. The criteria for the matrix are: management of industry, code of conduct, education, conservation implications, and socio-economic implications.

Definition of Evaluation Criteria

The criteria are defined below to clarify how they are used to evaluate the ecotourism sites. Each site was then given a score from 1-5 for each of these criteria. The

higher the number, the more proficient the ecotourism site was in each category. An overall score out of 25 was given when crafting suggestions for policy recommendations.

Management of Industry

Management of the industry is evaluated by how well the number of ecotourism operators is limited. This is one of the most valuable aspects. The management of the industry indicates the role, or lack thereof that the local government takes. If the number of operators is properly limited, there is a lessened potential to harm *R. typus*. Proper management of the industry ensures that the sharks are not being disrupted, or harmed. This would help to mitigate stress sharks may face from the presence of an ecotourism industry.

The management of the industry also includes the provisioning of licenses, or some form of tourism accreditation system. This places a value on those operators who take the time to get the proper certification, and understand the best practices behind *R. typus* ecotourism. In addition, having a process by which operators earn licenses promotes environmental, and societal benefits.

Code of Conduct

This criteria category is measured by the existence of a proper code of conduct ensuring the physical interaction between humans, and sharks to be properly managed. This is also measured by the enforcement of the code of conduct. This category evaluates if the tourists, and operators are complying with the code of conduct. Overall, the best indicator of a successful code of conduct is how well the code of conduct is changing the real interaction humans are having with sharks.

Education

The category of education has two parts. The first is defined by the amount of education the staff, and professionals are receiving from the governing agency at the ecotourism site. This is necessary to make sure the staff members are well equipped to promote the conservation of the species. The staff is the direct line of information to the tourists. It is necessary that the staff members are well educated, and capable of communicating to tourists. The staff members are the ones who need to communicate the COC to the tourists; therefore, the entire human-shark interaction is dependent on the staff's capabilities.

In addition, the staff members are the people communicating biological, and ecological knowledge about this species to the tourists. In order to help preserve this species, the tourists must be educated about this species. This interaction provides the ideal setting to promote conservation ideology to tourists, and inform them about the dangers this species faces. Therefore, the education category is also measured by the amount of education tourists receive. The education of the tourists improves their experience, and promotes conservation.

Conservation Implications

Conservation implications are measured by the observed, and recorded impact the tourists are having on the sharks. This is important, as the conservation of *R. typus* is the ultimate goal of this industry—if there is no *R. typus*, there is no industry. The sharks are needed in order to receive benefits—including monetary benefits. This category also includes the amount of research that is being supported from the ecotourism industry. This industry can help fund research on *R. typus* in order to further promote conservation.

Socio-Economic Implications

This is measured by the amount of money in which this industry generates. In addition it is measured by the amount in which this industry supports the local economy. If this industry helps improve the quality of life of the local residents, it is an indicator that the socio-economic benefits are great. One can argue that *R. typus*, can be considered ‘critical natural capital’, which is a natural aspect that once lost cannot be replaced, and loss of natural capital is irreversible (Butcher, 2006). This category communicates how *R. typus* is used as a source of income in the local area.

Matrix

The matrix is a tool used below to help evaluate the sites in this study. The sites were given a score for each category to determine the strengths, and weakness of each site. The overall combine score dictates which site is doing the most to promote positive management of this species. The closer the score is to 25, the better the site management. These scores were then used to help determine how to craft management suggestions that could be used in at future *R. typus* ecotourism industries.

Evaluation Matrix

Study Site	Management of the Industry	Code of Conduct	Education	Conservation Implications	Socio-Economic Implications	Summary and Recommendations
Ningaloo Reef	<p>4</p> <p>The limitations of operators, provides a competitive system to manage the number of operators.</p> <p>Although, the number of operators may still need to be evaluated.</p>	<p>4</p> <p>The current COC is strictly enforced, and maintained by the operators.</p> <p>Although, revisions about the way in which swimmers interact with the sharks need evaluation.</p>	<p>5</p> <p>The operators, and staff receive an excellent education from the DEC.</p> <p>The level of education tourists receives varies per operator, but is overall very comprehensive.</p>	<p>5</p> <p>This industry has been researching these sharks for years.</p> <p>The use of logbooks has contributed to information on the species.</p> <p>The fees deducted from this industry help to safeguard this species.</p>	<p>5</p> <p>The sharks in this area bring in extreme amounts of money to the local economy.</p> <p>While the location is very isolated, tourists travel great distances to have this experience and pay for it.</p>	<p>23/25</p> <p>Overall, the industry in Ningaloo Reef is a good example of a well-managed ecotourism industry.</p> <p>While there is always room for improvement, this site provides a good guide for other industries.</p>
Holbox Island	<p>2</p> <p>While this industry has formal management, it is not being enforced or maintained.</p> <p>There is a blatant disregard for regulations, and the number of operators needs to be limited.</p>	<p>3</p> <p>The COC has been modified, and seems to be working well in this location.</p> <p>The COC's enforcement needs better regulation, but it is working to mitigate damage.</p>	<p>2</p> <p>The operators are provided a formal education; the information is not being presented to the tourists.</p> <p>There is a need for greater communication between the industry professionals, and the tourists.</p>	<p>3</p> <p>While this site has ended the demand to hunt this species, it has the potential to be inflicting behavioral harm to the species.</p> <p>This could be mitigated through operator limitations.</p>	<p>5</p> <p>This industry is providing enormous economic benefits to the local community.</p> <p>This transition has transformed this small fishing village into an ecotourism hotspot.</p>	<p>15/25</p> <p>Overall, this industry will undoubtedly expand, and if not properly maintained could inflict serious harm upon whale sharks.</p> <p>While it has ended hunted in this area, there are potentially new problems arising.</p>
Tofo Beach	<p>0</p> <p>This industry has no current management.</p> <p>The government has not provided any limitation of operators.</p>	<p>0</p> <p>There is no current mandatory COC.</p> <p>There is a volunteer COC that is being implement by local NGOs.</p>	<p>3</p> <p>The local government has not provided an education plan.</p> <p>Although, the MMF has been educating people at this site.</p>	<p>3</p> <p>Hunting is still legal, but this industry is providing an alternative livelihood option.</p>	<p>5</p> <p>This industry is creating change in the local economy. It is projected to grow in the future.</p> <p>This industry is helping this nation transition out of poverty.</p>	<p>11/25</p> <p>Overall, this industry is young, and not managed properly.</p> <p>Although, the passionate individuals behind the local NGOs are helping this industry to progress.</p>

Chapter 5- Explanation of Matrix and Suggestions for Management

The matrix used in this analysis was helpful to determine which aspects of management are best utilized at each site. As a result of this matrix, I have crafted suggestions for management that can be potentially implemented across the globe.

Management of Industry Recommendations

It is clear after studying these three sites, that one of the most basic and important aspects of proper management is the limitation of operators. In order to do so, there must be some form of governing agency over the ecotourism industry.

In Ningaloo Reef, DEPAW is actively involved in the management of this industry. While Australia has the financial resources to have such an agency, other nations that are not as affluent may still have an opportunity to create their own agency. A program in Ningaloo Reef that could be implemented in other nations is the practice of taking a portion of ticket prices, and using it to benefit the industry. While Ningaloo Reef uses this practice to support the distribution of electronic logbooks to operators, this practice could initially be used to fund the formation of a governing organization. While this may take a while to establish, having the money to create a governing agency over *R. typus* ecotourism will be essential to creating a well-managed industry.

As observed by Holbox Island's low score in this category, just having a governing agency is not enough. This ecotourism site does have an agency regulating it, but this agency is not working efficiently to manage the growth of this site. An essential component that this site lacks is the management of licenses distributed. I have created a baseline rule that can be applied to limit the number of operators in the area.

While it may be difficult to determine the proper number operators to allow, using a ratio of one operator to 20 sharks (1:20) creates a beneficial baseline. The Ningaloo Reef aggregation is estimated to be 300-500 sharks. This ratio was crafted by dividing the lower estimate of the shark population at Ningaloo Reef (300) by the current number of licenses at Ningaloo Reef (15). If this same rule were applied to Holbox Island, the number of operators would significantly drop. While this rule may be hard to implement at preexisting locations due to the tension it might cause between operators, and government officials; it could be a precautionary baseline used at other sites that do not have an established number of operators.

Ningaloo Reef also scored very high when it came to not only limiting operators, but also making the application process intensive. The process of applying and acquiring an ecotourism license is a difficult process. The operators in Ningaloo Reef must prove that they are interested in more than just purely economic gain from the ecotourism industry. It is important that when operators apply for a license that they must state what they are going to do to preserve the natural environment that they are using for their benefit. Forcing operators to state their intentions ensures that the operators understand the importance of preserving the environment they are using.

In conclusion, each new industry site must create a governing agency responsible for sustainable tourism management. This agency must make limiting the number of operators a priority. By applying the above stated 1:20 ratio, this practice will ensure the number of operators remains at a manageable level, and mitigates the impact on *R. typus*. Finally, the last fundamental practice that must be carried over to new *R. typus* ecotourism sites is a competitive and demanding process in order to gain a license.

Code of Conduct Recommendations

The matrix also evaluated the COCs at each site. Ningaloo Reef and Holbox Island both scored high in this category. Both of these sites have a formal COC that is enforced, although Ningaloo Reef did a much better job at enforcement. A few aspects of a strong COC include: restricting the number of swimmers in the water, reducing boat speeds, restricting the behaviors of tourists while they are interacting with sharks, restricting the distance swimmers must stay from sharks, and restricting the amount of time swimmers are allowed to interact with a single shark for.

The Ningaloo Reef COC has acted as a baseline for most other sites, and I believe this is a beneficial practice for positive whale shark ecotourism. Although, I believe an addition could be made to the Ningaloo COC to reduce even further impacts at future sites. Currently, tourists are allowed to duck dive entirely under the shark, which can lead to the shark exhibiting avoidance behavior. Stating that diving under the shark is not allowed may be a helpful addition when creating new COCs. In addition, the local governments should be constantly monitoring, and modifying their COC to best suit their location. Once again finding the funding for monitoring this activity may be difficult at first, but as the industry slowly grows, so will the financial backing of the governing agency.

Overall, using Ningaloo Reef's COC as a baseline COC for new site is a beneficial practice. A few minor modifications can be made to increase the effectiveness of this COC, but overall it encompasses most interaction aspects. While adaptations will need to be made to cater to the demands of the new ecotourism site, Ningaloo Reef's COC has tremendous benefits for *R. typus*, and for the tourists.

Education Recommendations

The third category this matrix evaluated was the level of education at each site. Educating the staff members ensures that the staff members are aware of the importance of their profession. Moreover, it educates the operators who generally have no previous knowledge about the *R. typus* species. Again Ningaloo Reef scored very high in this category. The education plan at the Ningaloo Reef site is doing a great job educating the staff members and the tourists. The local government has the resources to educate staff, and make them take a mandatory course on whale shark ecotourism.

Although other locations may lack the resources to provide a comprehensive education plan, I think it is vital that a small portion of ticket prices be taken out, and placed towards the education of industry professionals. The staff members are the individuals who have the greatest impact on the tourists. The staff must be properly briefed on *R. typus* and the industry, or else the industry may be at great risk. Ningaloo Reef has a fairly simple, and cheap method of educating staff members, that proves to be very effective. Once again using Ningaloo Reef as a baseline would eliminate some of the start-up costs for upcoming sites. Minor adaptations to the education plan that is presented at Ningaloo Reef could prove to be effective in other nations.

One important aspect that should be included in the education plan is an emphasis on why conservation is vital at growing ecotourism sites. While this point may be redundant in Ningaloo Reef where the industry has been prospering for years, it is very important to state in nations where the ecotourism industry is new. In addition to the emphasis of conservation in the education process, a second important aspect to include in the education plan of staff members is language proficiency.

The low score of Holbox Island in this category is the result of staff members that may be educated on the topic of *R. typus* ecotourism, but are unable, or uncomfortable with passing information along to tourists, due to language barriers. If there is a palpable disconnect between the staff members, and the tourists, it can put the integrity of the entire ecotourism site at risk. This is observed in Holbox Island where the operators are educated, but there is a struggle to pass on information to tourists. This leads to tourists disregarding the COC, and other regulations. The central method to ensuring a well-managed industry lies in a focus on staff member education.

Although Tofo Beach does not have a formal education system, this site scored higher than Holbox Island because of the dedication of local NGOs. This site does a very effective job of educating people who want to listen. The local NGO, MMF, hosts nightly talks about *R. typus* information to the public. While this is currently a voluntarily talk, most of the tourists that come to Tofo Beach want to learn about marine wildlife in addition to interacting with the local wildlife. Therefore, this site demonstrates how even a small group of very dedicated individuals can create a big change, as far as the amount of education that is reaching tourists.

In conclusion, the education plan that is in place at Ningaloo Reef acts as an ideal education strategy for other sites. While this education plan may be costly to implement at upcoming ecotourism sites initially, overtime these industries will create a foundation and be able to support the costs of staff education.

Conservation Implications

The category of conservation implications may be the most important when considering it is the factor that leads to the longevity of an industry. All three sites scored

relatively high in this category, as I found they each benefited the conservation of *R. typus* in their own way. Ningaloo Reef scored the highest, as this site is actively setting, and accomplishing goals of conservation. Due to the length of time this industry has been established, it provides other sites with data about *R. typus* conservation.

The logbook system, which has been implemented in Ningaloo Reef, demonstrates how ecotourism operators can contribute to research on *R. typus*—which is a fundamental aspect to helping conserve, this species. In addition this industry supports active research as some of the ecotourism vessels in this location are doubling as research vessels, this is true for vessels at other sites as well. Active research is a vital component to contributing to conservation, because so little information is understood about this species.

While research is a fundamental aspect of the promotion of conservation efforts, one of the most difficult aspects of conservation is fundraising. The practice of taking a portion of ticket prices, and putting it towards conservation efforts is one practice at Ningaloo Reef, which should be implemented at other sites. This practice allows operators to make money, and governing agencies to have the proper funding to persist. In addition, it is important to inform tourists that this practice is occurring. After having the experience of swimming alongside the largest fish in the sea, most tourists are happy to hear a portion of their money spent is put towards helping this species.

Holbox Island also scored fairly high in this category as well. This industry has created a transitional economy, and this new economy is benefiting from the preservation of *R. typus*. Holbox Island's transition from a fishing community, to an ecotourism community has lead to the end of fishing at this site, and the promotion of conservation

measures. This site has also adapted many of Ningaloo Reef's conservation measures, such as logbooks—which continue to be a positive practice that should be implemented at all new ecotourism sites. Tofo Beach is similar to Holbox Island, as this community is shifting from hunting *R. typus* to swimming with them.

It is vital to continue to research the implications this industry is having on the sharks. Although it is important to consider, the formation of these ecotourism industries is bound to happen, because so much money can be made. While it can be argued that these sites are educing harm upon these species, it is more practical to mitigate the conservation implications, rather than argue against the formation of these sites.

Each site is making an effort to preserve this species, whether the incentive to do so comes from the potential economic gains that can be made, or a greater understanding of the importance of conservation. In either case, all sites are exhibiting some from of conservation practices. While these sites have the potential to harm sharks, and disrupt their natural ecology; in many cases, the formation of these industries is saving sharks from the direct harm of hunting.

Socio-Economic Recommendations

At all sites, the score given to the socio-economic category was high. It is clear that this industry can bring in enormous amounts of money. With the global *R. typus* ecotourism industry valued at US\$66 million, the ecotourism sites associated with shark aggregations have the potential to gain mass amounts of money from these sharks. At each site, the aggregation of these sharks provides the chance for the local community to transition towards non-consumptive resources use, and gain financial benefits in return.

Chapter 6- Further Research and Conclusions

Overall the aim of this study was to examine three *R. typus* ecotourism sites in depth, and extrapolate management ideas, and strategies that could be used across the globe at upcoming *R. typus* ecotourism sites.

Limitations

This study was limited due to the fact that I have only been to one of these study sites, therefore my personal experience as a researcher is limited. In addition, the amount of literature on this topic is limited, specifically at some of the newer ecotourism sites. Therefore, the amount of information that was gathering was limited due to the constraints of this project.

Conclusions

Overall, I believe the *R. typus* ecotourism industry can serve as a beneficial practice across the globe. While we as humans may be increasing the amount of time we interact with this species, it is the natural progression. Through the use of science, and technology we now have the ability to interact with this amazing species. These advances will undoubtedly increase the amount of interaction time spent between sharks, and humans. While some may view this interaction as humans imposing themselves on the shark's natural environment, one has to accept that humans are going to continue this practice. In order to move forward, and promote *R. typus* conservation; it is essential to analyze, and create proper management strategies.

Although, there is a large focus on the economic gains that come from this industry, as newer industries develop the need for more conservation-minded thought will have to be taken into consideration. If these upcoming sites want to increase the longevity

of their industries, they will have to recognize that the conservation of this species, and other marine animal species is the most important factor. While *R. typus* proves difficult to manage, as it is a global migrant, our actions as humans at these aggregation sites have the potential to help safeguard this species' population.

List of Acronyms

CALM – Conservation and Land Management

CITES - Convention on International Trade in Endangered Species

CMS- Conservation of Migratory Species of Wild Animals

COC – Code of Conduct

CONANP – Comision Nacional de Areas Naturales Protegidas

DEC - Department of Environmental Conservation

DER - Department of Environment Regulation

DPAW - Department of Parks and Wildlife

ECZ - Exclusive Contact Zone

FAD- Fish Aggregating Device

ICUN - International Union for Conservation of Nature

MMF – Marine Megafauna Foundation

NGOs – Non-Governmental Organizations

PAT - Pop-up Archival Tags

R. typus - Rhincodon typus

UNCLOS - United Nations Convention on the Law of the Sea

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