The impact of whale shark (*Rhincodon typus)* tourism in Quintana Roo, Mexico

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Kanina Harty graduated with a Masters in Marine Environmental Management from the University of York, UK. This paper was developed from research completed for her dissertation while studying. Working on projects involving elasmobranchs, other marine animals and environments worldwide has installed a dedication to discover better practises to benefit all concerned. Marine conservation and sustainability that benefit local communities are the main areas of focus and she would like to progress further and undertake a PhD in these areas in the future.

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Whale shark (*Rhincodon typus*), tourism numbers in Quintana Roo state, Mexico have increased from 1,500 to over 80,000 tourists per year in 14 years, attracted by the promise of an in-water experience with these charismatic megafauna. The rapid expansion of this tourism has encouraged bad practices in and out of the water, with reduced economic benefits for the local operators and increased impacts upon the behaviour of *R. typus*. This study investigates these impacts on *R. typus* and the tour operators; assessing the implications for the future sustainability of the industry through questionnaires, interviews and participant observations. Due to *R. typus* aggregations outside of the Whale Shark Biosphere Reserve, authorities were unaware of the true extent of collectively awarded permits. It was believed a total of 280 permits were granted, but this number was closer to 460 for one season. The regulations for interactions with *R. typus* were clear, but lacked enforcement. This study discovered that further research into how much revenue this tourism creates is essential to fund sufficient regulation, conservation and reinvestment to benefit local communities. A mandatory fee should be introduced to partake in *R. typus* tours, and an acceptable number of permits allocated for future sustainability.

Keywords: Mexican Caribbean; sustainable marine tourism; Isla Mujeres; tourism management; elasmobranch; Yucatan

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Introduction

The whale shark (*Rhincodon typus*) is the largest living fish in the world found in warm and temperate waters worldwide (Dando, Ebert & Fowler, 2014). Unlike predatory sharks, they move slowly, are planktivorous, and may reach up to approximately 20 metres in length (Dearden, Topelko & Zeigler, 2007; Rowat & Brooks, 2012). Found throughout tropical and temporal locations worldwide, in the open ocean and coastally, the sporadic presence of *R. typus* means that many aspects of these animal's lives still remain poorly defined (Colman, 1997). Most aggregations are seasonal and many coincide with fish or coral spawning events (Rowat & Brooks, 2012). Juvenile and sub-adult *R. typus* are known to aggregate seasonally in many coastal locations in the tropics; e.g. Seychelles, Djibouti, Mozambique, Western Australia, and Quintana Roo state, Mexico, where this study took place.

The convergence of currents, where the Caribbean Sea and the Gulf of Mexico meet, drives seasonal zooplanktic blooms from May to September comprised of 95% fish eggs (Cárdenas-Palomo, Herrera-Silveria, Noreña-Barroso, Galván-Magaña & Reyes-Mendoza, 2016; Cárdenas-Palomo, Herrera-Silveira, Velázquez-Abunader, Reyes, & Ordoñez, 2014). These productive waters support an unprecedented aggregation of *R. typus* off the coast of the Yucatán Peninsula during these months (Figure 1) (de la Parra-Venegas *et al.*, 2011; Remolina-Suárez *et al.*, 2007). [Figure 1 near here] Aerial surveys have recorded 420 individuals in an area of 18km^2 in a single day (de la Parra-Venegas *et al.*, 2011). These nearshore feeding aggregations, non-threatening behaviour and the slow swimming speed of *R. typus* make this the ideal location for in-water encounters with this species (Gallagher & Hammerschlag, 2011).

R. typus was reclassified as "Endangered" by the International Union for Conservation of Nature's (IUCN) Red List of Threatened species in July 2016; an upgrade from "Vulnerable"

since the last assessment in 2005 (Pierce & Norman, 2016). Threats, including an increase in fishing capacity worldwide, has caused an upsurge in sharks as bycatch (Dulvy *et al.*, 2008), while increased demand for shark fin soup in Southeast Asia has resulted in concentrated fishing effort on sharks, severely depleting global populations of many species (Whitcraft *et al.*, 2014; Topelko & Dearden, 2005; Cisneros-Montemoyer, Barnes-Mauthe, Al-Abdulrazzak, Navarro-Holm, & Sumaila, 2013). It was recognised that the threat of directed fisheries, shark finning and other anthropogenic threats has led to an estimated 40-92% decline of *R. typus* worldwide, with 63% reduction in the Indo-Pacific and ≥30% in the Atlantic (Pierce and Norman, 2016). Due to the majority of *R. typus* populations located in the Indo-Pacific, the global classification of "Endangered" was discovered to best suit the species. *R. typus* are monitored under Appendix II of Convention on International Trade of Endangered Species (CITES) with the aim to ensure control of the trade of *R. typus* parts globally (CITES, n.d.). Based on worldwide preservations *R. typus* are protected in Mexican waters under bill NOM-059-SEMARNAT-2010 (SEMARNAT, 2015).

There has been a steady increase in demand for those seeking thrilling interactions with these charismatic megafauna since the 1990s (Topelko & Dearden, 2005). An estimated 590,000 shark watchers expend >USD 630 million per year globally and in 15 years it's predicted to rise to approximately USD 780 million to exceed that of global landed catch of sharks (Cisneros-Montemoyer *et al.* 2013).

Off the coast of Quintana Roo, Mexico, fishermen have encountered *R. typus* for years but only brought it to the attention of scientists studying these animals in 2002. Thereafter *R. typus* tourism started to flourish with the first few boats beginning to operate in the region in 2003 (de la Parra-Venegas *et al.*, 2011). Originally *R. typus* were found in an area north of the island of Holbox, leading to the introduction of the Whale Shark Biosphere Reserve (WSBR) in

2009 (Figure 1). The reserve was created to improve conservation and management (de la Parra-Venegas *et al.*, 2011), however it wasn't until 2006 that *R. typus* were observed in an area outside of the reserve, locally known as "Blue Water" or "Afuera" (meaning "outside" in Spanish), where the largest proportion of sharks are now sighted during the season.

Many fishermen have diversified into *R. typus* tourism, transitioning away from local fisheries during the Mexican Caribbean *R. typus* season. These fishermen are known to earn a very small profit in comparison to the large companies that are understood to monopolise the market (Experienced guide, personal communication, 2016; Ziegler, Dearden & Rollins, 2016). The majority of individuals questioned in this area lacked essential tourism experience and knowledge, and were not sufficiently fluent in other languages to cater to the wide variety of tourists visiting the area in order to compete with the bigger businesses (McKercher & Robbins 1998; Ziegler, Dearden & Rollins, 2011). One experienced *R. typus* guide (Experienced guide), with five years of work experience in the study area, explained that they personally, along with many individuals from other parts of Mexico and around the world, travel to the area to specifically work during the *R. typus* season attracted by the potential of a higher than average income (Experienced guide, personal communication, 2016).

Previous research in the study area has primarily concentrated on the presence and distribution of the *R. typus* (Cárdenas-Palomo *et al.*, 2014; Hueter, Tyminski & de la Parra, 2013, de la Parra-Venegas *et al.*, 2011), the satisfaction of tourist experiences (Zeigler *et al.*, 2011; Mimila-Herrera, Trujillo-Córdova, Cárdenas-Palomo, & Reyes-Mendoza, 2016), perceived crowding and contact with *R. typus* in Holbox (Ziegler, Dearden & Rollins, 2016), *R. typus* behaviour with tourists (Trujillo-Córdova, Cárdenas-Palomo, Mimila-Herrera, & Reyes-Mendoza, 2016) and research and conservation status in the Western Caribbean (Graham, 2007). However, the majority of *R. typus* tourism takes place outside of the previously studied

areas, few studies have investigated the impact of *R. typus* tourism in recent years (Graham, 2007; Remolina-Suárez *et al.*, 2007; García-Rivas e*t al.*, 2016) and many investigations have not utilised information directly from government representatives.

The aim of this study was to evaluate the potential impacts of *R. typus* tourism in and around the island of Isla Mujeres through questionnaires, semi-directive interviews and participant observation investigations.

Methods

The island Isla Mujeres, off the coast of the Yucatán peninsula (Figure 1), was identified as the best location from which to base this study. Tour operators are located on Holbox Island in the north to Playa del Carmen 70km south from Cancún (Figure 1). This study identified Isla Mujeres as central to *R. typus* activities, the most accessible to the *R. typus* aggregation sites, enabled access to respondents in Cancún, but most importantly, the majority of tour operators and boat captains live and work from the island. A combination of data collection techniques involving questionnaires to tour operators, semi-directive interviews and participant observations, were identified as the best way to obtain the greatest understanding of *R. typus* tourism at this location during the time limitation (Sáenz–Arroyo, Roberts, Torre, & Carino-Olvera, 2005). The *R. typus* season is officially between 15th May and 17th September (SEMARNAT, 2015).

Structured questionnaires (Appendix A) were conducted during the height of the season over a five week period in June and July 2016. Traditional ecological and anecdotal knowledge from *R. typus* tour operators, boat captains and crew were used to determine the scale of operations in the area as these individuals were deemed the best informed about

actual practices that take place during *R. typus* tours, they are in the *R. typus* area almost every day and some have over 40 years of experience in this region and in the sea in general (Johannes, Freeman, & Hamilton 2000; Drew, 2005). Table 1 illustrates the themes addressed by each question in the survey. [Table 1 near here]

Potential respondents were selected opportunistically at known tour departure piers and asked to respond to a questionnaire for their anecdotal knowledge of the *R. typus* tour industry in the local area. Respondents were informed of the goals of the study and provided verbal consent before the questions were performed. Closed and open questions were presented to the respondents at various locations around Isla Mujeres and Cancún, to maximise responses to the research themes.

To ensure a response and guarantee consistency, all face-to-face questionnaires were asked by a single native Spanish-speaking interviewer. This approach was favoured as the best way to gather traditional ecological and anecdotal knowledge, explanation of questions, encourage a dialogue and gain more information (Huntington, 2000). The questionnaires were translated from English to Spanish and the responses translated back to English by the same individual.

The term 'tour operator' refers to organisations that market and organise the tours for guests, 'boat captain' refers to a licensed captain navigating the boat, and 'crew' are deckhands and/or guides working on the boat. Four of the larger tour operators from Cancún and Playa del Carmen were contacted via email, although only one response was received. Companies or tour operators not offering *R. typus* tours were excluded due to the time restrictions in the field.

Semi-directive interviews with government officials, experienced *R. typus* tour guides and knowledgeable *R. typus* experts were also conducted to produce a more in-depth study

(Appendix B). Officials in charge of the protected areas gave insight into the permit system, regulations and plans for the future (Huntington, 2000). Interviews with experienced *R. typus* tour guides were also conducted, as freelance workers they have had years of experience with different operators and captains. The option of anonymity was given, so a pseudonym was assigned to those who wanted to remain anonymous.

Management documents were examined and legislation and guidelines were compared with actual practices based on responses from interviews, questionnaires and participant observations. Assessments of these elements can help inform better management strategies and encourage the industry to follow important regulations to exploit this resource sustainably (Graham, 2007).

Four Participant Observations were made to gain insight into how the tours function (Newing, 2011). Observations were conducted of how the tour guides performed, interactions of tourists and guides with *R. typus* present and if participants followed regulations.

Contact was made through email and face-to-face interviews with experts regarding their invaluable knowledge on key issues with regards to *R. typus* and shark tourism globally. Extensive internet searches were performed with the use of Google and Google Scholar search engines with key terms: “whale sharks”, “whale shark tourism”, “whale shark Yucatan” and “Mexican Caribbean whale sharks”.

A literature review of grey papers was carried out to identify existing published and unpublished papers regarding *R. typus* tourism practices in the Caribbean Sea and globally.

Analysis

Microsoft Excel and statistics software R (version 3.3.1) were used for data recording and descriptive statistics.

All prices and profits are shown in United States Dollars (USD). Exchange rates were obtained from www.xe.com on 9th August 2016 and in all cases, Mexican Pesos (MXN) were converted to USD at MXN18.40 per USD rate (xe.com, 2016).

Results

Questionnaire

Of a total of 100 individuals approached, 74% completed the questionnaire. Reasons for refusing to complete the survey given were: they had previously completed this questionnaire, they didn't want to be associated with answers that may incriminate them, research fatigue, and they felt that their opinions would not be considered or acted upon. Average age of respondents was 39 years old (range 18-80) and the majority of respondents (97%) were male.

On one occasion, in response to the questions '*How much money do you make per trip?*' and '*How much money do you make per season*?' the interviewee reacted angrily.

Table 2 demonstrates the responses to closed questions from the questionnaire. When asked '*How long have you worked in tourism?*, the responses ranged from two months to over 40 years. The average was 15 years in tourism in general and 8 years working within the *R. typus* sector. [Table 2 near here]

A total of 84% (n=62) of respondents that answered the question '*Have you noticed a change in tourism since you started?*' said that there had been a change. Those that went on to answer, *'How has it changed?*', 11% noticed an increase in the number of boats, 10% the number of tour agencies, 3% the number of tour operators and 76% (n=46) believed there was an increase in all three changes.

When asked, *'Are the changes in whale shark tourism having positive or negative effects?'* 51% said it was negative, 31% said positive and 18% claimed that there were pros and cons to the tourism. Figure 2 exhibits that all age ranges believe that there are more negative than positive effects. [Figure 2 near here] The main positive effects identified were that tourism generated jobs and money. Negative effects were too many permits leading to too many boats on the water; negative impacts to *R. typus*; the surrounding area is also impacted; an increase in tour operators means that tours are cheapened; and money doesn't benefit the local tour operators as the larger agencies from Playa del Carmen and Cancún have a monopoly and are acquiring a disproportionate profit.

The zones that were most visited were never solely within the WSBR (Green Water) (Figure 1) only "Afuera" in Blue Water (61%) or in both areas (39%).

The questions, *'Do you keep a record of the trips (tourists/crew/location)?'* and *'Could we have access to those records for research purposes only?'* were proposed solely to discover if records were kept and if the respondent would be open to freely share this information. A total of 82% (n=56) said they or their company kept records and 70% said they would be willing to share these data. One respondent specified he would share this information if we agreed not to show it to the government.

The questions, '*How much money do you make per trip?*' and '*How much money do you make per season?*' caused some confusion. Some gave the price an individual tourist paid, some the price for a full boat of tourists, some their income and some the profit they made. From the answers that concerned profit, the average income for a captain is USD43.5 per boat per day. Income per season can be estimated using this formula:

USD 43.5 per day * 100 days per season = USD 4350 per season

(The season was 124 days. Allowance of 24 days were removed to allow for days the port could be closed due to seasonal weather conditions)

This equation omits the money made from tips. Experienced guide (personal communication, 2016) claimed that they made more money from tips than from a salary, stipend or percentage of takings.

Almost all respondents (95%) claimed the location of the *R. typus* aggregation was completely safe due to a combination of training and experience. All staff (100%) had been given some sort of training that included First Aid, mandatory boat and rescue courses or ecology and tourism courses. This training has been supplied since 2004 (Remolina-Suárez, 2007).

Whilst in-field collecting responses from the respondents there was only one occurrence when a company was observed giving a dedicated briefing outlining safety, conservation and interaction practices while participating in a *R. typus* activity. Guides have been known to verbally brief the tourists in the vehicle while travelling to the departure pier from other locations (Experienced Guide, personal communication, 2016) but the information offered during the briefings can vary (Ziegler *et al.*, 2011). Mimila-Herrera *et al.* (2016) discovered that almost 31% of tourists had not received any guidance regarding the rules when on the tour and that almost 44% of those who did receive information, said that they had already boarded the boat when briefed.

Only 30% of respondents said they had seen or heard of accidents involved with *R. typus* and 11% with tourists. This included *R. typus* coming into contact with tour boat propellers and cuts to fins, and unaware tourists colliding with *R. typus* and falling off boats.

During one interview with one respondent, when asked whether he had witnessed any accidents his captain advised us not to ask about accidents, “Accident is the forbidden word”.

A total of 67% thought that *R. typus* tourism should be regulated by the government and associated government entities.

Figure 3 shows that more respondents said that they think that *R. typus* tourism can continue as it is (63%). [Figure 3 near here] It’s important to highlight that there were only three respondents in the ≥60 age range and that only 29% of 20 – 29 year olds thought that it couldn’t continue the way it is.

An ANOVA showed that there was no significant relationship (a significant relationship was determined when $p \leq 0.05$) between the age of the respondent and any of the following responses when asked: *“How has it (tourism) changed?”* ($p = 0.228$), *“Is it a positive or negative change?”* ($p = 0.452$) and *“Do you think that whale shark tours/tourism can continue in this way in the future?”* ($p = 0.678$).

Table 3 shows a summary of issues respondents believe need to be addressed for *R. typus* tourism to continue in the future. There were 15 mentions of a need for more regulation, and that organisation of *R. typus* tourism needs to change. [Table 3 near here]

Table 4 shows respondents’ (n=35) main issues with regards to additional comments. Respondents mentioned that too many permits were given resulting in too many boats in the *R. typus* area, large companies have the monopoly and other unlicensed boats (“pirates”/ “vigilantes”) come into the area unauthorised and it is unfair. There were also comments that the excessive number of boats and tourists can cause stress to the sharks and they may never return. [Table 4 near here]

There were 14 questionnaire respondents who were concerned that when the sharks feel harassed or are injured, then they may decide to go elsewhere, not return to the area or

disappear entirely. *R. typus* researcher Dr. Simon Pierce believes that this will never be the case, as long as there is a large abundance of food the *R. typus* will return.

Of all the respondents who answered the questionnaire 58% gave their name and 47% their contact details. Those respondents that didn't share their details commented that they didn't want their identity associated with any repercussions regarding their answers.

Interviews

The government entity that looks after the natural protected areas including the WSBR (Figure 1) is the National Commission of Natural Protected Areas (CONANP). CONANP work alongside DGVS (Director General of Wildlife) and they both report to the Secretariat of the Environment and Natural Resources (SEMARNAT) in Mexico.

For the 2016 season, a cost-free boat permit was required to conduct *R. typus* tours. This permit restricted the holder to one visit every other day to *R. typus* sites. These permits were introduced to control boat and tourist numbers, however it is widely known that many boats visited the area daily (Management Official 1, personal communication, 2016). An interview was conducted with a management official from CONANP (Management Official 1) with experience working in the WSBR and the adjoining marine and terrestrial national park (Yum Balam) (Figure 1). Management Official 1 revealed that CONANP authorised 160 permits for the 2016 season and were aware that DGVS had authorised an additional 120 permits to total 280 permits. Table 5 shows that Management Official 1 was ill-informed regarding the actual quantity of permits awarded by DGVS. [Table 5 near here] An informed source (Anonymous, personal communication, 2016) confirmed that DGVS alone had been authorising between 243-301 permits for at least the four seasons prior to 2016, and between 403-461 permits in total. The permit from the DGVS allowed tourism activities in the area

outside the WSBR, as long as the holder provided a non-extractive service, e.g. refrained from fishing as an activity (Remolina-Suárez, 2007). Due to the sharks being sighted outside of the WSBR for the majority of the season, it was more popular to obtain a *R. typus* activity permit from DGVS because they didn't have to abide by the restrictions/rules of the WSBR when in Blue Water (Figure 1). Despite not knowing the true extent of the permit allocation, Management Official 1 was aware that there were too many boats in the area and explained CONANP and DGVS have previously tried to come to a joint management agreement to restrict the number of permits but an agreement had never been reached.

In December 2016, Mexican President Enrique Peña Nieto announced that Mexico will create a 5.6 million hectare reserve that will incorporate the entire Quintana Roo coast, south to the Belize border (CONANP, 2016; IUCN, 2016). The new Mexican Caribbean Biosphere Reserve (CONANP, 2016), will bring together all of the existing National Parks under one legislation.

Management Official 1 stated that the existing WSBR and the adjacent Yum Balam National Park, in August 2016, had four rangers to monitor and patrol 140,000 hectares (SEMARNAT, 2015) and 154,000 hectares (Poot-Balam, 1998) respectively and that the number of personnel staff had been cut in 2016. Management Official 1 specified that even though it had been difficult to regulate the areas already controlled by CONANP, the new reserve would mean that the same, stricter regulations could apply to the whole area including "Blue Water".

Management Official 1 claimed that a larger reserve would not automatically mean that there will be extra permits. They explained that researchers in the area are often disappointed about decisions made by the government but these researchers are reluctant to share their research findings, "…there are pictures and videos (but) …there is no viable analysis

that allows us to improve knowledge for smarter decisions. I'm not saying that this information doesn't exist" (Management Official 1, personal communication, 2016).

Another management official (Management Official 2) interviewed, believed that there were approx. 30,000 tourists per season. Aerial footage acquired of an instance, in August 2016 (Figure 4) demonstrates the presence of 100 boats and 249 sharks. [Figure 4 near here]

Using the aerial footage and making a more conservative average daily boat density estimate (80 boats), the potential tourist capacity per season could be greater than 80,000 using the following formula:

80 boats * 10 passengers * 100 days per season = 80,000 tourists per season

(The season was 124 days. Allowance of 24 days were removed to allow for days the port could be closed due to weather conditions)

While more detailed assessments of daily boat traffic to the *R. typus* area are necessary to determine true annual tourist visitation, this coarse calculation is more in-line with the over 100,000 visitors' estimate that Mimila-Herrera *et al.* (2016) made for the 2014 season. Both estimates are dramatically higher than the approximate 30,000 capacity estimated by management official 2 and García-Rivas *et al.* (2016) for 2012.

One question regarding *R. typus* tourism revenue, "*Do you know how much money whale shark tourism makes for this area?",* didn't encourage a confident response as unfortunately reliable information regarding the economic value of *R. typus* tourism is difficult to acquire or estimate. Management Official 1 explained that "it is impossible" to estimate, as many operators are dishonest about profits, some take tourists out every day instead of the

permitted every other day and there was no incentive or consequence to follow this regulation or to declare profits. Tour operators are required to declare their earnings at the end of the season, but due to habitual evasiveness these reports are not used as an accurate indication of revenue (Management Official 1, personal communication, 2016). Interviews with officials demonstrated that the government had no idea how much the *R. typus* industry brings to the area.

Participant observations

Every *R. typus* tour boat has an informative infographic poster that outlines the rules when on the tour and how to interact with the animals in the water (example Appendix C). Some points these posters stipulate are: that only biodegradable sunscreen is permitted, no touching of the sharks and to keep a distance of at least 2.5m away.

During participant observations, rules and regulations for the *R. typus* area were frequently broken by tour operators, and a number of dangerous situations for both sharks and tourists were observed; practices previously identified by Remolina-Suárez *et al.* in 2007. On more than one occasion, boat manoeuvres which intentionally and unintentionally obstructed the path of a number of *R. typus* and boats getting too close to sharks and tourists, were observed. However operators reported to authorities shown to be violating regulations or ignoring safe practices are not penalised and are only advised by authorities with no further action taken (Management Official 1, personal communication, 2016; Management Official 2, personal communication, 2016).

The expectation of a high number of sharks means that the same number of boats enter the area even when there are fewer sharks. One personal observation during a visit to the *R. typus* site demonstrated the presence of 42 boats and 23 people around a single shark

in one instance. Figure 5 shows at least 18 individuals (circled) in the water with a single *R. typus*. [Figure 5 near here] In other instances, as illustrated in figure 4, there are many sharks and the boats are spread out and not so intrusive as to impact the sharks' behaviour or tourist experience.

Participant observations showed evidence of boat or propeller strikes to the body and dorsal fins of numerous sharks (Figure 6). [Figure 6 near here] Government officials do not attribute these injuries to the presence of tour boats. Management Official 1 believed that the industrial container ships are responsible for injuries and there was no way to control the movement of sharks or influence the location of international shipping lanes. Pierce (personal communication, 2016) believed that the size of the scarring and other injuries observed on *R. typus* suggest a vessel much closer in size to tour boats than container ships. Unfortunately there is no evidence to identify that one particular type of boat is responsible for the injuries.

Discussion

The results highlight a distinct lack of cohesion between the stakeholders, government and departments within the government. The respondents to the questionnaire highlighted questionable practices in the *R. typus* tourism industry that were found to be common knowledge in the region, even to the government enlisted to monitor and control the *R. typus* industry in Quintana Roo.

This study was limited by the two months that researchers were available. A study for an extended amount of time and at additional locations (e.g. Holbox) could encourage more cooperation and a wider variety of participants. All three research methods have previously been used in this area: questionnaires (Ziegler *et al.*, 2011), semi-directive interviews (Velez *et al.*, 2014) and participant observation investigations (Velez *et al.*, 2014). However

questionnaire participants and semi-directive interviewee responses can be restricted by the rapport the interviewer created over a short period and by the responder's opinion in that instant (Velez *et al.*, 2014). Drawbacks with using these methods are that participants may have been ill-informed, based their response on opinion rather than fact, and topics could be missed or not further explained (Patton, 2015).

The main concerns raised by questionnaire respondents were that too many permits were allocated, hence too many boats in the water, and the monopoly of the larger tour operators. The 2016 season had an abundance of sharks, but previous seasons have seen boats queuing to interact with *R. typus* (Experienced guide, personal communication, 2016), therefore restrictions are essential to combat overcrowding and negative impact to the sharks. Ziegler *et al.* (2011) suggested that approximately 60% of licences were utilised by 3-4 of the largest tour operators and that there was discussion of a licence cap of 140 during the 2008 season. Many tour operators have not followed the rule that they should operate every other day as they disagree with the restriction (García-Rivas *et al.*, 2016). It has been suggested that to prevent overcrowding, no more than 160 boats should be present per day and there should be visual patrols to ensure the regulations are adhered to (García-Rivas *et al.*, 2016).

The issue of overcrowding isn't an everyday occurrence, but it's not rare either (Ziegler *et al.*, 2011). Previously studies have identified that the majority of tourists (70%) enjoyed their experience due to the large quantity of the *R. typus* interactions (Mimila-Herrera *et al.*, 2016). Of *R. typus* tour participants interviewed in 2008, 96.2% enjoyed their proximity to the sharks and 82.8% the number of sharks encountered during the tour but less than a quarter (23.4%) agreed that they were dissatisfied with the number of boats at the *R. typus* site (Ziegler *et al.*, 2011).

CONANP believed that DGVS authorised 120 permits in 2016 (Management Official 1, personal communication, 2016), but this number was grossly underestimated by the allocation of 301 permits by DGVS for this season to total 461 (Anonymous, personal communication, 2016). Respondents claimed that they had never solely conducted tours within the WSBR during the season. Tour operators either focused tours outside the WSBR in Blue Water (61%) or visited both areas (39%). Prior to this study CONANP has previously had little jurisdiction outside the WSBR and owners of DGVS permits only had to abide by the rule that they were partaking in non-extractive practices. They didn't have to officially follow restrictions imposed by permits from CONANP when within the WSBR (Management Official 1, personal communication, 2016). The lack of transparency between entities and the difficulty to obtain official permit data suggest secrecy or a need to conceal information.

The creation of the Mexican Caribbean Biosphere Reserve with the knowledge that there has been a lack of resources for existing reserves (Management Official 1, personal communication, 2016) could be counter-productive as there are many historical issues on the Quintana Roo coast that will influence management and raise questions as to how this area will be regulated (mexiconewsdaily.com, 2016). For example, in the adjacent town of Puerto Morelos (Figure 1) the local anthropological population has risen from 80 in 1950 to 12,000 in 2006; the number of visitors and hotels has risen three-fold from the years 1998 to 2005 which has had an extremely detrimental effect on local terrestrial and marine ecosystems through the lack of infrastructure and sewage systems (Rodríguez-Martínez, 2008). This rapid increase in people and lack of planning and management is indicative of the trend along the coastal region of Quintana Roo (Smardon & Faust, 2006). The government has also been known to misdirect the fees collected for the management of the MPA at Puerto Morelos and there is evidence of inadequate regulation enforcement (Rodríguez-Martínez, 2008). The introduction

of the larger national reserve sounds positive but it is not yet fully understood what level of protection or restrictions will be put in place. The response from Management Official 1 suggests that the larger marine park will ensure that CONANP will have more control over the areas where *R. typus* are found (including "Blue Water") and DGVS will not have the authority to contribute to permits. It could also mean that CONANP and DGVS will have to come to an agreement as it is not yet determined if a single entity or a number of organisations will have jurisdiction (Experienced guide, personal communication, 2017).

It was remarkable to discover that the government had no idea of how much revenue *R. typus* tourism could be worth to this region (Management Official 1, personal communication, 2016; Management Official 2, personal communication, 2016). It is essential to find out how much the industry brings to Quintana Roo as it can help with management, planning and maybe direct a portion of the revenue to fund better enforcement for sustainability.

At the end of August 2016 authorities called all captains, guides and crew, on Isla Mujeres to a meeting to discuss how to proceed for the rest of the season. To reiterate already existing regulations, guides without a deckhand licence were told that they shouldn't take tourists in the water and no alcohol allowed on the boat in case the captains are tempted to drink, to name a few issues (Experienced guide, personal communication, 2016). Concerned parties are already aware of these rules which many are reluctant to follow (Ziegler *et al.*, 2011). This was confirmed by Experienced guide, "the rules are very clear but many just don't follow them. Some do but most don't". The meeting was in direct response to the release of a video on social media that showed numerous people around one *R. typus*. Management Official 1, aware of this posted video, commented, "Why did they have to wait until these kinds of things are published to do things properly?".

A study by Trujillo-Córdova *et al.* (2016) failed to determine whether *R. typus* behaviour is negatively affected by the general presence of tourists in the water. Participant observations indicate that the sharks move faster in the water when there are many snorkelers present and are reluctant to "bottle" feed (where *R. typus* feed vertically in the water). Observations also showed that boat manoeuvres are used to obstruct the path of the *R. typus* to slow them or divert their path for better access for the guests.

There is not only the threat of boat traffic but the noise pollution too. A study by Topelko and Dearden (2005) stated that there was evidence that predatory sharks can become conditioned to the sound of approaching boats that use bait resulting in tourism boats being associated with food and sharks being attracted to their presence. Anecdotal evidence in Qunitana Roo suggests that this may be happening in the reverse with *R. typus*. Experienced guide stated that, "at the end of the season I believe they hear the boats coming and just go deeper". Several other boat captains commented that the sharks were swimming at depth later in the season and were reluctant to spend much time at the surface during the final weeks of the season. More research would help quantify if this is the case or that the food is no longer close to the surface.

Commercial traffic in the Quintana Roo area could be a greater threat to *R. typus* than previously identified. Figure 7(b) illustrates the density of industrial shipping and its proximity to the *R. typus* area in the region. Dr. Al Dove disclosed that he had contacted Cruise Line Industry Association (CLIA) to create awareness for this issue but CLIA had claimed that their cruise ships were only in the aggregation areas pre-dawn and post-dusk so avoid prime feeding times (Dove, personal communication, 2016). This suggests that the main threat could be strikes from container ships. [Figure 7 near here]

The Ningaloo Reef Whale Shark Management project in Western Australia, was recommended as a good example of *R. typus* tourism. It has very stringent controls and is thought to be one of the best for tourists and sharks in the world. The main stipulations Ningaloo tour operators have to follow are: only one vessel per shark, at a minimum distance of 30m; this first boat has to raise a flag and all other boats have to move 250m from the encounter; each boat has no more than 90 minutes in proximity to the shark; and the visitors have no more than 60 minutes in the water with the shark (DPaW, 2016). To highlight the main differences between Ningaloo and Quintana Roo: only 15 licenses were authorised in Western Australia with an estimated population of 279-589 individual sharks (Rob & Barnes, 2015). In Mexico there were exceptionally more permits (461) and at times there were up to 420 sharks in a single day (de la Parra-Venegas *et al.*, 2011). It would be difficult to convert these restrictions successfully to the Mexican Caribbean as it is impossible to control the distribution of so many boats and wild animals to adhere to these distances.

A project in Fiji involving shark diving has successfully implemented a fee system that is directly benefitting the local communities. A study by Brunnschweiler (2010), found that with complete cooperation with stakeholders, a USD12 fee obtained from visitors to enter the park created a level of gratitude for visitors and influenced an appreciation for their resource. Management Official 1 stated that there was a MXN31 (USD1.70) fee and wristband in place to enter the WSBR, but at least one of the guides and their colleagues interviewed were unaware of this fee as it wasn't widely implemented (Experienced guide, personal communication, 2016). By using the same calculations as the previous equations, an estimate of the potential contributions that could benefit management of the area can be made. If each visitor paid a USD10 fee:

USD 10 per tourist * 80,000 tourists per season = USD 800,000 per season

(The season was 124 days. Allowance of 24 days were removed to allow for days the port could be closed due to seasonal weather conditions)

This is a vast amount of money that could directly contribute to management and have a huge effect on the sustainability of the *R. typus* industry. It is essential to develop the most effective way to collect a fee that all participants are aware of and abide by. This simple equation can also be used to estimate the potential revenue that *R. typus* tours generate per season. Each tourist pays an average cost of approximately USD 100 to partake in the experience.

80,000 tourists per season * USD 100 per tourist = USD 8 million per season

(The season was 124 days. Allowance of 24 days were removed to allow for days the port could be closed due to seasonal weather conditions)

If this is the case, there is no evidence to suggest that local captains, crew or local government entities are reporting exceptional gains from these practices. Respondents claim that the larger tour operators in Cancún or Playa del Carmen are reaping a greater proportion of the benefits. This estimated revenue could also be greater if the number of allocated permits (461) is accurate. If only half of the boats permitted are entering the area daily, then that total could be a potential 230 boats per day with a maximum of 10 participants per boat (2,300).

Successful shark based tourism has to be based on a healthy population of sharks (Topelko & Dearden, 2005), but there is a lack of appreciation and awareness for this resource that consequently may be having a negative impact on the surrounding environment (Catlin, Jones & Jones, 2012; Remolina-Suárez *et al.*, 2007).

Conclusion

A single authority should be in charge of permit allocation (Ziegler *et al.*, 2016). It is widely known that too many permits are allocated, but all associated authorities need to be aware of this, and need to be more transparent with regards to permit allocation in Quintana Roo. Authorities need to have a more accurate idea of visitor numbers and the extent of the revenue produced by *R. typus* tourism. A lack of knowledge means there is no basis for sustainable management (Page, Forer & Lawton, 1999); businesses are less likely to act in a sustainable manner (McKercher & Robbins, 1998); and it makes it difficult for governmental organisations to make informed decisions (Management Official 1, personal communication, 2016). An adequate fee should be imposed to those wanting to participate in tours and the money should be used to apply necessary patrols to aid the government in implementation of regulations (Remolina-Suárez *et al.*, 2007). This money could also be used to encourage conservation and programmes to directly benefit the local community and protect an area still worth visiting (Brunnschweiler, 2010).

The larger biosphere reserve has been introduced, but there are continuing issues with insufficient funding for personnel and patrols in the existing areas within governmental jurisdiction. There are historical issues that have had negative effects on previous MPAs on the Quintana Roo coast (Rodríguez-Martínez, 2008) and without adequate management there is a reduced chance that this new reserve can be successful.

The secrecy behind accidents means that an open dialogue to avoid dangerous practices is being avoided, potentially putting others at risk. A large quantity of tourists are interacting with *R. typus* and the corresponding avoidance behaviours by *R. typus* are not rare incidents so moving in line with regulations would be more beneficial (Zeigler *et al.*, 2011).

In most cases, education plays a huge part in influencing the conservation of *R. typus* (Ziegler *et al.*, 2016). Training that highlights the benefits of sustainable tourism can give local boat captains and crew the tools to supply a full experience that is currently lacking (Vianna *et al.*, 2011) and encourage support and compliance of regulations (Velez *et al.*, 2014). Promotion and education to raise consumer awareness for healthy ecosystems can help encourage tourists to make better decisions, such as selecting an ethical tour operator (Topelko & Dearden, 2005), and they will be more willing to pay more for an experience that can benefit local communities (Cisneros-Montemayor *et al.*, 2013; McKercher & Robbins, 1998;).

As with many marine recreational activities that have evolved without initial restrictions, there are many facets, participants and variables that need to be considered to produce a successful management programme - there is no quick fix (Catlin *et al.*, 2012). This aggregation of charismatic megafauna has the potential to benefit research and promote conservation of *R. typus* in the Mexican Caribbean (Gallagher & Hammerschlag, 2011; Topelko & Dearden, 2005).

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No potential conflict of interest was reported by the author.

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Appendices

Appendix A – Questionnaire

IMPACTS OF WHALE SHARK TOURISM IN THE MEXICAN CARRIBBEAN QUESTIONNAIRE

DATE: _____LOCATION: _____
Q1. OPERATOR/COMPANY (OPTIONAL): _____
Q2. SEX: F / M **Q3. AGE: _____**
Q4. PROFESSION: (CAPTAIN/CREW/ADMINISTRATOR)

Q5. WHAT DEPARTMENT/AREA DO YOU WORK IN? (OFFICE/BOAT/RESEARCH)
_____

Q6. HOW LONG HAVE YOU WORKED IN TOURISM? _____

Q7. HOW LONG HAVE YOU WORKED with whale sharks? _____

Q8. How many boats is your company associated with? _____

Q9. Of those boats, how many have permits? _____

Q10. How many workers are working in your company? _____

Q11. HAVE YOU NOTICED A CHANGE IN TOURISM SINCE YOU STARTED?
YES ☐ NO ☐
☐ NUMBER OF BOATS ☐ NUMBER OF TOUR OPERATORS ☐ TOUR AGENCIES
OTHER
_____

Q12. HOW HAS IT CHANGED?
_____

Q13. IS IT A POSITIVE OR NEGATIVE CHANGE? POSITIVE ☐ NEGATIVE ☐
Q14. Why do you think that?
_____

Q15. DO YOU ONLY DO TOURS DURING WHALE SHARK/MANTA SEASON?
YES ☐ NO ☐

Q16. WHICH MONTHS DO YOU OPERATE?
_____

Q17. HOW OFTEN DO YOU TAKE TOURISTS ON TRIPS?
☐ 1 PER MONTH ☐ 2-4 PER MONTH ☐ 1-2 PER WEEK ☐ 1-2 PER DAY

☐ 3-4 PER DAY ☐ MORE

Q18. HOW MANY TOURISTS ON EACH TRIP?

☐ 1-2 TOURISTS ☐ 3-5 TOURISTS ☐ 6-10 TOURISTS ☐ 11-15 TOURISTS

☐ 15-20 TOURISTS ☐ 20+

Q19. WHICH ZONE DO YOU VISIT MOST OFTEN BLUE/GREEN WATER?

Q20. DO YOU ALWAYS GO TO THE SAME LOCATION? YES ☐ NO ☐

Q21. IF NO, WHERE DO YOU GO?

_____

Q22. HOW MANY OTHER BOATS APPROXIMATELY ARE AT THIS LOCATION?

_____

Q23. ARE THEY THE SAME TOUR OPERATORS/BOATS? DO YOU RECOGNISE THE SAME ONES RETURNING? YES ☐ NO ☐

Q24. DO YOU KEEP A RECORD OF THE TRIPS (TOURISTS/CREW/LOATION)?

YES ☐ NO ☐

Q25. COULD WE HAVE ACCESS TO THOSE RECORDS FOR RESEARCH PURPOSES ONLY?

YES ☐ NO ☐

Q26. HOW MUCH MONEY DO YOU MAKE PER TRIP? (OPTIONAL) _____

Q27. HOW MUCH MONEY DO YOU MAKE PER SEASON? (OPTIONAL) _____

Q28. IS THE STAFF TRAINED IN TOURIST SAFETY? YES ☐ NO ☐

Q29. WHAT TYPE OF TRAINING HAVE YOU HAD?

_____

Q30. WHO GAVE YOU THE TRAINING?

_____

Q31. IS THE STAFF TRAINED IN GOOD PRACTICES WITH THE ANIMALS?

YES ☐ NO ☐

Q32. DO YOU THINK THE SITE WHERE YOU TAKE TOURISTS IS TOTALLY SAFE? YES ☐ NO ☐

Q33. WHY DO YOU THINK THIS?

_____

Q34. HAVE YOU SEEN ANY ACCIDENTS WITH THE ANIMALS? YES ☐ NO ☐

HOW MANY TIMES? _____

Q35. HAVE YOU SEEN ANY ACCIDENTS WITH TOURISTS? YES ☐ NO ☐

HOW MANY TIMES? _____

Q36. WHAT HAPPENED?

_____

Q37. DO YOU THINK THE AREA SHOULD BE REGULATED? YES ☐ NO ☐

Q38. WHY?

_____

Q39. WHO SHOULD REGULATE THE AREA?

_____

Q40. WHY?

_____

Q41. DO YOU THINK THAT WHALE SHARK TOURS/TOURISM CAN CONTINUE IN THIS WAY IN THE FUTURE? YES ☐ NO ☐

Q42. WHAT, DO YOU THINK, NEEDS TO CHANGE?

_____

Q43. ADDITIONAL COMMENTS:

_____

Q44. NAME OF RESPONDENT (OPTIONAL)

_____

Q45. CONTACT NUMBER (OPTIONAL)

_____

¡Muchas gracias por su participación!

Appendix B – Semi-structured interview questions with government officials

Introduction

Introduce myself and thank the interviewee for willingness to participate. Ask for their permission to record the interview. Ask whether they would like to remain anonymous or not. If so, I will give them a pseudonym (e.g. 'Respondent 1'). Explain that the data collected will be used to add detail to questionnaire data that I have collected from local businesses and tour operators, for use in my Masters placement project. Reiterate that the interviewee has the right to refuse to answer any question(s) at any time.

Start recording. Before commencing with the main interview, ask the respondent to state out loud the following information: Name; company; background of company and role of the interviewee plays within the company.

Content

- How long have you worked in a career with wildlife?
- How long have you worked here?
- What so captains need for a permit?
- How often are the areas patrolled during the season?
- Do you think there should be a reserve in the "Blue Water" area?
- Would there still be industrial ships in the area?
- How many permits were given out this season?
- Would it be possible to have access to this information on permits per year?
- Is there training for tour guides and captains?
- After a video was released on social media there was a meeting on the island and I noticed a change in practices. Do you know why this is?
- Are you notified of accidents?
- If someone gets reported do they get punished straight away?
- Do you know how much money whale shark tourism makes for this area?
- Do you know that the boats are supposed to go out every other day and they go out every day?
- Have you noticed a change in whale shark tourism since you started working in wildlife?
- Do you think whale shark tourism is sustainable for the future?
- I heard you had budget cuts, how have you been affected?
- Are you going to give the same amount of permits next year

Appendix C – Example of infographic on whale shark tour boats

Source: Holbox Guide Magazine (2016)