Assessing the sustainability of whale shark tourism: a case study of Isla Holbox, Mexico

by

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B.Sc, University of Guelph, 2005

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Supervisory Committee

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Abstract

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Sharks are among the most threatened taxonomic groups worldwide. Shark tourism is viewed as a potential means of protecting threatened species, while also providing a sustainable livelihood for local communities. Whale sharks are one such species. Whale shark tourism has grown rapidly in the last twenty years. It is worth an estimated US$66 million and is available in over 15 countries worldwide. However, the management of this industry varies greatly from site to site, from little to no regulations in Thailand to license caps and interaction guidelines in Australia. Further, the long-term sustainability of whale shark tourism is dependent not only on local scale management, but also global scale issues affecting the targeted species.

This study assesses the current status and future sustainability of the whale shark tourism industry on Isla Holbox, Mexico. Specific areas of focus include: (1) tourist motivations and satisfaction with the environmental and tour features offered, (2) shark tourist specialization, (3) a comprehensive assessment of the site's sustainability using Duffus & Dearden's (1990) Wildlife Tourism Model, and (4) an assessment of the whale sharks' vulnerability to global scale threats (e.g. marine pollution; global climate change). Methods included a questionnaire provided to whale shark tour participants on Isla Holbox from June to September, 2008 (n=392, response rate=90%), in-water observation of human-whale shark interactions, and the application of a semi-quantitative climate change vulnerability framework.

Results suggest that the industry on Holbox is reaching its tipping point if changes are not made to improve its management policies and design. Industry issues include: (1) crowding due to poor control of the industry's growth (visitation and number of operators), (2) significant impacts on the whale shark population due to poor compliance with interaction guidelines, and (3) the inequitable distribution of benefits within the community, including significant economic leakages.

The results of the vulnerability assessment to large-scale threats suggest that global climate change could have a significant impact on the size and distribution of whale shark aggregations in the future. Thus, the majority of whale shark tourism activities, which are based on whale sharks aggregating in vulnerable habitats, may be unsustainable in the long-term regardless of management approach. The type of users and format of tours on Holbox further supports an increased vulnerability to climate change.

This study provides a significant contribution to understanding the sustainability of marine wildlife tourism activities targeting threatened species within critical habitats through the assessment of whale shark tourism sustainability using an integrated, multidisciplinary model that addresses both the social and biological dimensions of sustainability. It also includes the first comprehensive assessment of whale shark vulnerability to global climate change based on habitat type and its implications for whale shark tourism activities targeting this species at seasonal aggregation sites. In addition, this study also provides a greater understanding of tourist motivation and satisfaction within marine wildlife tourism, and shark tourism in particular and a first look at shark tourist specialization and its links to environmental impacts and management preferences.

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Dedication

Unless someone like you cares a whole awful lot,
Nothing is going to get better. It's not.
— Dr. Seuss, from The Lorax

You focus on what can work, what can help, or what you can do, and you seize it, and then – you don't let go. What [conservationists] see, and what I've come to see, is the possibility of making things better. That's what hope is: the belief that things can get better. The world belongs to people who don't give up. - Carl Safina

To Susie who showed me the door of opportunity and Phil who showed me how to open it.

Chapter 1: Introduction: Rationale and Objectives

1.0. Introduction

This study examines the sustainability of whale shark tourism on Isla Holbox, Mexico in terms of the quality of services offered, potential environmental impacts of tourism activities and large-scale threats faced, and the management approach of the industry. Such information is critical for the effective management of marine wildlife tourism activities targeting a threatened species within its critical habitat, as well as ensuring a sustainable livelihood for the local community. The purpose of this introductory chapter is to (1) provide an overview of the context and rationale for the research, (2) outline the research objectives and associated research questions of this study, and (3) outline the thesis structure.

1.1. Context

1.1.1. Background

Whale sharks (*Rhincodon typus*) are the largest fish in the ocean, attaining lengths of greater than 14 m and weights of over 30 metric tons (Joung et al., 1996). They are a highly migratory species (e.g. one individual travelled nearly 13,000 km in 37 months, Eckert & Stewart, 2001) that forms predictable seasonal aggregations at sites of high productivity (e.g. Australia, Belize, Mexico, Philippines) (Clark & Nelson, 1997; Taylor & Pearce, 1999; Eckert & Stewart, 2001; Heyman et al., 2001; Alava et al., 2002; Theberge & Dearden, 2006; Hsu et al., 2007; Norman & Stevens, 2007; Hobbs et al., 2009; Cardenas-Palomo et al., 2010; Kumari & Raman, 2010). These predictable

aggregations, along with the whale shark's large size, harmless nature, slow movement and its tendency to spend a significant time at the surface makes it an ideal species for tourism activities (Stewart & Wilson, 2005).

Whale sharks have emerged as iconic species for the regions in which the aggregations occur, providing an important stimulus for the local economies through flourishing tourism industries (Graham, 2004; Catlin et al., 2009). Shark tourism has been identified as an important factor behind current conservation efforts generating millions of dollars in revenue (Dearden & Topelko, 2005). Conservationists consider whale sharks a flagship species for shark conservation efforts because they are charismatic megafauna that provide a positive image of sharks for the public and have the potential to generate interest in the conservation concerns facing sharks. This role is important not only to counter negative public perception of sharks, but also to generate public support for changes in current shark harvesting activities (e.g. non-targeted fishing gear, shark finning), which have resulted in the annual loss of an estimated 20 to 70 million sharks (Clarke et al., 2006).

The same traits that make whale sharks ideal for tourism (i.e. large size, slow movement, tendency to stay at the surface) also make them susceptible to overexploitation (Stewart & Wilson, 2005). Furthermore, their K selected life history traits (e.g. slow growth, late age at sexual maturity, longevity) hinder the whale shark's ability to recover from such unsustainable activities. A noticeable decline in whale shark numbers has been noted both in fisheries data (Anderson & Ahmed, 1993; Joung et al., 1996; Hanfee, 2001; Alava et al., 2002; Pine, 2007) and at many aggregation sites worldwide (Stewart & Wilson, 2005; Dearden & Theberge, 2006; Meekan et al., 2006;

Wilson et al., 2006; Bradshaw et al., 2007; Graham & Roberts, 2007; Rowat, 2007; Bradshaw et al., 2008), despite protection at the international level (Table 1.1) (Dulvy et al., 2008).

Table 1.1. Global conservation status of the whale shark (*Rhincodon typus*) (adapted from Dearden et al., 2008).

	Conservation effort	Year
International		
IUCN Red List of Threatened Species	Listed as vulnerable to extinction	2000
Convention on International Trade of Endangered Species (CITES)	Listed under Appendix II	2002
Bonn Convention for the Conservation of Migratory Species of Wild Animals (CMS)	Listed under Appendix II	1999
United Nations Convention on the Law of the Sea (UNCLOS)	Voted unanimously to end shark finning at sea under the United Nations Fish Stocks Agreement	2010
Convention on Biological Diversity (CBD)	To conserve, sustainably use and share benefits of biological diversity	1992
National		
Australia	Protected within all state waters under Wildlife Conservation Act	
Belize	Habitat protection	2000
Honduras	Ban on fishing adopted	1999
India	Ban on fishing and trade	2001
Maldives	Ban on fishing adopted	1995
Mexico	Ban on fishing adopted	2000
Philippines	Ban on fishing adopted	1998
Seychelles	Protected under the Wild Animals Bill	2004
Taiwan	Ban on all whale shark fishing and trade	2008
Thailand	Ban on fishing adopted	2000
Palau	Declared their waters as world's first national shark sanctuary	2009
New Zealand	Protected in national waters	2010

Wildlife tourism, such as swim-with whale shark tourism, is viewed as one means of transitioning local communities from consumptive uses of marine natural resources to

more sustainable non-consumptive ones through the provision of sustainable livelihoods (Graham, 2004; Rodger et al., 2007; Troëng & Drews, 2008). However, concerns have been raised over whether or not these activities do more harm than good both in terms of the impacts on the target species (Orams, 1999), as well as the local communities (e.g. Shah & Gupta, 2000; World Bank, 2007; Zenteno, 2007; Cepeda, 2008). If a wildlife tourism site is allowed to grow without any management intervention, there is the potential for the industry to collapse due to the disappearance of the target species and loss of visitation (Enosse et al., 2001; Neto, 2003; Dearden et al., 2007).

1.1.2. The issue

Whale shark tourism has exploded in the last decade from only a few sites in the 1990s to over fifteen sites worldwide with further expansions planned (e.g. Indonesia, India). The industry is worth an estimated US$66 million worldwide (Graham, 2004). The economic stimulus this industry provides to the mostly developing nations involved can be very significant in terms of improving quality of life and providing livelihoods in areas where livelihood alternatives are few (Graham, 2004; Diaz-Amador, 2005; Cepeda, 2008). However, the manner in which the industry is managed may be problematic. Dearden et al. (2008) examined the whale shark watching industry at various locations worldwide in terms of the management models used (e.g. industry structure, organization, potential sustainability) and concluded that the management of this growing industry varies markedly from site to site, ranging from little to no regulations in places like Thailand to interaction guidelines and licensing caps in Australia and Belize. Furthermore, the norm appears to be maximizing tourist numbers with few controls and/or poorly enforced regulations.

It is highly likely that whale shark tourism visitation numbers will continue to increase in the future. These increasing numbers, along with the fact that whale sharks are considered threatened (Norman, 2005) and their numbers have been in decline at certain aggregation sites, raise the question of whether or not this industry is truly sustainable in the long-term. Sustainability within marine wildlife tourism can be defined as 'tourism which is developed and maintained in an area in such a manner and at such a scale that it remains viable over an indefinite period and does not degrade or alter the environment (human and physical) in which it exists to such a degree that it prohibits the successful development and well being of other activities and processes' (Butler, 1993, p.29). Consequently, it is important to ensure that any tourism activities targeting whale sharks are managed in a sustainable manner both from a social and biological perspective. Potential social impacts of a given tourist activity can affect tourists, such as perceived crowding, which reflects the level of dissatisfaction with the number of other boats and people encountered, as well as the local community, such as the generation of sustainable livelihoods or the loss of social cohesion. Potential biological impacts of tourism activities include effects on the target species itself (e.g. changes in behaviour and/or health) and its critical habitat (e.g. key feeding and/or breeding areas).

Previous research on whale sharks has focused primarily on the biology and ecology of whale sharks (e.g. Joung et al., 1996; Gunn et al., 1999; Eckert & Stewart, 2001; Meekan et al., 2006; 2009; Bradshaw et al., 2007; 2008; Castro et al., 2007; Gifford et al., 2007; Graham & Roberts, 2007; Hsu et al., 2007; Norman & Stevens, 2007; Ramirez-Macias et al., 2007; Rowat & Gore, 2007; Taylor, 2007; Holmberg et al., 2008; 2009; Rowat et al., 2008; 2009; Brunnschweiler et al., 2009; Hobbs et al., 2009;

Hueter et al., 2009; Schmidt et al., 2009; 2010; Kumari & Raman, 2010; Motta et al., 2010; Riley et al., 2010; Sleeman et al., 2010a,b), as well the socio-economic impacts of this industry on the local communities (Diaz-Amador, 2005**;** Rodriguez-Dowdell et al., 2007; Rowat and Engelhardt, 2007; Cepeda, 2008; Catlin et al., 2009). Little emphasis has been placed on understanding the impacts of the activities on the whale sharks (Norman, 1999; Quiros, 2007; Pierce et al., 2010) or the tourism experience itself (e.g. expectations, needs, satisfaction) (Davis et al., 1997; Catlin & Jones, 2010). Further, there has been no attempt to assess the effectiveness of management policies at a given site using an integrated approach that incorporates both social and biological aspects of the industry. Yet such a multidisciplinary approach is essential for effective wildlife tourism management, as it provides a holistic view of the problem and forms the basis for adaptive management and thus the long-term sustainability of a given activity.

The current study was initiated on Isla Holbox, Mexico, identified as having the largest and fastest growing whale shark watching industry in the world (Dearden et al., 2008). Projections for the whale shark industry on Holbox predict a continued growth of 25% per year with an estimated 39,063 tourists by 2011 (Zenteno, 2007), up from 1,500 in 2002 (de la Parra, 2008). Furthermore, the close proximity of Holbox to tourism destinations like Cancun and Playa del Carmen, which attract millions of visitors annually (Hendricks, 2005), has the potential to further raise tourism numbers to unsustainable levels. Even if the island itself could handle such high visitation, the visiting population of whale sharks may not. Understanding the tourist market, tourism impacts and larger-scale threats that could affect whale shark health in Holbox waters, will help guide the industry into a more sustainable mode for the future.

1.2. Research goals and objectives

The goal of this thesis is to assess the potential long-term sustainability of the whale shark tourism industry on Isla Holbox, Mexico using an integrative approach, which addresses both the social and biological aspects of sustainability. The objectives and related questions specified to fulfill this goal are as follows:

Objective 1. To investigate the motivations of tourists participating in whale shark tours on Holbox and assess tourist satisfaction with the environmental and tour features offered at this site.

Understanding tourist motivations and satisfaction with the experiences provided are a key component to the successful management of a tourism industry. If participants are not happy with what is being offered and management does not address these gaps in service, there is the potential for the tourism industry to collapse. The research questions associated with importance and satisfaction are:

a. Why are tourists participating in whale shark tours on Holbox? What are their travel motivations?
b. Does the whale shark tourism industry meet tourists' expectations and needs in terms of environmental and tour features? Are there specific areas of the experience that need to be addressed?

Objective 2. To investigate shark tourist specialization in the whale shark industry on Isla Holbox, Mexico.

User specialization is related to the different experiences, skills and interests of participants in a given activity (Bryan, 1977; 1979). Specialization has been linked to differing impacts, both real and perceived, of the activity on the environment (Thapa,

2000; Thapa & Graefe, 2003), as well as different perceptions of appropriate management approaches to controlling the activity (Oh & Ditton, 2006; Sorice et al., 2009). Thus if user specialization can be assessed for a given site, it can provide insight into differences in environmental impacts among users and help guide management interventions aiming to reduce these impacts on the targeted resource (Barker & Roberts, 2004; Dearden et al., 2007a; Thapa et al., 2006; Worachananant et al., 2008; Sorice et al., 2009). Research questions associated with this objective are:

a. Is tourist specialization evident in shark tourism? Can it be measured for the industry on Holbox?
b. If so, do different specialization groups have differing impacts on the environment and/or perceptions of appropriate management interventions?

Objective 3. To use Duffus & Dearden's (1990) Wildlife Tourism Model to assess the sustainability of the whale shark tourism industry on Isla Holbox, Mexico.

Duffus & Dearden's (1990) Wildlife Tourism Model (WTM) integrates Butler's (1980) tourism life cycle, Bryan's (1977) user specialization concept and Stankey et al.'s (1985) Limits of Acceptable Change (LAC) (both biological and social) in order to assess a tourism site's overall sustainability. Thus, the WTM framework provides an integrated approach to assess the current status and future sustainability of the Holbox whale shark tourism industry. Specific research questions are:

a. What are the key issues related to limits of acceptable change, both social and biological, for the whale shark tourism industry on Holbox? How can they be addressed?

b. How do the limits of acceptable change, specialization and growth of the whale shark tourism industry on Holbox fit within Duffus & Dearden's (1990) Wildlife Tourism Model? Is the industry following a sustainable path?
c. Based on the above information, how can the industry be managed more sustainably?

Objective 4. To assess the whale sharks' vulnerability to global scale threats (e.g. marine pollution, global climate change) and how these threats may affect whale shark tourism activities on Isla Holbox, Mexico.

Whale sharks are a cosmopolitan, highly migratory species found in all tropical and most warm temperate seas between the latitudes of 30^{o}N and 35^{o}S (Compagno, 1984). These qualities increase the likelihood of exposure to such large-scale threats as global climate change, overharvesting and marine pollution, despite protection at the national level in some of the whale shark's 130 range states. However, aside from overharvesting, there has been no assessment of whale shark vulnerability to these global threats. Specific research questions are:

a. How vulnerable are whale sharks to global climate change? Does it vary by habitat type?
b. How vulnerable are whale sharks to marine pollution (e.g. oil spills, toxins and marine litter)? Is it likely to affect whale shark abundance and distribution?
c. What are the potential effects of these international environmental issues on the sustainability of whale shark tourism on Holbox? Can the community on Holbox improve their resilience to potential changes in whale shark abundance and occurrence in the future?

1.3. Thesis structure

This thesis is organized into six chapters and three appendices. The content of each of the remaining chapters and appendices are outlined as follows:

- Chapter 2 examines the success of the whale shark tourism industry in meeting participants' needs and expectations with respect to tour services and environmental features. Importance-Performance (IP) analysis is used as an analytical tool to identify critical areas management must focus on in order to improve the tour and meet customers' expectations.

- Chapter 3 examines the concept of specialization with respect to shark tourism and suggests key criteria that can be used to distinguish among various shark user groups. The role of specialization within the context of adaptive management is discussed focusing on the link between user groups and differences in environmental awareness and perceived and real impacts on the environment, as well as support for management interventions.

- Chapter 4 Duffus & Dearden's (1990) model is used to assess the overall sustainability of the whale shark tourism industry on Holbox in terms of growth of the tourism site, user specialization, and limits of acceptable change (social and biological). Suggestions are made to improve management of this industry and ensure its long-term sustainability.

- Chapter 5 places the sustainability of whale shark tourism within the international context and assesses the whale sharks vulnerability to large-scale threats (e.g. global climate change and marine pollution) that could influence the abundance,

distribution and health of the targeted whale shark population off Isla Holbox, Mexico.

- Chapter 6 provides an overview of the major findings from the four subsections of this study (Chapters 2 through 5), as well as recommendations for the management of the industry and gaps in knowledge that should be addressed in future research.

- Appendix I contains the Human Research Ethics Board Certificate of Approval for the research undertaken on Holbox.

- Appendix II contains a copy of the questionnaire provided to whale shark tour participants on Holbox.

- Appendix III contains the raw data tables for the questionnaire results.

Chapter 2: But are tourists satisfied? Importance-performance analysis of the whale shark tourism industry on Isla Holbox, Mexico

From birth, man carries the weight of gravity on his shoulders. He is bolted to earth. But man has only to sink beneath the surface and he is free. – Jacques Cousteau

Abstract

Understanding the human dimensions of wildlife tourism is important for its successful management. Yet, there has been little interest in examining the interface of the social and biological aspects of whale shark tourism and its critical role in sustainable management. The objectives of this paper were to understand the motivations and satisfactions of whale shark tour participants on Isla Holbox, Mexico in order to assess the success of this industry in meeting customer expectations of environmental and setting features. The importance-performance analysis identified key issues with false advertising, lack of educational information, perceived crowding, and tour cost. These factors are representative of larger issues related to the uncontrolled growth of the whale shark tourism industry on Holbox. Consequently, management should limit the growth of the industry within more sustainable limits (license cap, reduce visitor numbers), as well as ensure the equitable distribution of economic benefits within the industry. Management should also focus on developing and implementing effective guide training and interpretation programs to minimise environmental impacts and further the conservation potential of whale shark tourism activities. Understanding the tourist market, motivations and satisfactions can help guide the industry into a more sustainable mode for the future.

Keywords

Sustainability, Marine wildlife tourism, Importance-performance analysis, Whale sharks

2.1. Introduction

2.1.1. Marine wildlife tourism

Marine wildlife tourism has grown rapidly in the last twenty years raising concerns over the sustainability of this sector. Increasing public interest in using the marine environment for leisure as well as for food has led marine wildlife tourism to have one of the highest growth rates in the tourism industry (Cater & Cater, 2007). For example, whale watching is worth an estimated US$2.1 billion per annum attracting 13 million

participants and is now offered in 119 countries worldwide, which is a drastic expansion from only 12 countries in 1983 (O'Connor et al., 2009). Shark tourism, a newly emerging niche market in marine wildlife tourism, has experienced strong growth with over 500,000 divers (Topelko & Dearden, 2005) visiting more than 300 dive sites in 40 countries (Carwardine & Watterson, 2002). Wildlife tourism is viewed as a means of transitioning local economies from unsustainable consumptive uses of marine resources to more sustainable non-consumptive ones (Graham, 2004; Troëng & Drews, 2008). However, concerns have been raised over the level of impacts these wildlife tourism opportunities have on the target species, with some researchers suggesting that wildlife tourism is simply another form of harmful exploitation of the marine resource (Orams, 1999).

Many shark populations are already facing high levels of stress due to commercial harvesting activities including shark finning (i.e. the practice of removing and retaining shark fins and discarding the body at sea) and by-catch issues (i.e. catch of non-targeted species), with approximately 20-70 million sharks killed every year (Clarke et al., 2006). An analysis of the 2008 World Conservation Union's (IUCN) Red List of Threatened Species (Vié et al., 2009) revealed that of the 1,045 sharks and relatives (i.e. rays and chimaeras) assessed, 20% were classified as threatened (i.e. critically endangered, endangered or vulnerable), a further 10% were near threatened and 50% were data deficient. These issues highlight the need for shark tourism management to design and implement a range of management interventions that emphasize conservation over economic returns.

Whale sharks are among those species classified as threatened on the IUCN Red List (Norman, 2005). There is also a growing tourism industry focused on interacting with whale sharks at many sites around the world (Dearden et al., 2008). This confluence of species vulnerability and increased tourism volume could be an indicator of an ecological and economic problem for whale shark tourism. Duffus and Dearden (1990) suggest that in the event of the uncontrolled growth of a wildlife tourism site, the site may collapse due to two factors: the disappearance of the targeted species as a result of excessive environmental impacts, and reduced visitation as a result of poor visitor experience. To address this type of problem, it is important to ensure wildlife tourism opportunities do not negatively impact on an already vulnerable species. Furthermore, the dual mandate of wildlife tourism managers to both minimize negative impacts on the target species while also providing an enjoyable tourism experience requires a clear understanding of both the human and biological dimensions of the activity (Duffus & Dearden, 1990).

Research on whale sharks has focused on biology and ecology, including population biology and structure (Joung et al., 1996***;*** Meekan et al., 2006; Bradshaw et al., 2007; 2008; Castro et al., 2007; Graham & Roberts, 2007***;*** Norman & Stevens, 2007; Ramirez-Macias et al., 2007; Holmberg et al., 2008; 2009; Schmidt et al., 2009; 2010), whale shark movements (Gunn et al., 1999; Eckert & Stewart, 2001; Eckert et al., 2002; Wilson et al., 2006; Gifford et al., 2007; Hsu, Liao, & Liu, 2007; Rowat & Gore, 2007), and behavioural ecology (Heyman et al., 2001; Graham et al., 2006; Martin, 2007; Nelson & Eckert, 2007; Taylor, 2007; Motta et al., 2010). There is growing interest in social research because of the socio-economic impacts of whale shark tourism on local

communities (Diaz-Amador, 2005; Rodriguez-Dowdell et al., 2007; Rowat & Engelhardt, 2007; Cepeda, 2008; Catlin et al., 2009). However, studies examining the tourism experience itself (e.g. tourist expectation, needs and satisfaction) have been largely neglected for whale sharks.

Research is essential for effective wildlife tourism management. Previous research focusing on the social aspects of marine tourism activities has identified factors that affect the visitor experience, including perceived crowding (Vaske & Donnelly, 2002; Needham et al., 2004; Dearden et al., 2007a; Breen & Breen, 2008; Lankford et al., 2008; Jin, 2009; Bell, 2010; Catlin & Jones, 2010), environmental impacts (Dearden et al., 2007a, b; Curtin et al., 2009; Uyarra et al., 2009; Meletis & Harrison, 2010), and marketing approach (e.g. Semeniuk et al., 2009). Understanding the needs and expectations of people who are investing time and money into participating in marine tourism activities can provide valuable insight for management planning and decision-making. For example, Davis et al. (1997) demonstrated that visitor satisfaction would not be diminished if the minimum viewing distance between whale sharks and swimmers was increased at Ningaloo Marine Park in Australia. The authors also found that participants' perceived crowding was reduced following the implementation of this rule, along with a reduced whale shark contact rate (Davis et al., 1997).

This paper focuses on the human dimensions of the whale shark watching experience on Isla Holbox, Mexico. In particular, it seeks to understand the motivations and satisfaction of the whale shark tour participants in order to assess the industry's success in meeting customer expectations of environmental and setting features. The theoretical underpinnings of this research will be discussed in the following section.

2.1.2. Theoretical overview of constructs

Wildlife tourism managers have a dual mandate of providing satisfying visitor experiences, while also ensuring these experiences do not significantly alter the natural environment (Duffus & Dearden, 1990; Needham & Rollins, 2008). Visitors may be dissatisfied with experiences available at a particular site due to such issues as crowding, available facilities and services and environmental impacts (Needham & Rollins, 2008). Mannell's (1999) behavioural model of outdoor recreation seeks to understand the interrelationship of visitor motivation, experience, and satisfaction with respect to a particular nature-based tourism activity (Figure 2.1). This model postulates that people participate in a specific activity within a specific setting in order to meet various sociological needs (i.e. push and pull motivations) (Mannell, 1999). Whether or not these needs are met depends on the environmental and social features of the site. If the experiences do meet expectations, then the person will be satisfied and the feedback loop would result in the person seeking out similar experiences in the future (Needham & Rollins, 2008). However, if experiences do not meet expectations, this could result in dissatisfaction and a lower chance of selecting this activity in the future (Needham & Rollins, 2008). Consequently, understanding visitor motivations for participating in a given activity and assessing how well the activity meets those needs is critical for the successful management of a wildlife tourism site.

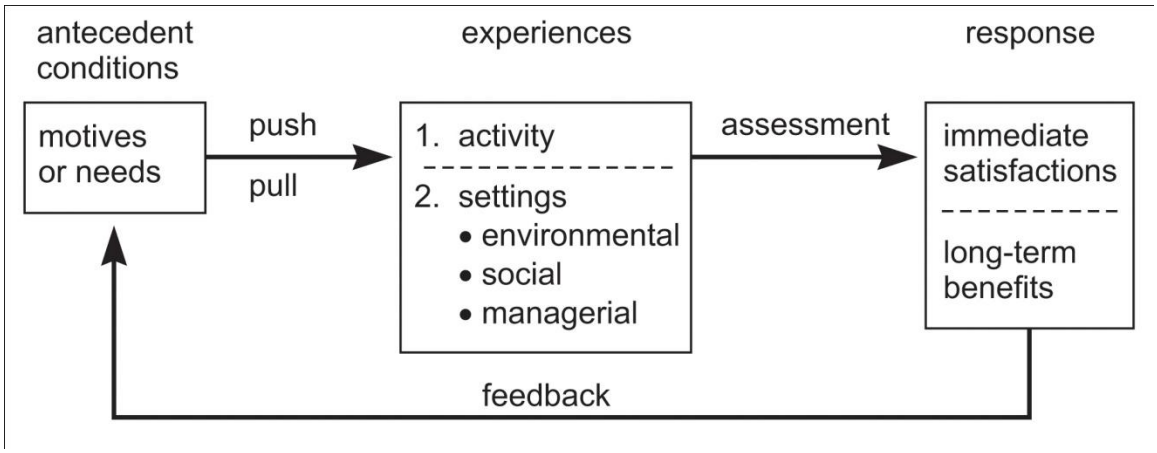

Figure 2.1. Behavioural model of outdoor recreation (after Mannell 1999).

Motivations are the basis for behaviour and critical in explaining why people behave the way they do. Motivation within tourism research seeks to explain why people travel, and is a key component and driving force behind tourist behaviour (Crompton, 1979; Hsu & Huang, 2007). A predominant paradigm for understanding motivation in tourism research is push-pull theory (Dann, 1977; 1981; Crompton, 1979; Hsu & Lam, 2003; Yoon & Uysal, 2005; Prayag & Ryan, 2010) and is arguably the most appropriate measure for studying travel motivations (Jang & Cai, 2002). According to Crompton and McKay (1997), "tourism motivation is conceptualized as a dynamic process of internal psychological factors (needs and wants) that generate a state of tension or disequilibrium within individuals" (p.427). This state of imbalance drives tourists to choose a particular travel destination or activity, while also being pulled or attracted by that destination's attributes (Dann, 1981). Push factors are mostly intrinsic, emotional factors and can include a desire to escape, excitement, adventure, to be with friends/family or rest and relaxation, while pull factors are mostly extrinsic site or activity specific and include recreational opportunities, cost, safety, natural scenery, cultural attractions, facilities and infrastructure (Uysal & Jurowski, 1994; McGehee et al., 1996). Typically, push factors

are considered to precede pull factors in terms of initiating travel desire (Crompton, 1979; Bello & Etzel, 1985). Pull factors are more important in understanding destination choice (Bello & Etzel, 1985). However, in tourism destination management, it is not just about understanding the needs and wants of tourists; it is also about maximizing tourist satisfaction (Yoon & Uysal, 2005).

Satisfaction is the ability to meet the needs and expectations of the tourists and is an important prerequisite to assessing the performance of a particular site or activity (Noe & Uysal, 1997; Schofield, 2000). Satisfaction is the primary method used to measure the quality of a visitor's experience (Tonge & Moore, 2007). If the visitor's experience is understood, managers can provide services and infrastructure that meet visitor expectations, as well as confirm that visitors are satisfied with the experiences provided (Hornback & Eagles, 1999). Site attributes, such as facilities and services, also affect the quality of the visitors' experience (Hamilton et al., 1991; Hollenhorst & Gardner, 1994).

2.1.3. Study site

Isla Holbox is a small island on the northeastern tip of the Yucatan Peninsula in Mexico (Figure 2.2). Whale sharks congregate in the plankton rich waters where the Gulf of Mexico and Caribbean Sea meet from May to September every year (Remolina Suarez et al., 2005). Holbox was predominantly a fishing village until 2002 when the locals discovered the tourism potential of the local aggregation of whale sharks. Holbox is thought to have one of the largest and fastest developing whale shark-watching industries in the world (Dearden et al., 2008), with over 17,000 participants in 2008 (de la Parra, 2008). Hence, Holbox is an important study site for examining the industry's sustainability.

Projections of the whale shark industry on Holbox suggest there will continue to be an expected growth of 25% per year with an estimated 40,000 visitors in 2011 (Zenteno, 2007), up from 1,500 in 2002 (de la Parra, 2008). The close proximity of Holbox to tourism destinations like Cancun and Playa del Carmen, which have millions of visitors every year, has the potential to further raise tourism numbers to unsustainable levels. Understanding the tourist market, motivations and satisfactions could help guide the industry into a more sustainable mode for the future.

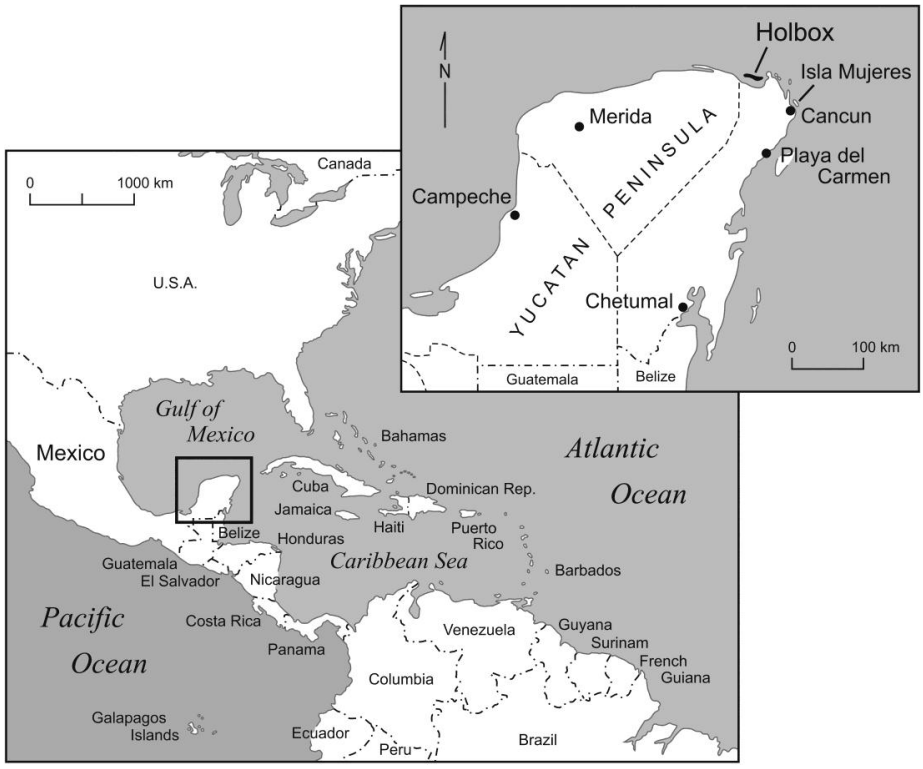

Figure 2.2. Map of study area.

2.2. Methods

The methods included site-based distribution of a questionnaire to whale tour participants on Isla Holbox, Mexico and in-water observation of whale shark-tourist interactions by the researcher. The questionnaire consisted of fifty-six mainly closed-ended questions

organized in four sections addressing various aspects of the whale shark tour experience including motivations and satisfactions, shark diving experience, social and environmental impacts and demographics. These questions were developed through a literature review and refined following a pilot study on Holbox in June 2008. Questionnaires were printed on 8.5" x 14" white paper and folded to produce ten-page booklets, after the technique developed by Salant and Dillman (1994). Portions of the questionnaire relevant to this paper are described below.

Questionnaires included closed-ended questions regarding the importance of, and satisfaction with, a list of motivations for participating in the whale shark tour on Holbox (eleven items), environmental and setting features (ten items) and service quality (six items). Surveys were provided in Spanish and English.

Questionnaires were distributed to whale shark tour participants on Holbox over a ten-week period from June to August 2008, which represents the whale shark season. Tourists were selected opportunistically as they descended from the boats upon return from the whale shark tours. Questionnaires were also distributed to hotels and travel agencies on Holbox that offered whale shark tours to on-island clients to distribute to their clients participating in the tour.

A total of 397 surveys were collected over the three-month period, resulting in a 5.0 % margin of error (95% confidence interval) (Salant and Dillman 1994). Approximately 90% of those participants approached completed a questionnaire. The main reasons for not completing a survey included a member of the group/couple had already completed one, language barriers, and lack of interest and/or time. The response rate for surveys collected through hotels and agencies is unknown. However, the latter

group made up only a small fraction of the overall sample size (approximately 10%) and thus would not significantly affect nonresponse bias. Literature suggests a response rate of 60% can be considered sufficient in accurately representing the population being sampled (Dolson & Machlis, 1991), while 70% is considered very good (Babbie, 2007). Thus, the 90% response rate provides an adequate representation of the whale shark tour participants on Holbox.

2.3. Results

2.3.1. Motivations for participating in the whale shark tour on Holbox

Whale shark tourism on Holbox is an important motivator for travel to the site. Eighty-five percent of respondents stated they would not return to Holbox if whale sharks were not present. Respondents were asked to rate the importance of a given set of motivations for participating in the whale shark tour on a five-point Likert scale with a score of 1 corresponding to ‘not at all important’ and a score of 5 ‘very important’. Figure 2.3 shows the rank importance of various tour motivations based on the percentage of respondents who scored a feature as important (score of 4 or 5). The top three reasons to participate in the whale shark tour were:

- interest in whale sharks (84.2%)
- to expand knowledge (83.5%), and
- to explore new environments (83.4%),

while the bottom three reasons were:

- interest in underwater photography (37.6%),
- to be with friends/family (36.1%), and

- to develop skills and abilities (32.8%).

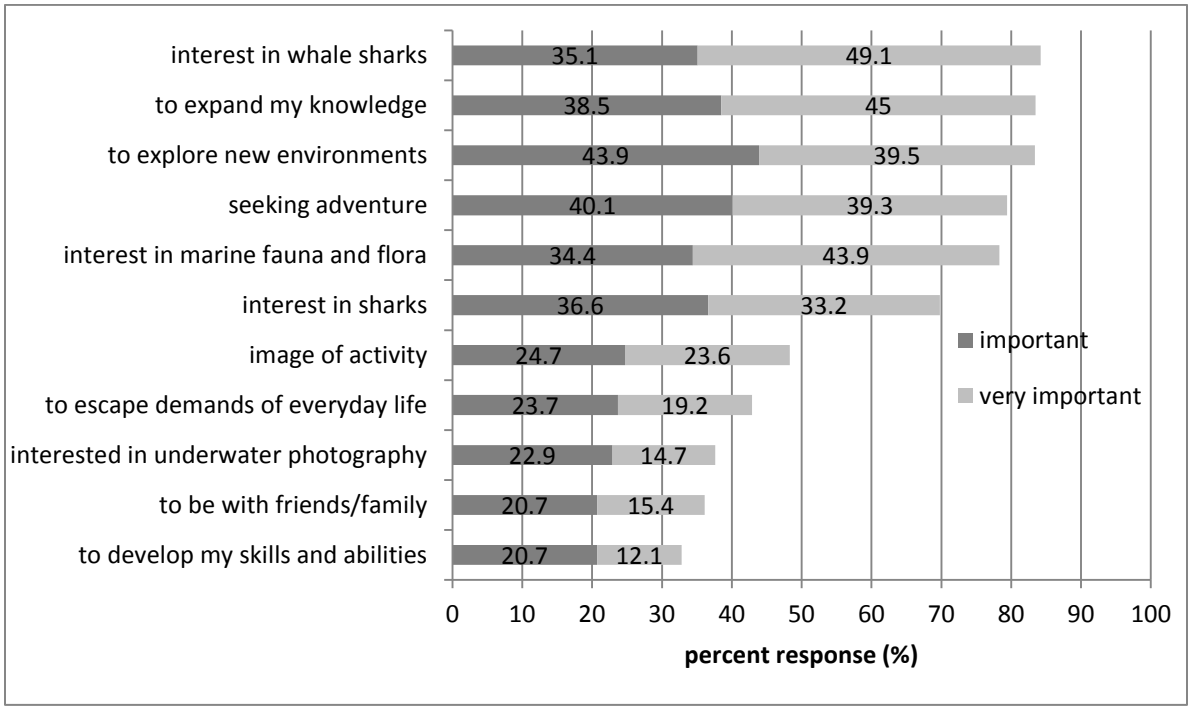

Figure 2.3. Importance of social/psychological motivations for participating in whale shark tours on Holbox.

2.3.2. Environmental and setting motivations

Participants were asked to score specific environmental and setting features, as well as tour services using Likert scales, as above. Figure 2.4 illustrates the range of responses of 'important' and 'very important' to a list of environmental and setting features as potential motivations for participating in the whale shark tour.

All motivations were at least moderately important, with a minimum 60% response rate. The most important motivations were:

- proximity to whale sharks (93.1%)
- commitment to the environment by the boat crew (88.9%)
- quality of marine transportation services (88.1%)

- information provided by the boat crew (87.6%), and
- good underwater visibility (87.4%).

The least important motivations were:

- easy snorkelling conditions (68.4%),
- variety of marine life (67.4%)
- abundance of large fish (61.6%), and
- abundance of marine life (61.3%).

Participants were also asked to name their top two most important environmental features from the provided list. The resulting five most important environmental features were, in descending order, proximity to whale sharks, number of whale sharks seen, good underwater visibility, number of boats, and number of other snorkelers. This order corresponds with the order of the five most important environmental features based on mean scores (although good underwater visibility and number of whale sharks was switched), confirming the validity of these results.

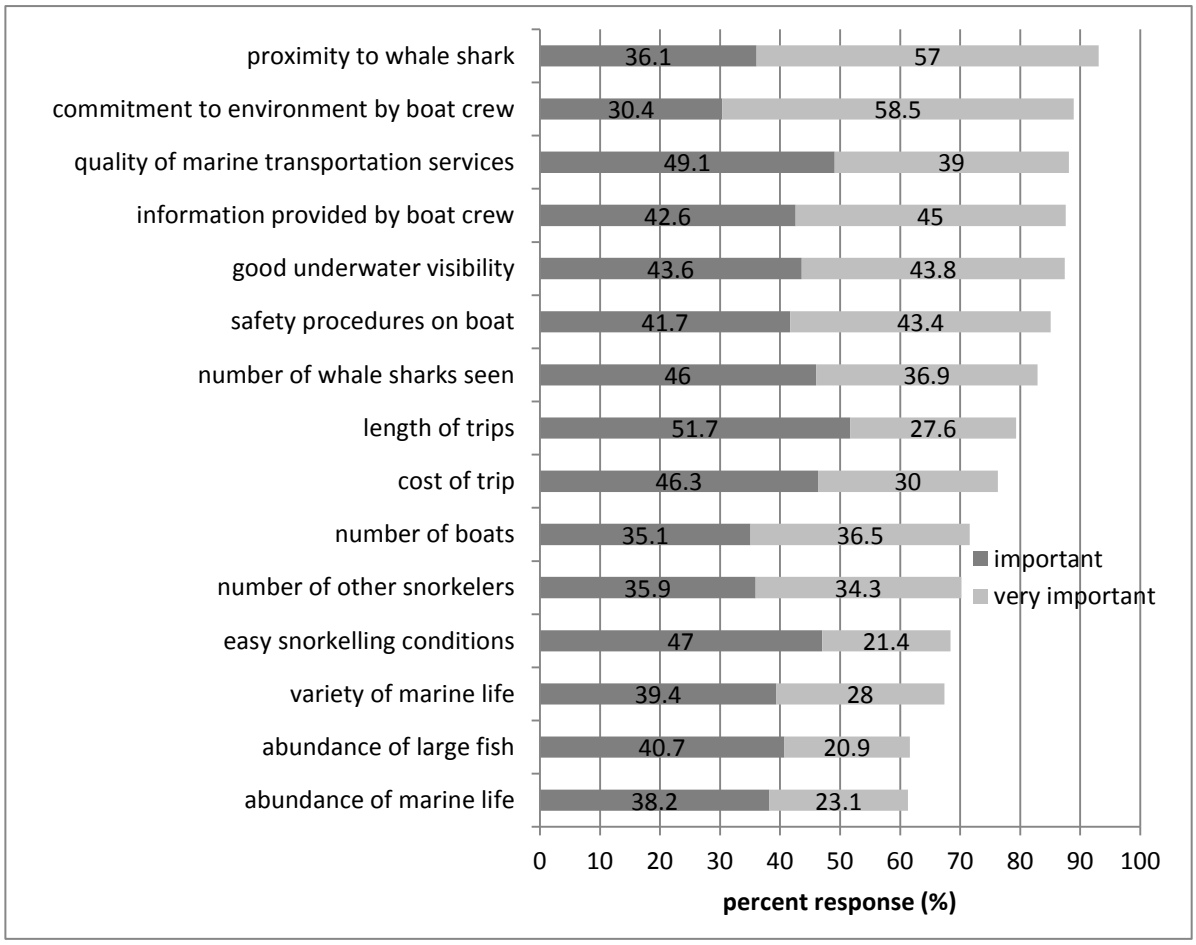

Figure 2.4. Importance of destination/services for participating in whale shark tourism on Holbox.

Respondents were asked to rate their satisfaction with the environmental and setting features and tour services on a five-point Likert scale with a score of 1 corresponding to ‘very unsatisfied’ and a score of 5 ‘very satisfied’. Figure 2.5 shows the results of this analysis in terms of the percentage of respondents who rated the given motivation as ‘somewhat satisfied’ and ‘satisfied’. Overall, respondents were very satisfied with the tourism industry on Holbox with nearly all of the respondents stating that they would recommend the tour (94.7%). Looking at satisfaction for both environmental features and tour services, the majority of respondents indicated they were

satisfied with conditions encountered on Holbox (86.6%). However, there were a number of participants (10.6%) who were dissatisfied with the overall experience.

As shown in Figure 2.5, most participants were very satisfied with:

- the proximity to whale sharks (96.2%),
- the quality of marine transportation services (84.9%), and
- the number of whale sharks encountered (82.8%).

However, a significant proportion of tour participants were dissatisfied with:

- the number of boats (23.4%),
- underwater visibility (22.9%),
- the variety of marine life (20.2%
- abundance of marine life (19.5%)
- the number of other snorkelers (18.8%). and
- the abundance of large fish (18.1%).

Looking at satisfaction and importance values separately is ineffective in assessing a particular tourism site's success in meeting participant needs and achieving sustainability. This approach is unable to account for differences in importance and satisfaction for particular site features. For example, examining satisfaction values alone would suggest that those site features with lower satisfaction values require management intervention. However, when satisfaction scores are compared to the corresponding importance scores, satisfaction may be rated higher than importance suggesting that participants are in fact satisfied with the features.

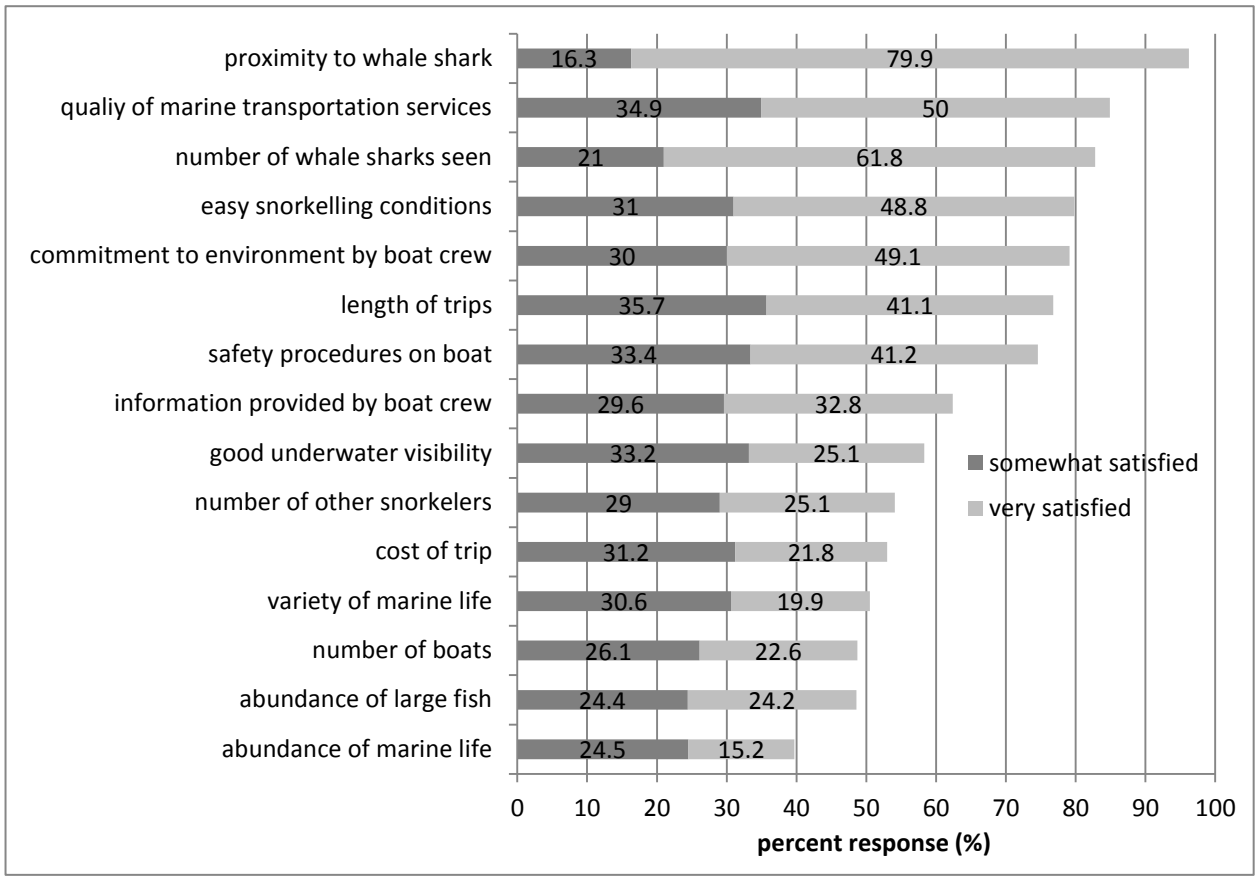

Figure 2.5. Satisfaction scores for environmental and tour features of the whale shark tourism industry on Holbox.

Importance-performance (IP) analysis is one approach to facilitate this comparison. IP analysis is a simple graphical approach that is designed to compare the mean score for 'perceived importance' of various tour features with the corresponding 'satisfaction rating' using a two-dimensional grid. This grid classifies mean scores into four categories to aid in data interpretation and assessing management priorities: 'keep up the good work', 'concentrate here', 'low priority' and 'possible overkill', allowing management to identify the areas of highest concern that warrant the use of limited funds. One problem arising with this approach is the debate in the placement of the crosshairs used to divide the grid into quadrants. Martilla and James (1977), who pioneered this

technique, highlighted the fact that IP analysis works with relative rather than absolute measures of importance and therefore the placement of crosshairs in relationship to motivation and satisfaction means is subjective. There are several crosshair measures that have been used, including actual means, scale means and statistical means (Oh, 2001; Tonge & Moore, 2007). A further option is to place the crosshairs at a point that denotes high importance and satisfaction along the chosen scale underlying the stringent quality of the assessment made (Wade & Eagles, 2003; Bennett & Rollins, 2009).

Alternatively, some researchers suggest that a diagonal line or iso-rating line model, which separates the graph into two areas, is a more appropriate means of assessing the high priority features requiring immediate management attention (e.g. Hawes & Rao, 1985; Slack, 1994; Sampson & Showalter, 1999; Bacon, 2003; Abalo et al., 2007). The 45^{o} line represents points where the satisfaction and importance ratings are equal. Items below the line have higher satisfaction scores than importance scores and generally indicate a sustainable industry. Conversely, items above the line show where management attention should be concentrated as satisfaction levels are lower than importance levels. An item's distance from the iso-line reflects the size of the discrepancy between the importance and satisfaction ratings (the 'importance-performance error', Sethna, 1982); the greater the distance above the iso-line, the greater the need for management intervention (Abalo et al., 2007). The iso-line approach appears to be a more sensitive method of identifying areas of concern because it focuses on differences in satisfaction and importance ratings, rather than subjective category selection. The emphasis on differences in mean scores is important considering the

potential for individual evaluation of a given set of attributes to inflate importance ratings (Oh, 2001).

To gain a better understanding of what factors detracted from the whale shark interaction experience and to focus management attention, an IP analysis was performed using the importance and satisfaction mean scores and the iso-rating line method. A gap analysis was performed to identify features with significantly different mean importance and satisfaction scores using paired t-tests. This method involves the subtraction of satisfaction mean scores from importance mean scores. The outcome represents the size and direction of the relationship between these two measures. A positive value represents a tour feature in which visitor expectations were not met, with dissatisfaction increasing with increasing size of the discordance between the two values. Negative values represent features that were found to be satisfactory. All features were significantly different ($p=0.05$), with the exception of length of trips and quality of marine transport (Figure 2.6). Results suggest respondents were satisfied with the snorkelling conditions encountered on Holbox (11), as well as the number of whale sharks observed (12) and their proximity to the sharks (13).

The IP analysis identified ten environmental and tour features of management concern. The environmental features highlighted in declining order of gap size (and therefore level of discordance between importance and satisfaction ratings) were good underwater visibility (6), number of boats (4), variety of marine life (3), abundance of marine life (1), number of snorkelers (5), and abundance of large fish (2).

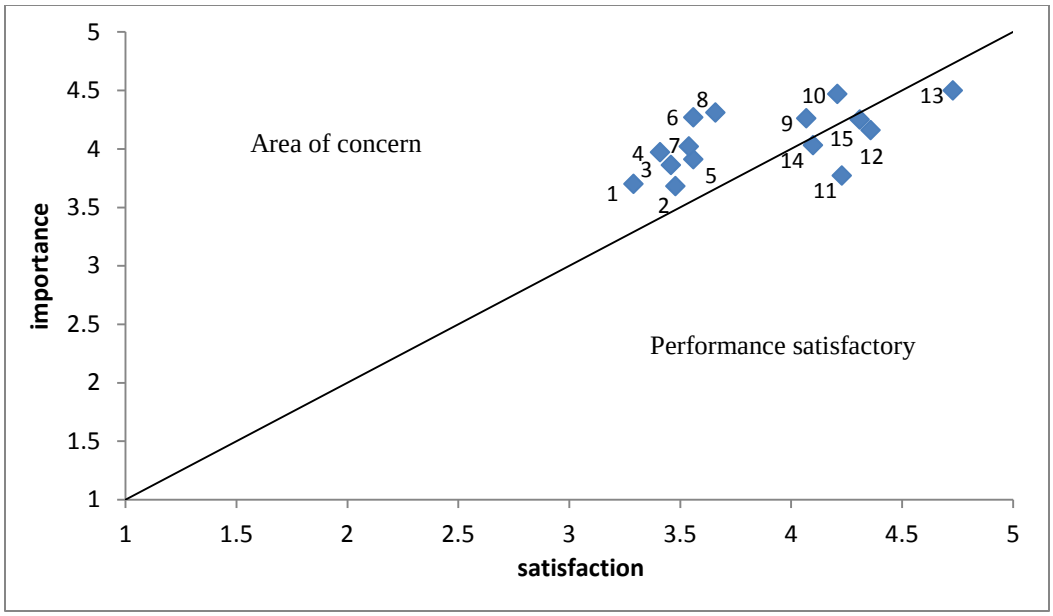

Figure 2.6. Importance-performance analysis of environmental and tour features.

Table 2.1. Importance-performance and gap analyses of environmental and tour features.

	Importance		Satisfaction		Gap value (I-P)	p
	mean	sd	mean	sd		
Area of Concern (importance > satisfaction)						
Environmental and setting features						
1. abundance of marine life	3.69	1.025	3.28	1.062	0.41	0.000*
2. abundance of large fish	3.67	0.999	3.48	1.163	0.19	0.008*
3. variety of marine life	3.87	0.946	3.46	1.110	0.42	0.000*
4. number of boats	4.00	1.014	3.40	1.203	0.60	0.000*
5. number of snorkelers	3.93	1.055	3.57	1.145	0.36	0.000*
6. good underwater visibility	4.28	0.784	3.56	1.187	0.73	0.000*
Tour services						
7. cost of trip	4.02	0.813	3.54	1.072	0.51	0.000*
8. information provided by the boat crew	4.33	0.717	3.69	1.211	0.64	0.000*
9. safety procedures on boat	4.26	0.768	4.07	0.976	0.19	0.002*
10. commitment to the environment by the boat crew	4.47	0.698	4.22	0.917	0.25	0.000*
Performance satisfactory (satisfaction > importance)						
Environmental and setting features						
11. easy snorkeling conditions	3.78	0.963	4.23	0.913	-0.45	0.000*
12. number of whale sharks encountered	4.18	0.774	4.35	0.984	-0.17	0.000*
13. proximity to whale sharks	4.51	0.619	4.73	0.634	-0.22	0.000*
Tour services						
14. length of trips	4.03	0.779	4.12	0.906	-0.09	0.155
15. quality of marine transportation services	4.26	0.703	4.32	0.820	-0.06	0.261

* significantly different at α=0.05, based on a paired samples t-test
sd = standard deviation

In a separate question, participants were asked to rate their overall satisfaction with tour services. The tour services on Holbox received a mean score of 4.09, with the majority of respondents (82.3%) indicating they were satisfied with services available on Holbox. However, the IP analysis identified four tour features that needed management attention: the lack of information provided by the boat crew (8), the cost of the trip (7), the lack of commitment to the environment of the boat crew (10), and the lack of safety procedures on board (9) (Figure 2.6). Despite being ranked as the second most important aspect of the tour service, the information provided by the captain and guide left a significant number of participants (22.4%) dissatisfied with what was available on Holbox. The cost of the whale shark tour received the lowest satisfaction rating (53.0%) with nearly a fifth of respondents dissatisfied (17.8%). Commitment to the environment and safety procedures on board received high satisfaction ratings, with only 5.3% and 7.8% of respondents unhappy with the services offered on Holbox, respectively.

However, one must be careful in the interpretation of results of the IP analysis in which mean scores are used, as these values do not reflect the variability present in the sample (Randall & Rollins, 2009). For example looking at item 1 (abundance of marine life) below, the mean importance score is 3.29 with a standard deviation of 1.075. Therefore, 68% of mean scores for this feature are between 2.29 and 4.29, which would shift many people further away from the iso-line (i.e. worse performance) or below the iso-line (i.e. satisfactory), depending on the corresponding variability in response rates for the satisfaction score for this item. Consequently, IP analysis is simply one means of identifying areas for management attention and these outcomes may not reflect the views of all participants.

2.4. Discussion

Understanding tourist needs and expectations can help inform management interventions and improve the quality of services offered at a particular tourism destination. The results of the IP analysis for the whale shark tourism industry on Holbox identified several areas of relative concern with respect to environmental and setting attributes, crowding and tour services. Each will be discussed in turn followed by potential management approaches, including addressing issues with false advertising, implementing a license cap and developing a better guide training program.

2.4.1. False advertising

Results of the IP analysis identified underwater visibility as the feature with the greatest discrepancy between importance and satisfaction, and therefore of greatest concern to management. Although underwater visibility is not a factor that management can typically control, the dissatisfaction experienced on Holbox is at least partially because of the use of false advertising within the industry. Hotels, dive shops and tour operators use images from Southeast Asia and Australia (where water clarity is generally much higher) to sell the whale shark tour on Holbox. In comparison, the waters off Holbox have much lower visibility (at times less than 1 m) due to very high concentrations of plankton. Understandably, tourists are unhappy with site conditions when they have been sold a tour based on images of deep blue seas with excellent visibility.

Several tour agencies also make promises regarding the availability and frequency of encounters with other marine life (e.g. manta rays, turtles, dolphins, golden rays, eagle rays, flying fish) to make the tour more appealing to tourists. However, there is only a guarantee of seeing whale sharks on any given day. Thus, many tourists are enticed to go

on these tours with unrealistic expectations regarding the species diversity of the area resulting in reduced satisfaction with the environmental features of the tour (e.g. abundance of large fish and marine life, variety of marine life). Problems could be avoided by ensuring that advertisements for the Holbox industry use accurate information and do not promise features or services that cannot be delivered.

2.4.2. Educational information

Following the issues related to underwater visibility, the IP analysis identified the information provided by the boat crew as the next feature of most importance to managers. This feature is related to the educational information available on the tour. Not only was it identified as an area of concern for management, but expansion of knowledge also was rated the second most important social/psychological motivation for participating in the whale shark tour on Holbox (83.5%).

Some of the larger operators and hotels acting as third party booking agents do provide an informational DVD during the morning briefing, but it is not required viewing. The DVD is provided in multiple languages (English, French, Spanish, and Italian) and covers safety procedures on board, as well as an overview of whale shark biology and ecology. However, the briefing typically consists of detailing which tourists will be going to which boat while the DVD is playing in the background. The outcome is that the important information regarding safety procedures on board and whale shark ecology and conservation is not conveyed to the tourists.

Regardless of whether or not briefings are provided prior to embarkation, guides are required to provide a pre-encounter briefing for their customers. Most guides do explain the interaction rules to the tourists prior to arriving in the whale shark viewing

area. However, many guides do not provide any further information (e.g. biology/ecology, research, threats), despite the fact they received this information during their mandatory certification process. The latter is partially due to language and cultural barriers. The majority of those involved in the industry were, or currently are, local fishermen with a low degree of schooling (Zenteno, 2007) who are uncomfortable and/or unable to deliver the information in a second language.

The lack of information provided to whale shark watching participants affects the conservation potential of this industry. Whale sharks are emerging as a flagship species for the shark conservation campaign. However tourists visiting Holbox do not receive any significant information regarding whale shark biology and ecology nor the threats they, along with other sharks, currently face beyond what is shown in the pre-interaction DVD (which they may or may not have seen). This type of environmental information is critical in instilling a conservation ethic in tourists (e.g. Powell & Ham, 2008; Zeppel & Muloin, 2008; Ballantyne et al., 2009, in press). For example, Powell & Ham (2008) found that a well-designed interpretation program had a significant impact on pro-environmental attitudes of visitors (awareness of area, support of management interventions), as well as longer-term intentions to support and participate in conservation efforts.

2.4.3. Perceived crowding

Another important area of concern identified in the IP analysis is the number of boats encountered in the whale shark viewing area. The problem with boat numbers is a direct result of the uncontrolled growth of the industry. Visitation has increased from 1,500 participants in 2002 to over 17,000 in 2008 (de la Parra, 2008). The Mexican

government's reluctance to control the growth of the whale shark watching industry on Holbox suggests a government philosophy of maximizing numbers in order to maximize economic returns for local industry. This approach, while successful in the short term, has led to a large increase in the number of operators entering the industry. The number of boats licensed to operate has gone up from 42 in 2003 to 250 during the 2010 season, despite discussion and initial planning for a license cap of 140 during the 2008 season.

The lack of government limits has created a high concentration of tour operators within the whale shark viewing area. The latter could create conflict among the tour operators (only one boat is allowed to interact with a shark at one time), as well as increase perceived crowding for the participants, both in terms of the number of swimmers and boats encountered. Catlin & Jones (2010) determined that while crowding related to number of swimmers was on the decline for the whale shark tourism industry at Ningaloo Marine Park, Western Australia, crowding related to the number of boats was emerging as a new concern. Bell (2010) examined perceived crowding of visitors to Molokini Shoal Marine Life Conservation District, Hawai'i and found that the number of boats had a significant impact on the quality of visitor experience with two thirds of respondents feeling crowded and 80% supporting management interventions that would limit the number of boats in the area.

The large number of boats licensed to offer tours on Holbox increases the likelihood that multiple boats will have to alternate their swimmers in order to interact with a single shark. Further, boat captains use their radios to inform other boats of the location of whale sharks, thereby increasing the number of boats wanting to interact with a given shark. The 'sharing' of sharks amongst multiple boats increases the likelihood

that the limit of two swimmers and guide will be disregarded. Indeed, participant feedback suggests that more than the allowed number of swimmers was interacting with a shark at least a quarter of the time, with up to ten people in the water at once. Some boat captains drop off their swimmers regardless of whether or not there are other swimmers already interacting with a shark. On one particularly poor day for whale shark sightings during the 2009 season, more than thirty boats were observed around a single shark, with up to twenty people in the water at one time (Figure 2.7). Operator disregard for the allowed number of swimmers may be behind the high dissatisfaction with the number of encountered snorkelers, as 80% of respondents supported the current limit of two swimmers and guide. The high levels of support for the current swimmer limit also suggest that a means of solving potential issues with swimmer crowding is to enforce the existing encounter rules.

Figure 2.7. Images of multiple boats interacting with a single whale shark off Isla Holbox (photo: J. Ziegler).

The whale shark encounter guidelines on Holbox specifically state that the number of boats allowed within the viewing area should be limited; however, the guidelines do not stipulate an acceptable number (CONANP, 2008). In contrast, the code of conduct for the whale shark tourism industry in Donsol, Philippines does specify that

only 30 boats are allowed at one time in the whale shark viewing area and each tour will last a maximum of three hours (Municipal Executive Order No. 23, 2009). Similarly, the whale shark tourism industry in Placencia, Belize has placed a cap on the number of boats allowed within the whale shark viewing zone per 1.5 hour time slot (four boats per time slot, twenty-four boats per day, Carne, 2008) to restrict the number of boats (and tourists) entering the viewing area per day (Cohun, 2005). These examples suggest that the number of boats allowed within the whale shark viewing area is an important factor for the responsible management of the industry, both from a social (crowding) and biological (environmental impacts) perspective, and one that is completely disregarded by the industry on Holbox.

2.4.4. Cost

A final area of concern identified in the IP analysis is that of tour cost. The lack of commitment in controlling the growth of the whale shark watching industry on Holbox has led to a mismatch of the supply and demand. At present, boat capacity outnumbers the number of people wanting to participate in the whale shark tour. Consequently, there is a high turnover rate of permit holders because the operating costs for the three-month whale shark season tend to be greater than the money generated selling the tour for many of the smaller operators (Zenteno, 2007). In other words, the smaller operators are more likely to go into debt than make a profit.

The large number of boat licenses flooding the market has also resulted in an industry that is unable to provide an equal share of the market to all its members. Three or four of the larger operators on Holbox own at least 60% of the market share, leaving approximately forty of the smaller operators fighting over the remaining 40% (Zenteno,

2007). The small operators' lack of organization, limited financial capital, schooling and business acumen make it even harder for them to break even compared to the larger operators, who tend to be entrepreneurs with other business interests (e.g. golf cart rental, mini-supermarkets, food stands) (Zenteno, 2007). As a result, many of the smaller operators are forced to lower prices in order to remain competitive, despite the fact they are already struggling to make up overhead costs (Zenteno, 2007).

Price discrepancy is a real problem for the industry on Holbox and further stratifies the operators in the industry. As demonstrated in the results of the IP analysis, the cost of the tour is an immediate area of concern that must be addressed. During the 2008 season, cost varied from US$40 to over US$500 depending on the operator used, as well as the starting point of the tourists (i.e. day versus on-island tourist) and transport used (i.e. van, airplane). Yet the more expensive tour prices did not necessarily correspond to a higher quality experience. The larger operators rely mainly on their ties with hotels and tour agencies, and not the quality of the services offered, to attract clients. Consequently, many of these operators are more likely to provide a mass product focused on maximizing profits by offering the bare minimum in tour services at the same or an increased cost to the tourist. For example, many of the smaller tour operators provide not only the whale shark swim, but also snorkelling at a local reef to see nurse sharks. The larger operators, dealing with many of the day tourists, do not include this experience, although the booking agencies still use it as a selling point to attract tourists. Thus, the issue of cost may not reflect a problem with the actual price of the tour, but value for money spent and further problems with false advertising.

The government response to the problem of mismatched supply and demand is to increase demand. During the Second International Whale Shark Conference held on Holbox in July of 2008, a government representative suggested that these market differences would be best resolved if the industry increased tourism numbers through the implementation of a more widespread marketing campaign (regional, national, international). According to this logic, increased tourism numbers would allow all operators the opportunity to offer tours on a daily basis, instead of only once or twice a week, a practice that the smaller operators have been forced to adopt (Zenteno, 2007). The proposed strategy does not take into account the issue of sustainability for the species, the impact of too many tour operators, nor customer satisfaction.

A better approach would be to provide an equal opportunity for all operators to offer their services to potential clients. Examples of the successful implementation of this management approach exist in both the Philippines and Belize. The whale shark industry in Donsol, Philippines has a single tourist registration point, which designates which captains and guides will be with which group of tourists by rotating through an alphabetical list of available guides and captains. On the other hand, managers of the whale shark industry in Placencia, Belize implemented a lottery system for the six daily 1.5 hour time slots to ensure that all operators have an equal chance of getting access to the whale shark area and prime time slots (Graham & Bustamante, 2007).

A potential solution for the problems with equitable access on Holbox could include a combination of the above approaches. The industry on Holbox is similar to Belize in that many guides and captains work for specific operators making it difficult to assign tourists to individual captains and guides. Yet, simply implementing a lottery

system for tour operators would not help equalize access to the whale shark area, as operators would still be responsible to find their own customers. Creating a single registration point for tour participants (e.g. with CONANP) would resolve this issue. Registered tourists would then be assigned a boat at random using an alphabetical list of operators (not guides/captains), thereby eliminating problems associated with larger operators (with more boats) having an increased likelihood of being selected. Regardless of method, it is clear that the managing agencies for the industry on Holbox need to address problems with the inequitable distribution of the market.

2.4.5. Growth Management

Results of the IP analysis highlight a problem with the uncontrolled growth of the whale shark tourism industry on Holbox. If competition is not addressed, the resulting cost cutting will ultimately affect critical safety and service standards. Other marine tourism industries, such as scuba diving, face similar problems in which over supply and fierce competition lead to an overall decline in industry standards (Dearden et al., 2007a). In an attempt to set basic safety and service standards with the whale shark watching industry on Holbox, the Mexican government established regulations that control who can provide these tours and how, including setting minimum safety and environmental requirements, such as the use of four-stroke engines and radios (Remolina Suarez et al., 2005). The guides and captains must also undergo a certification process that covers safety, such as first aid and aquatic rescue, tourist guidance, snorkelling techniques and information regarding the biology and ecology of whale sharks (Remolina Suarez et al, 2005).

However, the results of this study suggest the Holbox industry is already facing issues of low satisfaction with the information provided by the boat crew, as well as

concerns over safety procedures and commitment to the environment. Lack of government enforcement of the existing regulations only compounds the problem resulting in tour operators applying the rules as they see fit. Thus, it is important to improve guide training in order to gain community buy-in and increase compliance.

Cohen (1985) identified four roles of the tour guide: 1. instrumental (i.e. safety), 2. social (i.e. group harmony), 3. communicative (i.e. interpretation), and 4. interactional (i.e. impacts on culture and environment). The guides and captains on Holbox need better training to address each of these roles and improve the conservation value of the industry through interpretation and leadership. Training should include information regarding the threats to sharks, as well as the impacts of tourism on whale sharks (e.g. Quiros, 2007; Pierce et al., 2010). Guides should also receive English classes to enable them to communicate more effectively with their customers (approximately 60% are foreign, Cepeda, 2008). This training programme would not just increase the knowledge of tour operators, but would work to make the guides and captains more likely to enforce the rules when in the whale shark viewing area, as well as share their knowledge with their customers. In turn, the increased visitor knowledge could help improve the conservation potential of whale shark tourism activities, as research suggests that well designed interpretation programs, which include threats and conservation actions, can positively influence the environmental ethic of participants (e.g. Orams, 1997; Tisdell & Wilson, 2005; Ballantyne et al., 2007; 2009; in press; Powell & Ham, 2008).

2.5. Conclusions

Marine wildlife tourism is one of the fastest growing sectors in the tourism industry (Cater & Cater, 2007) and shark tourism is emerging as an important niche market in this

sector (Topelko & Dearden, 2005). The phenomenal growth of the shark tourism industry coupled with the fact that a significant number of shark species are considered vulnerable to extinction underline the importance of considering the precautionary principle (i.e. to err on the side of caution in terms of action when scientific understanding of impacts is not available) when developing tourism activities. Yet, there has been little interest in examining the interface of the social and biological aspects of tourism activities and its critical role in sustainable wildlife tourism management.

Nevertheless, the results of this paper demonstrate the importance of understanding the human dimensions of wildlife tourism for the successful management of these activities. The comparison of tourist motivations and satisfaction of available environmental and tour features using IP and gap analyses highlighted critical aspects of the whale shark tour that were detracting from visitor experience, including problems with false advertising, lack of educational information, perceived crowding, and tour cost. These factors are representative of larger issues related to the uncontrolled growth of the whale shark tourism industry on Holbox.

Consequently, any successful solution to the problem of effective management would have to include limiting the number of boats in the industry within more sustainable limits, as well as ensuring the equitable distribution of economic benefits within the industry. If these goals can be achieved, it would eliminate current problems with questionable business practices (e.g. competition, false advertising). Further, problems with perceived crowding would be much improved if the industry simply followed the rules at hand (e.g. limit number of boats in viewing area, two swimmers at a time, one boat per shark). Finally, management should focus on improving the guide

training programme to address issues with leadership, interpretation, compliance and language barriers to further the conservation potential of whale shark tourism activities. The close proximity of Holbox to tourism destinations like Cancun and Playa del Carmen, which have millions of visitors every year, has the potential to further raise tourism numbers to unsustainable levels. Understanding the tourist market, motivations and satisfactions can help guide the industry into a more sustainable mode for the future.

Chapter 3: Are recreation specialists really more concerned about the environment? A case study of the whale shark watching industry on Isla Holbox, Mexico

Harmony with land is like harmony with a friend; you cannot cherish his right hand and chop off his left. - Aldo Leopald

Abstract

Whale shark tourism is a growing niche market within the marine wildlife tourism sector. The whale shark's status as a threatened species, coupled with growing visitation and varying management models at whale shark tourism sites worldwide, raises questions over the long-term sustainability of this industry. Specialization has been linked to differences in environmental behaviours and acceptable management interventions. Thus, understanding the specialization profile of tourists at a tourism site can provide insights into its effective management. The objectives of this study were two-fold: to identify key criteria that could be used to distinguish among various shark user groups based on specialization, and to assess whether differences in specialization could help explain the variability observed in pro-environmental behaviours and support for management intervention. Specialists tended to be older, with higher dive training, a greater knowledge of sharks and the threats they face, more sensitive to crowding, and use an underwater camera compared to both generalist and intermediate users. Surprisingly, specialists were also significantly more likely to touch the sharks, but significantly less likely to perceive any negative environmental impacts of the tourism impacts compared to other user groups. Further, they were significantly more satisfied with the current laissez-faire management approach. Contact rates appear to be linked to the use of underwater cameras and were mostly accidental in nature. These findings highlight the need for improved interpretation and guide intervention in order to reduce impacts on an already threatened species within its critical feeding habitat.

Keywords

Specialization, Environmental impacts, Wildlife tourism, Interpretation, Whale sharks,

Role of guides

3.1. Introduction

3.1.1. Whale shark tourism

Whale sharks are one of the most watched shark species in the world (approximately one

fifth (100,000, Norman & Catlin, 2007) of all shark tourists (500,000, Dearden et al.,

2008) participate in swim-with whale shark tourism activities worldwide) with whale shark tourism valued at US$66 million (Graham, 2004). The characteristics that make whale sharks an ideal species for tourism include large size, slow movement, and tendency to stay at the surface. However, these characteristics also make them vulnerable to overharvesting (Chen & Phipps, 2002). In addition, whale sharks are the target for illegal activities, such as finning (i.e. the practice of removing shark fins and discarding the body at sea), because of the continued demand for shark products in Asian markets (Paddenburg, 2010). The targeted overexploitation of whale sharks occurs despite protection at the international level, including listings in Appendix II of the Convention on Migratory Species, Appendix II of the Convention on International Trade of Endangered Species, and the World Conservation Union's Red List of Threatened Species (Norman, 2005). For these reasons, the whale shark has emerged as a flagship species for the conservation of sharks and marine ecosystems worldwide (Graham, 2004; Norman & Catlin, 2007; Pine, 2007).

With today's growing interest in marine wildlife viewing, increasing tourist numbers at whale shark sites could significantly affect the conservation value of whale shark tourism. High tourist volumes could have a deleterious impact on the target species and the surrounding environment, the quality of the visitor experience, as well as the community dependent on that species for their livelihoods if growth of the tourism industry is not managed appropriately (Duffus & Dearden, 1990; Higham, 1998; Garrod & Fennel, 2004). Thus, there is an imperative to understand the sustainability of a particular tourism site in order to assist management decisions regarding appropriate levels of use for that site (Duffus & Dearden, 1990).

Following an assessment of the sustainability of whale shark tourism sites, Dearden et al. (2008) identified the industry on Isla Holbox, Mexico as the largest and fastest growing tourism site in the world. Isla Holbox, located approximately 2 hours from Cancun, is a small fishing village off the northern tip of the Yucatan peninsula with an approximate population of 1,500 people (Figure 3.1). From the months of May through September, whale sharks aggregate in large numbers (estimated aggregation size of 1410 individuals, de la Parra, 2008) off the coast of Holbox. The whale sharks' arrival coincides with an increase in primary productivity due to seasonal changes in oceanic currents where the Caribbean and Gulf of Mexico meet creating areas of upwelling and high nutrient content (de la Parra, 2008).

Since whale shark tourism was first established on Holbox in 2002, the industry has experienced the fastest growth and the highest swim-with whale shark visitor numbers worldwide (Dearden et al., 2008), with over 17,000 people during the 2008 season (de la Parra, 2008). An important contributing factor to this growth is Holbox's close proximity to mass tourism destinations like Playa del Carmen and Cancun. These mass tourism destinations offer day tours to swim with the whale sharks on Holbox, which could potentially have a negative impact on the future of this industry if no attempt is made to control its growth.

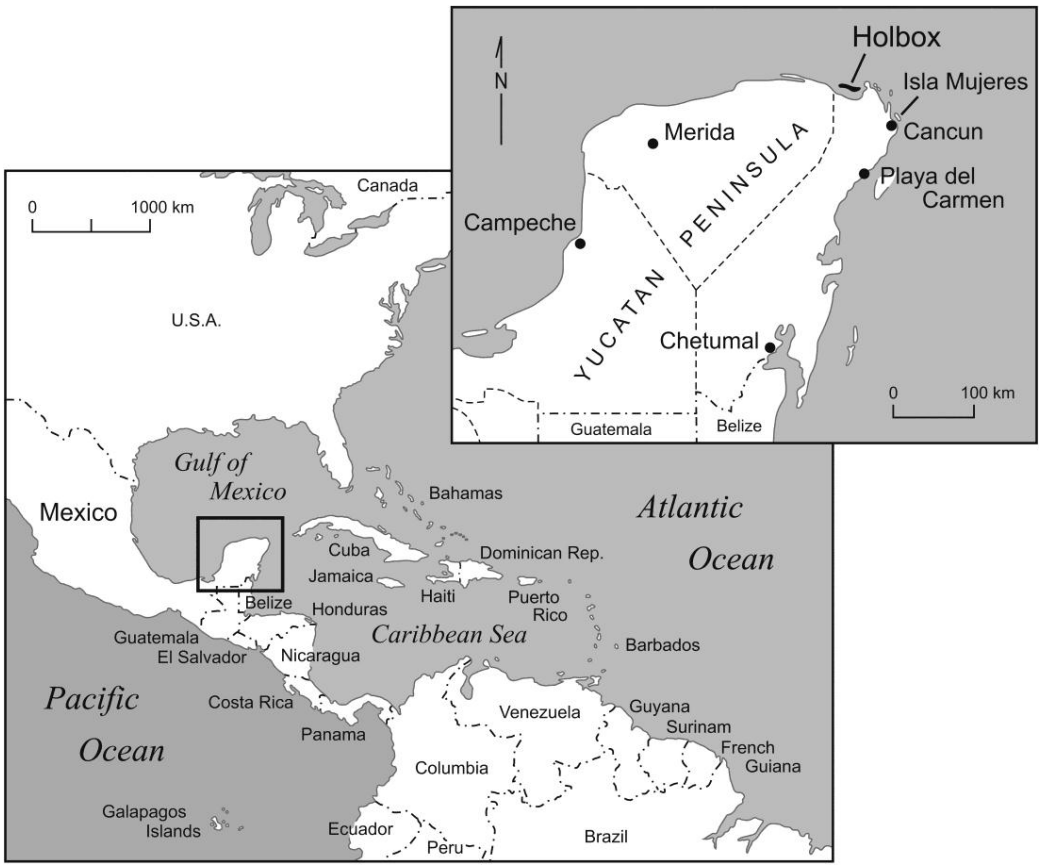

Figure 3.1. Map of study area.

The effective management of the industry on Holbox requires both ensuring the conservation of the targeted species and providing an enjoyable recreational experience for the tour participants (Duffus & Dearden, 1990). However, the majority of research on whale sharks has focused on the biophysical aspects of the sharks including general biology and ecology (Graham et al., 2006; Heyman et al., 2001; Stevens, 2007; Motta et al., 2010), population structure (Meekan et al., 2006; Bradshaw et al., 2007, 2008; Castro et al., 2007; Schmidt et al., 2009, 2010), and migration (Eckert & Stewart, 2001; Eckert et al., 2002; Rowat & Gore, 2007; Wilson et al., 2001, 2006). Little research has been conducted on the impacts of whale shark tourism on the target population (Norman, 1999; Quiros, 2007; Pierce et al., 2010), the community dependent on tourism activities

(Diaz-Amador, 2005; Cepeda, 2008; Catlin et al., 2009) or the tourists themselves (Davis et al., 1997; Catlin & Jones, 2010).

However, participant needs and expectations are important in assessing management effectiveness, as visitors will not continue to pay for experiences that do not yield high satisfaction levels. Tourist satisfactions differ amongst different tourist types. One important variable, and the one to be considered in this paper, relates to the degree of specialization in the tourist activity.

Accordingly, the goals of this study were to:

1. assess environmentally responsible behaviour and support for pro-environment management interventions for whale sharks users on Holbox, and
2. determine if specialization can help explain variability in the above factors.

The following section discusses the concept of specialization and its relationship to environmental awareness and behaviour in more detail.

3.1.2. Specialization

Understanding participants' needs and expectations of a recreational activity or site is a critical aspect of improving management's responsiveness in the face of growing public interest in marine wildlife tourism opportunities. However, wildlife tourists do not form a homogeneous group in terms of their skills, interests and behaviours (Duffus & Dearden, 1990; Needham et al., 2007). Consequently, researchers have focused their efforts on segregating users into meaningful subgroups in order to improve understanding of differing behaviours and attitudes toward natural resources (Bright et al., 2000; Dearden et al., 2007a,b; Malcolm & Duffus, 2008; Semeniuk et al., 2009; Sorice et al., 2009; Needham, 2010). Segregating characteristics used in the literature include demographics

(Zinn & Pierce, 2002; Dougherty et al., 2004), management preferences (Semeniuk et al., 2009), and value orientations (Needham et al., 2007; Needham, 2010).

Experience has also been used to differentiate among wildlife recreationists (Todd, 2000; Thapa et al., 2006; Dearden et al., 2007a,b; Meisel-Lusby & Cottrell, 2008; Jett et al., 2009). Wildlife users differ in terms of their beliefs, values, ethics, experiences and views of appropriate wildlife interactions, which then affects the users' expectations and satisfaction with the wildlife encounter in question (Martin, 1997; Moscardo, 2000; Higham & Carr, 2002; Scott & Thigpen, 2003; Curtin & Wilkes, 2005; Dearden et al., 2007a). These differences have been linked to the concept of specialization (Bryan, 1977; 1979; Inglis et al., 1999). Bryan (1977; 1979) placed users along a continuum from novice to specialist based on time, money and equipment dedicated to a given activity, as well as psychological commitment and skill. As users become more specialized in a particular activity, their motivations, resource preferences, attitudes towards management policies, values and beliefs may also change, usually towards a more pro-conservation position (Bryan, 1977; Scott & Shafer, 2001; Thapa et al., 2006).

Specialization has been successfully used to ascertain conservation attitudes (Mowen et al., 1997; Dyck et al., 2003), environmental behaviours (Thapa, 2000; Thapa & Graefe, 2003), motivations (McFarlane, 1994), setting preferences (Martin, 1997; Bricker, 1998; McFarlane, 2004), perceived crowding (Graefe et al., 1986) and preferences for management action (Bricker & Kerstetter, 2000; Salz et al., 2001; Oh & Ditton, 2006; Sorice et al., 2009).

Duffus and Dearden (1990) linked specialization with Butler's (1980) 'tourism life cycle', which describes the growth of a wildlife tourism site over time, and

recognized that the specialization profile for a tourism site may change over time. The authors suggest that the typical growth of a site follows a pattern in which the highly specialized wildlife users who originally pioneered the site as a tourism destination are gradually displaced by an influx of generalized users (Duffus & Dearden, 1990). These new users not only require an increase in the amount of infrastructure, but also are more likely to accept lower site standards in terms of crowding and environmental impacts, including negative impacts on the target species.

If user specialization can be assessed for a given site, it can provide insight into differences in environmental attitudes, behaviours and impacts among users. Thus, specialization research has the potential to help guide management interventions aiming to reduce negative impacts on the targeted resource (Barker & Roberts, 2004; Oh et al., 2005; Dearden et al., 2007a; Thapa et al., 2006; Worachananant et al., 2008; Sorice et al., 2009). High specialists are thought to have a greater environmental awareness than generalist users (Bryan, 1977; 1979; Duffus & Dearden, 1990; Sutton & Ditton, 2001; Dyck et al., 2003; Dearden et al., 2007a; Thapa et al., 2006). Consequently, specialization is expected to be negatively correlated with negative impacts on the environment and positively correlated with support for conservation-focused management interventions (Sorice et al., 2009).

However, previous research examining the interrelationship of specialization, environmental impacts and support for management intervention does not always support the above correlations (e.g. Todd et al., 2000; Thapa et al., 2006; Jett et al., 2009; Sorice et al., 2009). For example, Todd et al. (2000) found that specialist divers were more likely to touch and/or remove artefacts than more generalist divers, while Sorice et al.

(2009) determined that specialist scuba divers did not support having less access to a resource or extensive supervision even if it would improve the quality of the environment. These contradictions in expected behaviour and support for management interventions with respect to specialization level highlight the importance of understanding specialization for the successful management of a wildlife tourism site, especially one targeting threatened or vulnerable species.

There is little agreement among researchers on how to measure specialization. Although the majority of studies advocate the use of a multi-dimensional approach that focuses on behavioural, cognitive and affective factors to measure specialization (Scott & Shafer, 2001), problems have occurred delineating which dimension a particular indicator measures, as well as the interrelationships among these dimensions (Needham et al., 2007). Furthermore, many researchers approximate specialization along a linear continuum using single items or the sum of scores from multiple dimensions (e.g. Ditton et al., 1992; Donnelly et al., 1986; Dyck et al., 2003; Kerstetter et al., 2001; Dearden et al., 2007a; Lee et al., 2007; Malcolm & Duffus, 2008). This approach may oversimplify specialization because it relies on researchers choosing the subgroups, it assumes that the dimensions included co-vary, and it ignores the depth of information provided by each dimension (Needham et al., 2007). Dimensions do not always increase linearly in lock-step fashion. Some recreationists may have low skills but participate regularly in, and are committed to, an activity, while others may have the skills and commitment, but lack the frequency of participation (Scott & Shafer, 2001; Scott et al., 2005). In either case, the variability within each dimension may be lost when integrated into a single value.

In response to these concerns, cluster analysis has emerged as a technique to segment a given population into subgroups based on variation within each dimension measured without assuming the covariance of these dimensions (Scott et al., 2005). Although cluster analysis is a descriptive technique and still requires the researcher to choose the final cluster solution, it may provide a more appropriate segmentation of the participants into subgroups (Lee & Scott, 2004; Scott et al., 2005). Cluster analysis has been successfully used to segment specialization subgroups in diverse recreational activities including hunting (Needham et al., 2007), fishing (Chipman & Helfrich, 1988; Fisher, 1997; Oh et al., 2005), camping (McIntyre & Pigram, 1992), and birdwatching (McFarlane, 1994; Hvenegaard, 2002; Scott & Thigpen, 2003, Scott et al., 2005).

Although the specialization construct has been successfully applied to marine tourism (e.g. Sorice et al., 2006; 2009; Dearden et al., 2007a; Malcolm & Duffus, 2008**)**, there has been little attempt to distinguish types of shark tourists. Catlin and Jones (2010) compared outputs from a 1995 survey of whale shark participants at Ningaloo Marine Park (NMP), Western Australia (Davis et al., 1997) to a follow-up 2005 survey in order to identify a shift in user specialization at this site. The authors used changes in such characteristics as dive certification, age distribution, nationality, dependence on services and perceived crowding to reveal a shift towards a more generalized tourism base as predicted by the Duffus and Dearden (1990) model (Catlin & Jones, 2010). The comparative analysis of the whale shark industry at NMP was only possible because of the earlier study providing key longitudinal information. Without a baseline reading of the whale shark participants, changes in specialization are difficult, if not impossible, to assess.

Catlin and Jones (2010) did not attempt to subdivide the users into specialization groups. Consequently, it is unclear if the authors' selected characteristics, discussed above**,** co-vary with shark specialization. Furthermore, the characteristics identified as relevant at NMP may not represent relevant independent specialization markers. For example, the measure of diver experience on its own is inadequate to measure shark tourism specialization. A very experienced diver with advanced certification would be considered a shark specialist even if s/he has no interest in shark diving. The problem of using dive certification as a key characteristic of shark specialization is an important issue for the industry on Holbox, as many tourists participating in whale shark tourism on Holbox are divers visiting dive sites in Cozumel and Playa del Carmen. As for the changes in distribution of nationalities and ages, these are particular to NMP and would be difficult to assess at other sites without previous data. For example, a shift to a more domestic tourism base may signal a more generalist user at NMP. However, a similar shift on Holbox is unlikely to occur, as the mass tourism markets in Cancun and the Mayan Riviera directly feed the industry. Hence, there is a need to establish specific criteria that identify a more dedicated shark tourist.

Within the study goals previously discussed, the objectives of this paper are three-fold. Firstly, it suggests key criteria that can be used to distinguish among various shark user groups based on specialization. Secondly, it looks to assess whether differences in specialization can help explain the variability observed in pro-environmental behaviours and support for management intervention. Thirdly, based on the analysis of specialization and impacts, the paper suggests management interventions to improve the conservation value of the whale shark industry on Holbox, such as developing a more comprehensive

interpretation program and improving operator buy-in for the encounter guidelines in place.

3.2. Methods

The methods included site-based distribution of a questionnaire to participants in whale shark tours on Isla Holbox, Mexico and in-water observation of whale shark-tourist interactions by the researcher. The questionnaire consisted of fifty-six mainly closed-ended questions organized in four sections addressing various aspects of the whale shark tour experience on Holbox including motivations and satisfactions, shark diving experience, perceived social and environmental impacts and demographics. These questions were developed through a literature review and refined following a pilot study on Holbox in June 2008. Questionnaires were printed on 8.5" x 14" white paper and folded to produce ten-page booklets, after Salant and Dillman (1994). Portions of the questionnaire relevant to this paper are described below

Questionnaires included open-ended questions regarding past shark watching experience (number of organized shark encounters, variety of shark species encountered, location of interactions) and general knowledge of sharks, as well as closed-ended questions regarding centrality of shark watching to life (importance of whale sharks in decision to visit Mexico), satisfaction with tour services and environmental features, compliance with encounter guidelines, importance of whale sharks as a tourism draw and demographics. Surveys were provided in Spanish and English.

Questionnaires were distributed to whale shark tour participants on Isla Holbox over a 10 week period from June to August 2008, which represents the whale shark season. Tourists were selected opportunistically as they descended from the boats upon

return from the whale shark tours. Questionnaires were also distributed to hotels and travel agencies on Holbox that offered whale shark tours to on-island clients to distribute to their clients participating in the tour.

A total of 397 surveys were collected over the three-month period, resulting in a 5.0 % margin of error (95% confidence interval) (Salant & Dillman, 1994). Approximately 90% of those participants approached completed a questionnaire. The main reasons for not completing a survey included a member of the group/couple had already completed one, language barriers, and lack of interest and/or time. The response rate for surveys collected through hotels and agencies is unknown. However, the latter group made up only a small fraction of the overall sample size (approximately 10%) and thus would not significantly affect nonresponse bias. Literature suggests a response rate of 60% can be considered sufficient in accurately representing the population being sampled (Dolson & Machlis, 1991), while greater than 70% is considered very good (Babbie, 2007). Thus, the 90% response rate provides an adequate representation of the whale shark tour participants on Holbox.

3.3. Results

Key questions believed to reflect a more specialized shark user were selected to identify the distinct whale shark user groups. Questions included were:

1. the number of different shark species with which an individual had swum previously;
2. the number of different regions visited in order to specifically encounter sharks; and
3. the importance of whale sharks in their decision to visit Mexico.

The above items represent different levels of measurement: number of shark species and regions was measured on a ratio scale (i.e. represent real numbers with non-arbitrary 0), while the importance of whale sharks was measured on an ordinal scale (i.e. rank ordering describes order but not size or degree of differences between items). Further, the spread of ratio measurements was strongly positively skewed resulting in outliers that would prevent the use of statistical analysis due to lack of sufficient data (Table 3.1). Thus, these values were transformed into nominal (or categorical) data for ease of comparison and application of appropriate statistical tests.

A score of '1' represents a 'generalist' user's response, while a score of '2' represents a 'specialist' user's response. The categories were delineated as follows:

- number of different shark species encountered during previous organized shark tours

  1.00 represents 0 to1 species and 2.00 represents 2 or more species

- the number of different regions visited to encounter sharks

  1.00 represents 0 to1 regions and 2.00 represents 2 or more regions

- the importance of whale sharks in the user's decision to visit Mexico

  1.00 represents a response of not sure, not at all important and slightly important, while a score of 2.00 represents a score of quite or extremely important.

Table 3.1. Frequency and skewness of different measures used to categorize shark specialists.

Measurement scale	Frequency	Skewness
Ratio		
number of different shark species		
0	285	2.447
1	46	
2	28	
3	4	
4	4	
number of different regions		
0	285	2.219
1	53	
2	26	
3	3	
4	1	
Ordinal		
importance of whale sharks		
1 - not at all important	166	0.586
2- slightly important	69	
3 - quite important	63	
4 - extremely important	65	
5 - not sure	5	

Data was analyzed using a k means cluster analysis (SPSS, 2008) in order to identify the key user groups that made up the whale shark tourist population on Holbox. A Scheffé test was then performed in order to identify the groups that differed significantly from each other. Two, three, four, five and six cluster solutions were explored. The three-cluster solution was selected as providing the best solution because it had a reasonably good sample size for each cluster solution, as well as significant differences among groups and these differences were meaningful **(**Kaufman & Rousseeuw, 2005) (Table 3.2).

Table 3.2. Results of the three-cluster solution of shark specialization.

	Specialization clusters			F	df	p	Scheffé test		
Specialization questions	G	IST	S				G-IST	G-S	IST-S
Number of shark species[a]	1.03	1.05	1.92	247.5	338	0.000		*	*
Number of regions[b]	1.01	1.00	2.00	1299.0	338	0.000		*	*
Importance of whale sharks[c]	1.00	2.00	1.76	2679.4	338	0.000	*	*	*
Sample size (% of total)	218 (64.0)	98 (28.7)	25 (7.3)						

G = 'generalist', IST = 'intermediate shark tourist', S = 'specialist'
[a] 1.00=generalist, 0-1 species; 2.00= specialist, 2 or more species
[b] 1.00=0-1 regions; 2.00 = 2 or more regions
[c] 1.00= unimportant or neutral; 2.00=important
* groups are significantly different at α=0.05

Low specialists had swum with few shark species in few regions and placed no importance on whale sharks in their decision to visit Mexico. Intermediate shark tourists had swum with few shark species in few regions, but placed a lot of weight on whale sharks as a reason for visiting Mexico. The more advanced users had swum with many shark species in many different regions and placed significant weight on whale sharks in their decision to visit Mexico, but not as high as the intermediate group.

A chi-squared analysis (SPSS, 2008) was performed to assess cluster robustness based on items that had been linked to level of specialization in other activities (e.g. Dearden et al., 2007a; Thapa et al., 2006; Sorice et al., 2009) (Table 3.3). The outcomes support the 'specialist' as identified through dive tourism. For example, the more specialized tourists had the highest proportion of advanced divers (p=0.000), were significantly older (p=0.015), more likely to have an underwater camera (p=0.017), felt more crowded (p=0.005), had greater knowledge of sharks (p=0.002) and the threats they face (p=0.010), and the majority decided to participate prior to leaving home (p=0.000).

Table 3.3. Shark participant characteristics by level of specialization.

Participant characteristics	Percent response			df	x^2	p
	G	IST	S			
Dive certification						
none/open	75.7	66.3	40.0	2	14.787	0.000*
advanced	24.3	33.7	60.0			
Age						
18-35	57.1	51.1	21.7	4	10.688	0.015*
36-55	37.6	42.4	69.6			
> 55	5.2	6.5	8.7			
Self-reported shark knowledge						
little-intermediate	94.4	90.7	75.0	2	11.377	0.002*
advanced-expert	5.6	9.3	25.0			
Knowledge of threats to sharks						
poor	88.2	84.0	65.0	2	7.888	0.010*
excellent	11.8	16.0	35.0			
When decided to participate in whale shark tour						
at home	39.9	68.4	64.0	2	24.062	0.000*
in Mexico	60.1	31.6	36.0			
Perceived crowding						
not at all to slightly crowded	76.3	81.3	52.0	2	9.324	0.005*
moderately to very crowded	23.7	18.8	48.0			
Underwater camera						
no	36.6	25.8	16.0	2	6.751	0.017*
yes	63.4	74.2	84.0			

G=generalist, IST=intermediate shark tourist, S=specialist
* = significantly different at α=0.05

However, some results concerning user awareness of environmental impacts and support for management interventions were contradictory to diver specialization findings (Table 3.4). Previous research suggests that specialized divers have a greater conservation ethic than less specialized divers (e.g. Thapa et al., 2006; Dearden et al., 2007a). Specialist divers are more aware of potential negative impacts on the environment (Dearden et al., 2007a) and are more likely to employ environmentally responsible behaviours that minimize these impacts (Thapa et al., 2005; 2006; Anderson, 2007). Yet, in this study, the more specialized shark users were significantly more likely to make contact with whale sharks (37.5%) compared to either intermediate (27.2%) or low (19.5%) specialists (p=0.038). Specialists were also significantly less likely to perceive negative impacts of the tourism activity on whale sharks (12.5%) compared to

either the intermediate (29.2%) or generalist (39.7%) users (p=0.007). Further, intermediate and specialist users were significantly more likely to consider the overall impact of the industry on whale sharks as positive compared to the generalist users (p=0.005), as well as more likely to perceive whale shark encounter guidelines as adequate compared to the generalist shark tourists (p=0.017). There was no significant difference among specialization groups in terms of their willingness to pay for the whale shark tour (p=0.120), nor their willingness to make a donation for whale shark conservation (p=0.280). Specialist and intermediate users were more likely to consider interpretation important compared to the generalist users (p=0.012), but intermediate users were significantly more likely to be satisfied with the learning opportunity on Holbox (p=0.021) compared to the other user groups.

Intermediate users were similar to the generalists in terms of age, dive experience, shark knowledge and perceived crowding. However, they were like specialists in that they placed a high level of importance on whale sharks as a tourist attraction, decided to participate in this activity prior to leaving on their trip, perceived a positive overall impact of the activity on both sharks and the environment, placed a high emphasis on the importance of the learning experience, and were satisfied with the regulations in place to minimize these impacts. However, intermediate shark users were significantly more likely to perceive negative impacts on the sharks (29.2%) compared to the high specialists (12.5%). They were also significantly more likely to perceive whale sharks as important tourist attractions (88.7%) compared to generalist (62.4%) and specialist (78.3%) users (p=0.000), as well as more satisfied with the learning opportunities available on Holbox (p=0.021).

Table 3.4. Shark participant attitudes and behaviours by specialization.

Participant attitudes and behaviours	Percent response			df	x^2	p
	G	IST	S			
Tourism has a negative impact on whale sharks						
disagree	60.3	70.8	87.5	2	8.658	0.007*
agree	39.7	29.2	12.5			
Overall impact on the environment and whale sharks						
positive	41.9	58.7	62.5	2	9.358	0.005*
negative	58.1	41.3	37.5			
Made contact with a whale shark						
no	80.5	72.8	62.5	2	5.186	0.038*
yes	19.5	27.2	37.5			
Importance of whale sharks as tourist attraction						
not important	37.6	11.3	21.7	2	22.934	0.000*
important	62.4	88.7	78.3			
Would return to Holbox if no whale sharks were present						
yes	15.1	10.2	8.7	2	1.879	0.391
no	84.9	89.8	91.3			
Importance of learning experience						
not important	67.4	54.1	48.0	2	7.426	0.012*
important	32.6	45.9	52.0			
Satisfaction with learning opportunity						
poor	44.4	29.6	44.0	2	6.360	0.021*
good	55.6	70.4	56.0			
Aware of regulations						
no	36.6	37.8	19.0	2	2.774	0.250
yes	63.4	62.2	81.0			
Regulations adequate						
no	18.3	6.1	5.6	2	6.813	0.017*
yes	81.7	93.9	94.4			
Willingness to pay						
US$50-150	39.2	48.4	29.2	4	5.502	0.120
US$151-250	50.2	42.9	50.0			
>US$250	10.5	8.8	20.8			
Willing to make donation						
no	38.9	32.6	33.3	2	1.161	0.280
yes	61.1	67.4	66.7			

G=generalist, IST=intermediate shark tourist, S=specialist
* = significantly different at α=0.05

Low specialists were predominantly young (57.1% 18-35 years old) non-divers (75.7%) who decided to participate in the whale shark tour after arriving in Mexico (60.1%). Although a substantial proportion of these generalist shark tourists did feel moderately to very crowded (23.7%), this number was significantly lower than the high specialists (48.0%) (p=0.005). These lower levels of perceived crowding in the generalist users support findings from previous specialization studies (e.g. Graefe et al., 1986;

Dearden et al., 2007a; Anderson, 2007). Generalist users were significantly less likely to have made contact with the sharks ($p=0.038$), more likely to recognize negative impacts of tourism activities on the sharks ($p=0.007$), perceive whale shark watching as having an overall negative impact on the sharks ($p=0.005$) and less likely to think regulations in place were adequate ($p=0.017$) compared to either intermediate or high specialists.

To gain a better understanding of the reasons why tourists made contact with whale sharks, contact type was compared to level of specialization, camera use, number of swimmers and knowledge of the global threats facing sharks (Table 3.5). Results suggest no significant difference between accidental and intentional contact and specialization level ($p=0.454$) or number of swimmers in the water ($p=0.538$). The use of an underwater camera was found to influence significantly contact type ($p=0.006$), with 82.1% of underwater photographers making accidental contact compared to 42.9% making intentional contact. Environmental knowledge (or lack thereof) also appears to have had a significant impact on contact type, as all visitors who made intentional contact had poor knowledge of the threats facing sharks ($p=0.027$).

Table 3.5. Potential influences affecting contact type with whale sharks.

Potential influences	Contact type		df	x^2	p
	Accidental	Intentional			
Specialization level					
low	53.5	58.3	2	0.195	0.454
intermediate	33.9	33.3			
high	12.9	8.3			
Camera use					
yes	82.1	42.9	1	8.811	0.006*
no	17.9	57.1			
Knowledge					
poor	75.4	100.0	1	3.714	0.027*
excellent	24.6	0.00			
Number of swimmers encountered					
2 to 3	73.9	64.3	2	1.240	0.538
4 to 5	14.5	14.3			
6 to 10	11.6	21.4			

* = significantly different at α=0.05

3.4. Discussion

Similar to other marine tourism activities, whale shark tourists on Holbox do not form a homogeneous group and, subsequently, have differing attitudes of appropriate environmental behaviours and management interventions. The characteristics of the different shark users on Holbox will be discussed within the context of the diver specialization literature, followed by a discussion of the relationship between shark specialization and environmental impacts. Finally, potential management interventions (e.g. interpretation program, guide training) will be suggested to reduce the overall impact of this activity on the whale sharks and improve its sustainability.

3.4.1. Specialization

Overall, increases in specialization followed the predicted trends of the specialization literature (e.g. Duffus & Dearden, 1990; Ditton et al., 1992; Dearden et al., 2007a; Catlin & Jones, 2010). Whale shark specialists were more likely to be older, with higher dive

training, a greater knowledge of sharks and the threats they face, and use an underwater camera compared to both generalist and intermediate users. Shark specialists were also more sensitive to crowding than the other users. These results support previous research on specialization and crowding (e.g. Graefe et al., 1985; Duffus & Dearden, 1990), including whale shark tourism research (Catlin & Jones, 2010).

However, discrepancies did arise. The more specialized users placed less importance on whale sharks as a tourism draw (78.3%) compared to the intermediate users (88.7%). A potential explanation for the observed discrepancy relates to the concept of post-experts. The latter term refers to former experts ('specialists' as defined in this paper) who are no longer at their peak (Todd, 2000). Unlike other recreational activities, diving, and in this case shark diving, experience continues to accrue with time even if individuals are no longer at peak fitness, such that post-experts have the highest degree of experience (Todd, 2000). The specialists on Holbox were significantly older (>35) and placed less importance on whale sharks than intermediate users. Thus, it is possible that some specialists are actually post-experts participating in the activity as a secondary feature to a larger trip the main reason for which is not shark diving. For example, they may have travelled to the area to relax or dive in Cozumel or Playa del Carmen with friends and family and the whale shark trip, although still an important factor, was not central in their decision-making process.

However, shark tourist specialization does not appear to follow a continuum as first proposed by Bryan (1977). Generalist shark tour participants may not necessarily become more specialized over time. Instead, shark tourists appear to be subdivided based on market segmentation. The latter concept also involves subdividing a target population

into distinct groups but does not require a transition from one group to another over time (Needham et al., 2007).

3.4.2. Environmental impacts

Since whale shark tour participants do not form a homogeneous group in terms of their motivations and expectations, it follows that their perception of anthropogenic impacts on the environment may vary as well (Sorice et al., 2007; Semeniuk et al., 2009). Previous specialization research has linked increased skill and experience with a pro-environmental ethic (Thapa et al., 2005; 2006; Worachananant et al., 2008) and support for resource management interventions (Salz et al., 2001; Oh et al., 2005; Oh & Ditton, 2006). The argument is that high-specialists, who place a greater importance on a given natural resource than other user groups, are more likely to notice negative impacts to this resource. They are therefore expected to minimise negative impacts on the targeted resource and support more restrictive management interventions that would ensure continued access in the future (Sorice et al., 2009). Thapa et al. (2006) found that more specialized divers were more likely to display environmentally responsible behaviours, while Oh & Ditton (2006) found that specialized anglers were less likely to support relaxation of restrictive harvesting measures that provided the quality of fishing they preferred.

Contrasting results also exist (e.g. Todd et al., 2000; Sorice et al., 2009). For example, Jett et al. (2009) studied the specialization of boaters in relation to environmental attitudes and compliance with speed limits associated with manatee zones and determined that specialization had a negatively correlated relationship with marine conservation attitudes. Specifically, the authors found that the more experienced boaters

(who were more likely to have had exposure to the debate regarding speed reductions in critical manatee zones) were less likely to support the need for these speed reductions and therefore comply with them.

In this study, the more experienced whale shark tourists were significantly more likely to have made contact with whale sharks than other users. Previous dive specialization research suggests that a diver's level of impact on the environment is dependent on two factors: skills and experience (Davis et al., 1995; Harriott et al., 1997), and environmental knowledge and attitudes (Thapa et al., 2005; 2006). According to the former factor, a novice diver does not possess the appropriate buoyancy control and finning techniques to avoid contact with the reef. Consequently, this type of contact is accidental in nature. Accidental contact due to poor snorkelling skills did occur during the interaction with whale sharks on Holbox, based on observations of interactions, but was associated with novice swimmers. Yet, in this case, those users with the highest dive certification were also those with the highest accidental contact rates suggesting that something beyond skills was driving this behaviour.

A potential explanation is related to the specialists' increased likelihood of using underwater cameras. Research suggests that underwater camera use is linked to increased incidents of environmental impacts (e.g. Barker & Roberts, 2004; Worachananant et al., 2008). Rouphael and Inglis (2001) determined that specialized underwater photographers were more likely to cause extensive damage to coral reefs than divers without cameras. Furthermore, 'naïve' divers provided with cameras were no more likely to damage the reef than divers without cameras.

On the other hand, Barker and Roberts (2004) found that specialization played no role in contact rates, only whether or not a diver had a camera. Uyarra and Coté (2007) studied the impacts of divers on coral reefs with respect to the presence of cryptic species and found that underwater photographers spent more time in contact with the reef when in the presence of cryptic species than non-photographers, regardless of experience level. Further, the authors found that these contacts were mainly accidental in nature, which suggests the desire to photograph these unique species may have overridden the divers' environmental concerns.

Evidence on Holbox appears to support these findings. Shark specialists were not only more likely to make significantly more contact with whale sharks, they were also more likely to own an underwater camera than generalist and intermediate users. Further, a comparison of accidental/intentional contacts and specialization level found no noticeable relationship between contact type and user experience. Instead, the higher contact rates appear to be linked to the presence of an underwater camera. Thus, specialists, on the hunt for the perfect whale shark shot, tended to ignore minimum viewing distances and got too close to the shark resulting in physical contact.

Research suggests that environmental awareness increases with specialization, such that more advanced users are more sensitive to environmental impacts and subsequently less likely to cause damage (Virden & Schreyer, 1988; Townsend, 2000; Oh et al., 2005; Thapa et al., 2006). However, specialist shark users on Holbox were the least likely to perceive negative impacts of tourism on whale sharks, despite having the greatest direct impact on the sharks. This discrepancy between perception of impacts and specialization suggests that specialists may see themselves as the exception (i.e. do not

consider cumulative impacts) and do not perceive their behaviour as detrimental to the sharks in the short or long term.

Todd et al. (2000) suggest that more experienced divers have had increased opportunities to make contact with marine life (whether it is coral, substrate or fish) and may be more likely to see this as an inevitable aspect of the activity. Previous research supports these findings and underscores the weak links between conservation attitudes and self-reported or observed pro-environmental behaviours (e.g. Tarrant & Cordell, 1997; Jett et al., 2009). In other words, recreationists may not perceive their behaviour (such as making contact with the whale sharks) as a manifestation of their conservation attitudes (Jett et al., 2009).

Indeed, some studies have found that environmentally responsible behaviour is dependent on environmental knowledge, rather than experience. McCawley and Teaff (1995) found that divers concerned about the impacts of their actions on the environment, regardless of skill or degree of development, tended to be more concerned with environmental protection and demonstrated more support for the rules and regulations in place compared to divers who were not concerned with their environmental impacts.

Results of this study support this conclusion. Generalists had the lowest contact rates among the three user subgroups. They were also significantly more likely to agree that tourism has a negative impact on whale sharks, perceive an overall negative impact of the activity on the environment and sharks, and view regulations as inadequate compared to the other user groups. The increased sensitivity to negative impacts is in spite of lower knowledge of sharks, including threats they currently face, compared to the specialists. Consequently, differences in perceived impacts appear to be linked to concern

for the marine environment, not specialization. The specialists appear to have a different perception of negative environmental impacts on the species than the generalist subgroup, which may be a reflection of previous experiences and therefore views of acceptable levels of impact.

These differences may also reflect preferred management intervention levels. Todd et al. (2000) determined that generalist divers were more likely to support invasive management interventions compared to specialized divers who preferred a more hands-off approach. Jett et al. (2009) found that highly specialized boaters were more likely to have a negative perception of management interventions in manatee areas. Sorice et al. (2009) determined that more specialized scuba divers did not support having less access to a resource or extensive supervision. The authors suggest this unexpected relationship between specialization and support for management interventions may be a reflection of the self-regulated nature of scuba diving in which norms of acceptable behaviours are established during the initial certification process and subsequently left in the hands of individuals (not actively regulated by government like with other activities, e.g. fishing) (Sorice et al., 2009).

Specialists on Holbox may support the current, more lax regulations because it allows them more freedom when interacting with the whale sharks. Although the interaction guidelines stipulate which behaviours are acceptable, the inconsistent education coupled with the lack of enforcement of these guidelines allows participants to decide, at their discretion, which rules to follow. Thus, it is not surprising that the laissez faire management appeals to the specialist shark users on Holbox.

Semeniuk et al. (2009) studied user preferences for management interventions at Stingray City Sandbar (Cayman Islands) and found that participants were heterogeneous in terms of their management preferences for the available stingray interaction activities. The majority of users, labelled 'pro-management', supported actions that would reduce impacts on stingrays (e.g. risk of injury, reduction in numbers), while the remainder of users, labelled 'pro-current', strongly supported the continued direct interactions with the rays (e.g. feeding, handling), despite agreeing that the quality of their experience would be negatively affected if ray numbers diminished. Interestingly, a vast majority of 'pro-management' users had only a mild concern for potentially negative impacts on the stingrays in spite of their strong desire to minimize injuries to the rays. Semeniuk et al. (2009) suggest this may be related to a lack of knowledge regarding potentially deleterious behaviours and underlines the need to inform tourists of these impacts.

The lack of correlation between intentional contact and specialization level supports the link between environmental knowledge and appropriate behaviours. According to the literature, intentional contacts are associated with an individual's environmental knowledge and attitudes, rather than their skills and abilities (Thapa et al., 2005). In other words, a diver is unaware or does not believe that contact with the reef is detrimental to the environment. Similarly, results of this study demonstrate that intentional contacts were related to environmental knowledge, as users with excellent knowledge of threats to sharks did not make intentional contact with whale sharks, regardless of specialization level. These findings further highlight the need for environmental interpretation that emphasizes the impacts of particular behaviours.

3.4.3. Improving compliance and promoting shark conservation

The development and implementation of an effective interpretation program has the potential to improve the environmental knowledge of tourists and therefore their compliance with the encounter guidelines (McCawley & Teaff, 1995). A well-conceived interpretation program can not only improve the tourists' knowledge of the target species, but also critical threats the species is facing, negative impacts of the tourism activity (including tourist behaviours), and how tourists can get involved in marine conservation efforts (Lück, 2003; Ballantyne et al., 2009; in press; Curtin et al., 2009). Since environmental knowledge is a critical factor in predicting pro-environmental behaviour, environmental education programs can influence positively the attitudes and pro-environmental behaviours of recreationists (Medio et al., 1997; Thapa et al., 2005).

However, many operators do not provide a well-rounded interpretation program (Whitt & Read, 2006). Wiener et al. (2009) studied the link between interpretation programs and depreciative behaviours (e.g. coral trampling, harassing marine life) in marine tourism activities in Hawai'i and found that many tour operators did not include an environmental component to their interpretation program (e.g. human impacts on reef, how to get involved in conservation). Instead, the interpretation programs focused on personal safety and reef and marine etiquette.

The interpretation provided on Holbox is very similar to the above approach. Available interpretation ranges from morning briefings with a non-mandatory informational DVD to relying on the captain/guide to provide information regarding interaction guidelines and basic whale shark information. A typical morning briefing consists of detailing which tourists will be going to which boat while the informational

DVD is playing in the background. Thus, the important information regarding safety procedures, whale shark ecology and the need for conservation is not conveyed to the tourists. The rules that are emphasized onboard include the mandatory use of a life jacket and not touching the sharks. Although all licensed whale shark boats are required to display a sticker outlining the encounter guidelines onboard, there is no substantial information provided to tourists regarding whale shark biology/ecology, threats to the sharks or ways to get involved in whale shark conservation.

A well-planned and executed interpretation program can help reduce the environmental impact of whale shark tourism activities on the sharks. Ballantyne et al. (2009) assessed tourists' support of various interpretation programs at Mon Repos Conservation Park (a turtle-based wildlife experience, Australia) and determined that the ideal management plan would clarify the reasons for any constraints involved, involve tourists as conservation partners and ensure a consistent message in terms of expectations for interactions. Using this research as a model, the whale shark tourism industry on Holbox would have to address each of the above-mentioned issues in order to achieve higher compliance levels, minimize environmental impacts on the sharks and improve the conservation value of the activity.

Restructuring the guidelines and interpretation program on Holbox would help address these issues. Potential changes could include:

1. incorporating a teleological (i.e. explanatory) approach in the encounter guidelines to clarify the reasons for any constraints (Garrod & Fennel, 2004), and
2. a short, but in-depth briefing that outlines the interaction guidelines, impacts of inappropriate tourist behaviours (including cumulative impacts), the threats whale

sharks face and ways in which tourists can help in their conservation (e.g. the global whale shark photo-identification library spearheaded by ECOCEAN, 2010).

Use of the teleological approach (i.e. one that clearly explains why a certain restriction has been implemented) has been shown to be more effective in gaining increased compliance, especially when management policies restrict visitor behaviours (e.g. Marion & Rogers, 1994; Mason, 2005; Ballantyne et al., 2009; Curtin et al., 2009). Gjerdalen & Williams (2000) found that codes of conduct that do not make sense to the user or include apparently irrelevant behaviours are less likely to be effective than those that include a description of the consequences of not following them. For example, instead of simply stating 'do not touch' whale sharks, the new guidelines, incorporating known impacts of tourist behaviours on whale sharks (e.g. Quiros 2007; Pierce et al., 2010), could clarify that making contact disrupts whale shark feeding behaviour, thereby harming the whale shark's long-term fitness and likelihood of returning to the area in the future.

The incorporation of information regarding deleterious impacts of tourist behaviours on the whale sharks would help tourists recognize the signs of harassed whale sharks (e.g. banking, evasive diving). Dearden et al. (2007b) studied perceived impacts of divers on coral reefs in Phuket, Thailand and found that those divers who witnessed damage were more likely to support reef conservation projects, as well as less likely to return to Phuket than divers who did not. These results demonstrate the power of knowledge. Many tourists on Holbox are currently unaware of any potential negative impacts of their actions on the whale sharks because they do not know how to recognize stressed behaviour in these sharks. Perhaps if tourists had this information, they would be

more sensitive to their own harmful behaviours, as well as those of others (swimmers, captains/guides) and intervene to ensure the code of conduct is followed.

An interpretation program of this nature could also address the missed opportunity to reach incidental ecotourists. Incidental ecotourists are those people who have multiple travel interests and come across wildlife inadvertently as part of an add-on to a general tour (Grossber et al., 2003). In the case of the whale shark tourism industry on Holbox, the incidental ecotourists are the vast majority of the generalists who decided to do the whale shark tour on a whim as part of a more traditional vacation in Cancun or the Mayan Riviera. Grossberg et al. (2003) studied the impact of incidental tourists on a local population of endangered black howler monkeys at Lamanai Archaeological Reserve, Belize and concluded that site management was missing an opportunity of increasing support for the protection of the species through educating mass tourists of the needs for conservation. The same can be said for Holbox. The fact that none of the shark user subgroups could adequately list current threats facing sharks (e.g. only 11.8% of generalists, 16.0% of intermediate users, and 35.0% of specialists) suggests there is a need for conservation education that is not being met. Consequently, an interpretation program covering the critical role sharks play in maintaining healthy, functioning ocean ecosystems and the severe threats they currently face internationally would help facilitate a reversal of the public's negative perception of sharks, as well as potentially initiate a conservation ethic for those otherwise mass tourists visiting Holbox.

Improving the visitors' environmental awareness and compliance to encounter guidelines is important, but it is only part of the solution. The managers of the whale shark industry must improve operator support for the encounter guidelines. The captains

and guides are ultimately those who are responsible for ensuring appropriate behaviours during the whale shark encounters, as they have the most to lose if the whale shark population off Holbox collapses. Guides have the potential to improve the effectiveness of an interpretation program through better communication and engagement of tour participants (Lück, 2003; Mason, 2005; Zeppel & Muloin, 2008; Peake et al., 2009; Randall & Rollins, 2009), as well as acting as role models for appropriate behaviours when interacting with wildlife (Boren et al., 2009; Curtin, 2010). Medio et al. (1997) demonstrated that divers had lower impacts on the reefs after they were exposed to an illustrated pre-dive briefing and in-water demonstration of appropriate dive behaviour. Barker and Roberts (2004) found that dive master intervention in the water significantly reduced contact rates, not the pre-dive briefing. These examples highlight the potential role of tour operators in monitoring participant behaviour in order to ensure minimal impacts.

The fact that in-water intervention can have such a positive influence on proper diver behaviour provides a promising solution to compliance problems on Holbox. The success of this type of intervention is especially important as Barker and Roberts (2004) note that a one-sentence reminder not to touch the reef is insufficient to affect a diver's behaviour. Yet, this type of passive approach is used on Holbox to communicate arguably the most important rule, i.e. not making contact with the whale shark. Beyond briefings and leader intervention, the number of people participating also has a significant cumulative impact (Barker & Roberts, 2004).

Therefore, reminding divers of the cumulative nature of their actions would be beneficial to counteract the high contact rates encountered on Holbox. For example,

captains/guides could remind divers, especially underwater photographers, of the potentially harmful cumulative effects of harassing and touching whale sharks in their critical feeding habitat in terms of their future fitness and long-term survival. Although specialists do not believe that their individual behaviour negatively affects whale sharks, the fact is that at least one quarter of 20,000 yearly visitors, or 8,000 people, are touching whale sharks. Whether accidental or intentional, these contacts are cumulative and affect the health of the whale shark population. If tourists understand that they are not the exception and that their individual action is the problem, along with thousands of similarly minded individuals, then this knowledge may alter their beliefs and modify their inappropriate behaviours.

Operator buy-in to the code of conduct plays an essential part in whether or not operators actually fulfil this leadership role. Lack of ownership has been identified as a critical factor preventing the success of a given code of conduct (Garrod & Fennell, 2004; Cole, 2007). Thus, gaining tour operator support for the guidelines is critical to the sustainability of tourism operations where time and budget constraints prevent the effective monitoring and enforcement of activities, such as the industry on Holbox. The high contact rates and pervasive problems with inappropriate operator behaviour on Holbox (e.g. vessel approach, interacting with stressed sharks, more than one boat interacting with a shark, more than two swimmers in the water at a time, swimmers and boats blocking the shark's path) indicate operators do not support the interaction guidelines.

Operators are the first line of defence in terms of informing participants of appropriate interaction behaviours and enforcing the guidelines in the whale shark

viewing area. However, if the operators do not buy into the code of conduct, then they cannot be expected to enforce the code in the field. Garrod & Fennell (2004) found that ownership of voluntary codes increased if local stakeholders are allowed to participate in their establishment. However, whale shark tour operators on Holbox were included in the establishment of the interaction guidelines in 2003, as well as subsequent revisions to this code (e.g. in 2004) (Remolina Suarez et al., 2005).

Instead, this lack of ownership appears to stem, at least partially, from tour operators' attitudes towards conservation. Wiener (2006) highlighted the importance of operator attitude and motivation in the success of a given interpretation program. She found negative operator attitudes resulted in poor motivation to provide interpretation (e.g. lack of responsibility, fear of losing money, placed onus on someone else). Wiener et al. (2009) found that many marine tourism operators in Hawai'i would not intervene when inappropriate behaviour was observed (e.g. chasing turtles, trampling coral) because they rely on customer satisfaction for the success of their business and the provision of tips (Wiener et al., 2009).

Currently, there is no enforcement of regulations on Holbox. This lack of enforcement leaves it up to the discretion of the captain and/or guide to decide what is considered acceptable behaviour and whether or not to intervene. Many whale shark guides/captains on Holbox do not react when they see swimmers making contact with sharks or exhibiting other inappropriate behaviours (e.g. no life vest, not respecting viewing distances, uncontrolled entry into the water, surface diving). Reasons for these low intervention levels include factors such as the guides and/or captains:

1. are uncomfortable taking a leadership role (i.e. cultural and/or language barrier),

2. do not feel these actions have negative impacts on the sharks,
3. are reluctant to intervene for fear of retribution (e.g. lost tips, anger, complaints to boss)
4. some operators are also guilty of accepting money in exchange for allowing inappropriate behaviours, such as touching the sharks or swimming without lifejackets.

A final issue with achieving compliance is that of mixed messages (e.g. Ballantyne et al., 2009; Wiener et al., 2009). Appropriate behaviours of all parties (i.e. tourists and operators) affect overall compliance. Wiener et al. (2009) studied the practices of marine tourism operators in Hawai'i and found pervasive issues with tour operators dumping food scraps, harassing marine wildlife, and feeding fish despite claims of support for 'green' practices. The authors warn this type of hypocritical behaviour risks confusing participants and undermines any conservation messages communicated.

Mixed messages on Holbox are related to operator practices as well as images. Inappropriate behaviours include depositing swimmers in the path of sharks and not respecting minimum approach distances (boat and guide). Some operators also use images of guides touching whale sharks as part of their advertising. These images create false expectations of the experience, condone inappropriate behaviours, and may result in long-term environmental impacts (e.g. whale shark evasive behaviours prevent feeding resulting in reduced fitness, Quiros, 2007). Local guides are the ones who have the most to lose from these unsustainable practices, yet, their actions demonstrate that they do not believe this type of behaviour negatively affects the whale sharks and, by extension, permit tourists to do the same.

These issues with attitudes towards conservation and mixed messages highlight the need to improve training workshops for the captains and guides of Holbox. Guides have many roles to play (e.g. leader, educator, communicator) (Cohen, 1985; Weiler et al., 1991; Pond, 1993; Weiler & Davis, 1993). However, each of these roles requires specialised training (Black et al., 2001). Randall & Rollins (2009), building on Cohen (1985), studied the potential role of sea kayak guides in contributing to environmental conservation in Pacific Rim National Park (Canada) through visitor surveys. The authors concluded that tour guides were neglecting their role as models of environmentally responsible behaviours to the potential detriment of the visitors' experience.

The results of this study suggest training workshops on Holbox need to include studies demonstrating the negative effects of human behaviours on the sharks (e.g. Quiros, 2007), as well as strategies to improve interpretation approaches. If operators were provided with evidence of specific behaviours eliciting negative reactions from the sharks, they may be less likely to accept such behaviour from their clients. Further, these workshops need to address problems with cultural attitudes, language barriers and leadership in dealing with tourists in order to ensure the operators intervene when inappropriate behaviours occur.

The cumulative, long-term impacts of tourism activities are not always noticeable immediately. In such cases it may be in the best interest of managers to implement the precautionary principle (PP) (Sorice et al., 2003). The PP may be defined as 'when human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm' (COMEST 2005 p14). Notwithstanding the paucity of scientific data demonstrating the negative impacts

of tourism activities on whale sharks (e.g. Quiros, 2007; Pierce et al, 2010), there is evidence of these impacts in cetacean tourism studies (e.g. Constantine, 2001; Lusseau, 2003; Constantine et al., 2004; Lusseau, 2004; Bejder et al., 2006a,b; Williams et al., 2006; Stensland & Berggren, 2007; Christiansen et al., 2010). Given this evidence, it is in the self-interest of the whale shark tourism managers to implement the PP in regulations, including encounter guidelines and permit requirements. The whale shark's status as a threatened species, along with the occurrence of tourism activities in critical feeding (and potential breeding) habitat, makes implementing a precautionary approach more critical for the protection of the whale sharks and the tourism activity's long-term sustainability. The implementation of the PP on Holbox could take the form of government (via CONANP) limiting the number of visitors and the number of boats in the whale shark viewing area (e.g. license caps, cap on number of boats allowed within the whale shark area at a time, temporal closures), as well as making a greater effort to ensure compliance with the encounter guidelines (e.g. improved guide training, interpretation program).

3.5. Conclusion

Whale shark tourism is a growing niche market within the marine wildlife tourism sector. The whale shark's status as a threatened species, coupled with growing visitor numbers at whale shark tourism sites worldwide, raises questions over the long-term sustainability of this industry. Understanding visitors' environmental awareness and behaviours is important for minimising tourism impacts on the targeted species and the surrounding environment. Yet, visitors do not form homogeneous groups. Specialization has been linked to differences in environmental attitudes and behaviours (e.g. Thapa and Graefe 2003), and acceptable management interventions (e.g. Oh and Ditton 2006; Sorice and

others 2009). Thus, understanding the specialization profile of tourists at a tourism site can provide insights into effective management for that site.

This study found that whale shark tourists on Holbox are not homogeneous. Segregating characteristics used to differentiate among shark users included a combination of previous shark watching experience and the importance of viewing whale sharks in the decision to visit Mexico. Further, specialization does not appear to follow a continuum as first proposed by Bryan (1977); instead, shark tourist specialization appears to be more closely linked to market segmentation. Specialization was also linked to differences in environmental awareness and behaviours, as well as appropriate levels of management intervention among the different user groups. Whale shark specialists were found to have the greatest direct impacts on the sharks and were significantly less likely to perceive any negative environmental impacts of the whale shark tourism activities compared to the other user groups. They were also significantly more satisfied with the current laissez-faire management approach compared to the generalist users.

The noncompliance of the tourists and operators on Holbox highlights the need for the following changes to management practices:

- a re-design of the interaction guidelines (e.g. explanatory approach),
- development of an interpretation program that addresses global threats to sharks, inappropriate tourist behaviours, cumulative impacts, and ways for tourists to get involved in shark conservation, and
- an improved guide training program (e.g., leadership training, language/cultural barriers, impacts of specific swimmer behaviours on sharks).

Whale sharks are a threatened species. As such they require that tourism activities, even if non-consumptive in nature, apply the PP to ensure the lowest possible negative impacts on the population. These lower impacts are especially important at whale shark feeding sites that have become whale shark tourism sites, such as Holbox. To achieve this, a conservation ethic needs to be instilled during training workshops so that tourism operators take responsibility for their own actions, and those of their clients, to ensure the sustainability of tourism activities and the survival of the species.

Chapter 4: Assessment of the sustainability of the whale shark tourism industry on Isla Holbox, Mexico

We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road -- the one less traveled by -- offers our last, our only chance to reach a destination that assures the preservation of the earth. - Rachel Carson

Abstract

Sharks are among the most threatened taxonomic groups worldwide. Shark tourism is viewed as a potential means of protecting threatened species, while also providing a sustainable livelihood for local communities. The reality is that many wildlife tourism sites do not prioritise species conservation as the primary management goal resulting in potentially irreversible impacts on the target species. The purpose of this paper is to assess the current status and future sustainability of the whale shark tourism industry on Isla Holbox, Mexico using Duffus & Dearden's (1990) Wildlife Tourism Model. Results suggest that this industry is reaching its tipping point if changes are not made to improve its management policies and design. Industry issues include: 1. crowding due to poor control of the industry's growth (visitation and number of operators), 2. significant impacts on the whale shark population due to poor compliance to interaction guidelines, and 3. the inequitable distribution of benefits within the community, including significant economic leakages. A transition to an ecotourism approach to whale shark tourism management emphasising reduced visitation, guide training and interpretation, and a restructuring of the industry to ensure the equitable redistribution of economic benefits would help make the industry more sustainable in the long-term.

Keywords

Sustainability, Marine wildlife tourism, Whale sharks, Limits of acceptable change

4.1. Introduction

4.1.1. Shark tourism

Sharks are among the most threatened taxonomic groups with close to 60% of species considered threatened at some level and some species estimated at 60-90% of their abundances from just 20 years ago (Baum et al., 2003; Clarke et al., 2006). The main reason for this decline is overexploitation (Fowler, 2010). Along with protection at the

international and national levels through legislation and treaties (e.g. World Conservation Union's Red List, Convention on International Trade of Endangered Species, Convention on Migratory Species), shark tourism can provide an economic incentive to convert communities targeting these sharks for consumptive use into wildlife tourism destinations. Shark tourism has been identified as an important factor behind current conservation efforts, generating millions of dollars in revenue and attracting over 500,000 divers annually (Dearden & Topelko, 2005).

However, it is critical that shark tourism activities do not negatively impact the target species. Target species may disappear due to reduced fitness associated with increased harassment levels if tourism occurs in their critical feeding and breeding habitats (e.g. Sorice et al., 2003, 2006; Bejder et al., 2006; Lusseau & Bejder, 2007), which could then lead to the collapse of the industry. An industry collapse would have serious ramifications for the associated communities, especially those in developing nations that do not have alternate economic development possibilities.

These concerns over impacts and the potential consumptive nature of wildlife tourism activities underline the importance of ensuring shark tourism activities are sustainable in the long-term. Sustainability within the context of tourism can be defined as 'tourism which is developed and maintained in an area in such a manner and at such a scale that it remains viable over an indefinite period and does not degrade or alter the environment (human and physical) in which it exists to such a degree that it prohibits the successful development and well being of other activities and processes' (Butler, 1993, p.29). Sustainability is about minimising the long-term costs to both the environment and the local community (Higginbottom, 2004).

Ensuring minimal costs is especially important when tourism activities target threatened species within their critical feeding habitat, such as the whale shark. Whale shark tourism is a growing sector of shark tourism. Although typically a solitary species, the whale shark forms large, seasonal feeding aggregations at several locations worldwide (e.g. Mexico, Australia, Belize, Philippines, India) (Colman, 1997; Heyman et al., 2001; Pine, 2007; de la Parra, 2008; Kumari & Raman, 2010). These predictable aggregations have led to an explosion in whale shark tourism since the early 1990's and the establishment of the whale shark as one of the most-watched sharks in the world today (approximately one fifth (100,000, Norman & Catlin, 2007) of all shark tourists (500,000, Dearden et al., 2008)).

Dearden et al. (2008) examined whale shark watching and the different models that have evolved in terms of industry structure, organization and potential sustainability. They concluded that management of this growing industry varies markedly from site to site, ranging from little to no regulations in Thailand to interaction guidelines and licensing caps in Australia and Belize. It is highly likely that whale shark tourism visitation numbers will continue to increase in the future. This rise in visitation coupled with the apparent decline in whale shark sightings at known aggregation sites worldwide (e.g. Dearden & Theberge, 2006; Meekan et al., 2006; Graham & Roberts, 2007), raises the question of whether or not this industry is truly sustainable in the long-term.

The current study was undertaken because the whale shark tourism industry on Isla Holbox, Mexico was identified as having the largest and fastest growing whale shark tourism industry in the world (Dearden et al., 2008). If this growth is allowed to continue unchecked, there is the potential for the industry to reach unsustainable levels resulting in

the collapse of both the ecosystem and the local economy (Enosse et al., 2001; Neto, 2003; Dearden et al., 2007). Therefore, how the whale shark tourism industry is being managed on Holbox is critical to its long-term sustainability. The goal of this paper is to assess the sustainability of the management approach used for the whale shark tourism industry on Holbox using Duffus & Dearden's (1990) Wildlife Tourism Model (WTM). The WTM framework will be discussed in more detail below, followed by an overview of the organization of whale shark tourism management on Holbox.

4.1.2. Sustainability framework

Duffus and Dearden's (1990) WTM framework links Butler's (1980) 'tourism life cycle', which addresses the growth of a tourism site over time, with Bryan's (1977; 1979) leisure specialization continuum and Stankey et al.'s (1985) Limits of Acceptable Change (LAC) framework (Figure 4.1). Bryan's (1977; 1979) leisure specialization continuum places recreation users along a continuum from novice to specialist based on time, money and equipment dedicated to a given activity, as well as psychological commitment and skill.

The LAC framework uses social and ecological evaluative standards to determine the acceptable levels of impact a particular activity has on a site (e.g. crowding levels, underwater visibility, acceptable environmental impacts, amount of allowable infrastructure) (Duffus & Dearden, 1990). This approach is different from a carrying capacity approach as the activity is managed to meet desired conditions instead of a specific number of participants (Stankey et al., 1985). The LAC process consists of four components (Stankey et al., 1985):

1. identifying desirable (and achievable) social and ecological conditions,
2. assessing current site conditions,

3. identifying management actions, and

4. monitoring and evaluating implemented management actions.

This framework has been successfully applied to manage various tourism activities, including marine tourism (e.g. Inglis et al., 1999; Shafer & Inglis, 2000; Sorice et al., 2003; Roman et al., 2007; Leujak & Ormond, 2008).

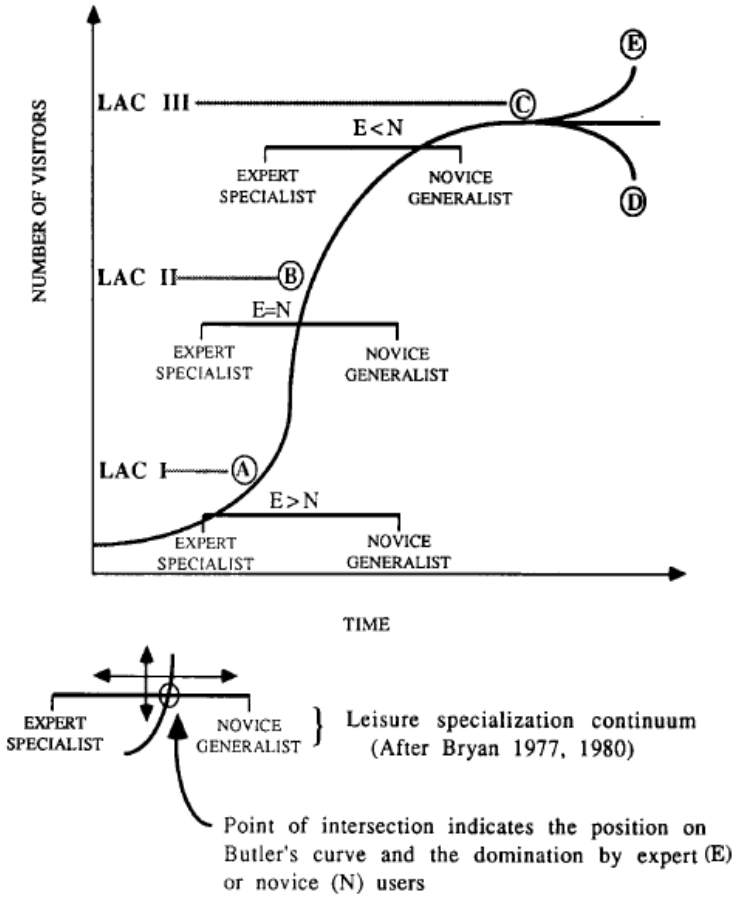

Figure 4.1. Wildlife Tourism Model that shows the growth of a tourism site in terms of the number of visitors, limits of acceptable change (LAC) and user specialization (Duffus & Dearden, 1990).

According to Duffus & Dearden's (1990) model, a given wildlife viewing site initially has relatively low visitation (A) and is dominated by a specialized user requiring very little infrastructure and having minimal impact on the environment and target

species. However, as the site becomes better known, there is a rapid increase in visitation, including an influx in more generalized users who require increased infrastructure and services, as well as place increased pressure on the target species and the environment (A to C). This transition to a generalist user results in the eventual displacement of the specialized users, who move on to seek a less disturbed site.

The transitioning from equilibrium point A through to D or E occurs when the carrying capacity of the area is exceeded and represents a shift in the LAC (Duffus & Dearden, 1990). The changes in LAC that occur as the site grows have major consequences on the long-term sustainability of the site. The increase in a more generalised tourist base means greater negative impacts become acceptable, such as reductions in the target species' population and increased crowding (Duffus & Dearden, 1990). Furthermore, in the absence of any management intervention, the activity may become unsustainable as it causes such severe overcrowding and negative ecological impacts that tourist numbers will drop along with the number of sightings of the target species resulting in the collapse of the industry (point D).

The WTM model has been used successfully to assess the sustainability of various types of wildlife tourism, including albatrosses (Higham, 1998), whales (Malcolm, 2004), dugongs (Hines et al., 2005), sea turtles (Wilson & Tisdell, 2001), whale sharks (Catlin & Jones, 2010) and manatees (Sorice et al., 2006).

4.1.3. Overview of whale shark tourism management on Isla Holbox, Mexico

Isla Holbox is a small island off the northern tip of the Yucatan peninsula with an approximate population of 1,500 people (Figure 4.2). Whale shark tourism on Holbox occurs both within and outside a national protected area, Yum Balam Flora and Fauna

Protected Area (APFFYB). Consequently, the industry is managed by two agencies within the Secretariat of Environment and Natural Resources (SEMARNAT): the General Direction of Wildlife (DGVS) and the National Commission of Protected Natural Areas (CONANP) (Diaz-Amador, 2005). The DGVS is charged with the sustainable management of the whale shark tourism activities when they occur outside the protected area but still within Mexican national waters. CONANP is charged with managing the tourism activities when they occur within APFFYB. Thus, both DGVS and CONANP have the authority to issue permits required for the non-extractive use of this species (Cepeda, 2008).

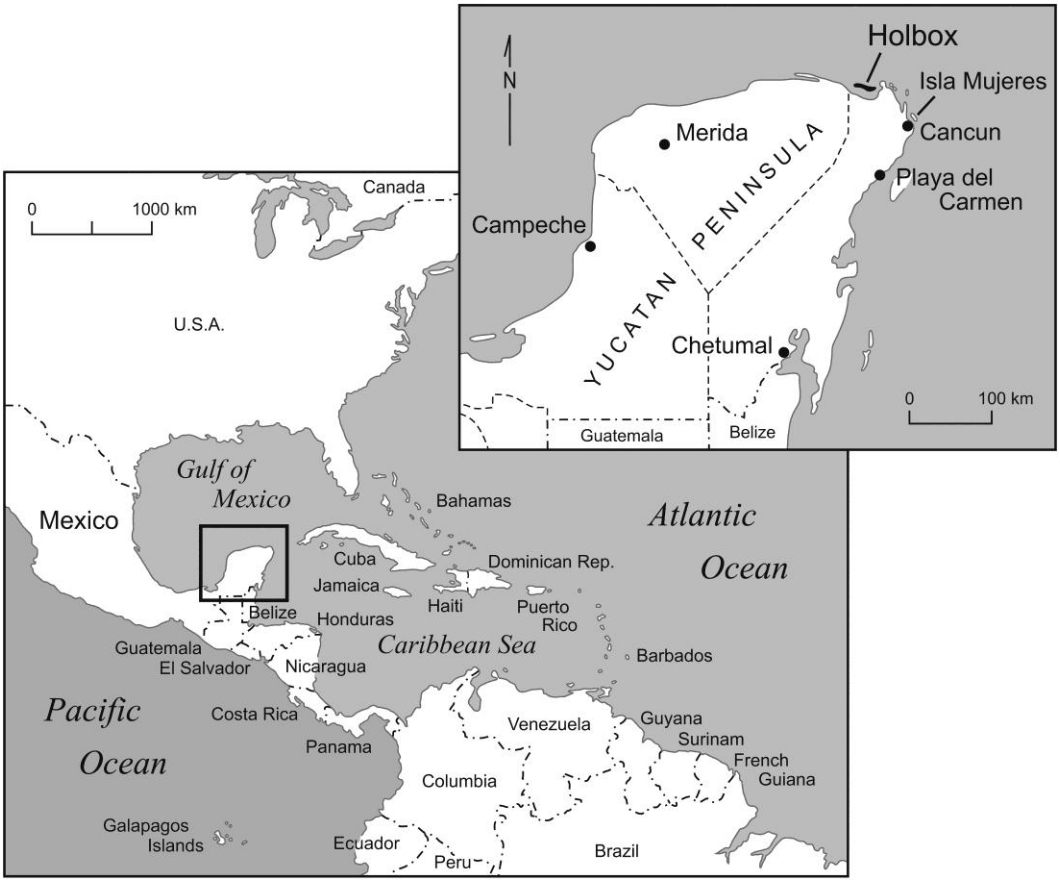

Figure 4.2. Map of the study site.

In 2009, Mexico declared the remaining unprotected whale shark habitat a national Whale Shark Biosphere Reserve (CONANP, 2009). This type of listing differs from a Flora and Fauna Protected Area like Yum Balam in that authorities can limit or prohibit activities that alter the ecosystem (Article 48, General Law of the Ecological Balance and Protection of the Environment, LGEEPA), instead of simply having the authority to allow local communities to sustainably use natural resources within the protected area (Article 54, LGEEPA) (Cepeda, 2008). Further, biosphere reserves require a core area with corresponding buffer zones in order to protect critical habitats or species from external impacts (Article 48, LGEEPA). However, to date, neither the APFFYB, nor the Whale Shark Biosphere Reserve have official management plans in place (CONANP, 2010). Moreover, whale sharks have not remained within the boundaries of the new Biosphere Reserve, thereby eliminating the benefits of closed access and resulting in continued problems with unregulated activities targeting whale sharks (Varillas, 2010).

The whale shark industry on Holbox does have a code of conduct first implemented during the 2003 season. This code outlines acceptable interaction methods (e.g. no contact with sharks, only two swimmers and a guide with a shark, maximum speed of 3 knots within the whale shark viewing area), as well as operator requirements (e.g. use of propeller guard, participation in population monitoring) (de la Parra, 2008). The enforcement of the code is under the purview of the Environment Protection Agency (PROFEPA). However, budget and human resource constraints result in few if any inspections during the season. The only regular inspections are those of CONANP ensuring the appropriate number of tourists is aboard each boat and the payment of the

access fee to APFFYB.

There has been little effort to control the growth of the whale shark tourism industry on Holbox since its inception in 2002. A cap on the number of permits for the industry was discussed during the 2008 season (pers. comm., F. Remolina Suarez), but was not implemented (Varillas, 2010). Instead, the focus has been on strengthening the advertising infrastructure within the region and internationally in order to increase tourism volume to the area (e.g. Noticaribe, 2010).

Future growth is thus an important concern for the sustainability of this industry. According to a World Wildlife Fund (WWF) carrying capacity study of the island, the industry is expecting a visitation increase of 25% each year, such that by 2011 they will attain 39,063 tourists (Zenteno, 2007). Even if the island itself could handle such high visitation, it does not mean that the visiting population of whale sharks could.

The purpose of this paper is to assess the current status and future sustainability of the Holbox whale shark tourism industry using Duffus and Dearden's (1990) Wildlife Tourism Model. Specific research questions are:

a) What are the key issues related to limits of acceptable change, both social and biological, for the whale shark tourism industry on Holbox? How can they be addressed?
b) How do the limits of acceptable change, specialization and growth of the whale shark tourism industry on Holbox fit within Duffus and Dearden's (1990) Wildlife Tourism Model? Is the industry following a sustainable path?
c) Based on the above information, how can the industry be managed more sustainably?

This assessment will permit a clearer understanding of some of the important issues the whale shark tourism industry on Holbox is currently facing and consequently what management would need to address when making changes to policy and/or industry structure.

4.2. Methods

The methods included site-based distribution of a questionnaire to whale tour participants on Isla Holbox, Mexico and in-water observation of whale shark-tourist interactions by the researcher. The questionnaire consisted of fifty-six mainly closed-ended questions organized in four sections addressing various aspects of the whale shark tour experience including motivations and satisfactions, shark diving experience, social and environmental impacts and demographics. These questions were developed through a literature review and refined following a pilot study on Holbox in June 2008. Questionnaires were printed on 8.5" x 14" white paper and folded to produce ten-page booklets, after the technique developed by Salant and Dillman (1994). Portions of the questionnaire relevant to this paper are described below.

Questionnaires included closed-ended questions regarding the perceived level of crowding, as well as open-ended questions regarding how many swimmers were encountered in the water at once and how many should be allowed. Surveys were provided in Spanish and English. Answers to open-ended questions were translated from Spanish to English by the author.

Questionnaires were distributed to whale shark tour participants on Isla Holbox over a ten-week period from June to August 2008, which represents the whale shark season. Tourists were selected opportunistically as they descended from the boats upon

return from the whale shark tours. Questionnaires were also distributed to hotels and travel agencies on Holbox that offered whale shark tours to on-island clients to distribute to their clients participating in the tour.

A total of 397 surveys were collected over the three-month period, resulting in a 5.0 % margin of error (95% confidence interval) (Salant and Dillman 1994). Approximately 90% of those participants approached completed a questionnaire. The main reasons for not completing a survey included a member of the group/couple had already completed one, language barriers, and lack of interest and/or time. The response rate for surveys collected through hotels and agencies is unknown. However, the latter group made up only a small fraction of the overall sample size (approximately 10%) and thus would not significantly affect nonresponse bias. Literature suggests a response rate of 60% can be considered sufficient in accurately representing the population being sampled (Dolson & Machlis, 1991), while 70% is considered very good (Babbie, 2007). Thus, the 90% response rate provides an adequate representation of the whale shark tour participants on Holbox.

4.3. Results

Information related to biological and social LAC, such as satisfaction with environmental and tour features and contact rates, were measured in Chapters 2 and 3, respectively. Specialization information used in the WTM analysis was assessed in Chapter 3. In order to estimate social LAC, tour participants were asked to rate perceived crowding, both with respect to the number of swimmers and boats in the whale shark viewing area.

Perceived crowding is an important criterion in assessing tourist satisfaction with the social setting features of a tourism destination (e.g. Manning & Valliere, 2001; Dearden et al., 2007; Lankford et al., 2008; Vaske & Shelby, 2008; Bell, 2010). In order

to gain a better understanding of issues with perceived crowding of tourists within the whale shark tourism industry on Holbox, tour participants were asked to rate perceived crowding with respect to the number of swimmers in the whale shark viewing area. Respondents were asked to rate level of perceived crowding using a nine point scale. The majority of respondents (76.2%) felt not at all or slightly crowded with an average score of 3.04 (Table 4.1). The remaining 23.8% of respondents felt moderately to extremely crowded, which suggests a problem with the number of swimmers and/or boats in the whale shark viewing area.

Table 4.1. Perceived crowding during the whale shark tour.

Crowding	Percent response
not at all crowded (34.0%)	
1	34.0
slightly crowded (42.2%)	
2	20.4
3	10.5
4	11.3
moderately crowded (20.1%)	
5	6.4
6	7.8
7	5.9
extremely crowded (3.7%)	
8	1.3
9	2.4

mean: 3.04
sd: 2.19

Whale shark encounter guidelines on Holbox stipulate that only two swimmers are allowed in the water at any one time with a given shark and that a licensed guide must accompany them (CONANP, 2008b). Based on survey responses, this protocol was followed 74.5% of the time, while the remaining 25.5% resulted in anywhere from four to ten people swimming with a single shark (Table 4.2). There was on average six people with a whale shark when the swimmer limit was exceeded. The majority of respondents

(88.2%) felt that a maximum of three people should be allowed to interact with a shark at a time, as stipulated in the encounter guidelines, supporting the effectiveness of this rule in minimizing crowding problems. The remaining 11.8% of respondents would support four or more people in the water at one time with an average of five people.

Table 4.2. Actual and preferred swimmer numbers.

	Percent response
number of swimmers encountered	
2 to 3	74.5
4 to 5	12.1
6 to 10	13.3
number of swimmers should be allowed	
0 to 3	88.2
4 to 10	11.8

There was a significant relationship between perceived crowding and the number of swimmers encountered in the water. The number of swimmers who felt moderately to very crowded increased significantly as the number of snorkelers encountered in the water increased, while the number of swimmers who felt not at all crowded decreased ($p=0.000$) (Table 4.3). Interestingly, the proportion of respondents who felt slightly crowded were approximately the same for each of the crowding levels (i.e. 2 to 3, 4 to 5 and 6 to 10 swimmers).

When the level of perceived crowding was compared to the number of swimmers the respondents' felt should be allowed in the water at one time, the majority of respondents (88.0%) supported zero to three snorkelers regardless of perceived crowding (Table 4.3). Those swimmers who felt moderately to extremely crowded were significantly more likely to support zero to three snorkelers than those swimmers who felt slightly crowded ($p=0.045$). Further, 6.9% of those swimmers who reported the highest crowding levels would still support six to ten swimmers in the water.

Table 4.3. Actual and preferred number of swimmers based on level of perceived crowding.

	Perceived crowding			df	x^2	p
	N	**S**	**C**			
# swimmers encountered						
2 to 3	87.4	72.4	55.7	4	29.037	0.000*
4 to 5	7.1	13.5	17.0			
6 to 10	5.5	14.1	27.3			
# swimmers should be allowed						
0 to 3	89.5	84.0	93.1	2	4.813	0.045*
4 to 10	10.5	16.0	6.9			

*significant at α=0.05
N=not at all crowded, S=slightly crowded, C=moderately to very crowded

4.4. Discussion

Understanding the current status of the whale shark industry on Holbox is critical to ensuring its future sustainability. The industry on Holbox was assessed using Duffus & Dearden's (1990) WTM. The discussion will be broken down into two main sections: first an assessment of the industry based on tourism growth, LAC (social and biological) and specialization, and second a discussion of the potential to transition the whale shark tourism industry of Holbox to an ecotourism approach that emphasizes triple bottom line sustainability (i.e. environmental, economic, and social).

4.4.1. Assessment of the whale shark tourism industry using the WTM framework

4.4.1.1. Tourism growth

The growth of the whale shark tourism industry on Holbox approximates Duffus & Dearden' (1990) WTM curve, with fairly low visitation when it was first established (point A), followed by a dramatic increase in visitors from 6,000 to over 17,000 as the site became better known from 2004 to 2008 (approximating a transition through point B to C), and finally a tapering off as the site approaches its carrying capacity with visitation only increasing by 4% from 2007 levels in 2008 (point C) (Figure 4.3). Furthermore,

growth in the number of guides mirrors this pattern with a fifteen-fold increase from original levels in 2002 (de la Parra, 2008) (Figure 4.4). The number of permits issued jumped from 42 in 2003 to 140 in 2008 to 207 for 2009 (Varillas, 2010) to 250 for the 2010 season (Camaz, 2010), despite stated plans to implement a license cap of 140 permits during the 2008 season (pers. comm. F. Remolina Suarez). The model suggests that if the site continues to grow without any intervention there is the potential for the site to collapse due to severe tourist crowding and negative impacts on the environment, including the target species itself (point D) (Duffus & Dearden, 1990). With the government's continued willingness to issue ever greater permit numbers along with plans to expand visitation numbers, the potential for collapse may not be a theoretical outcome for long.

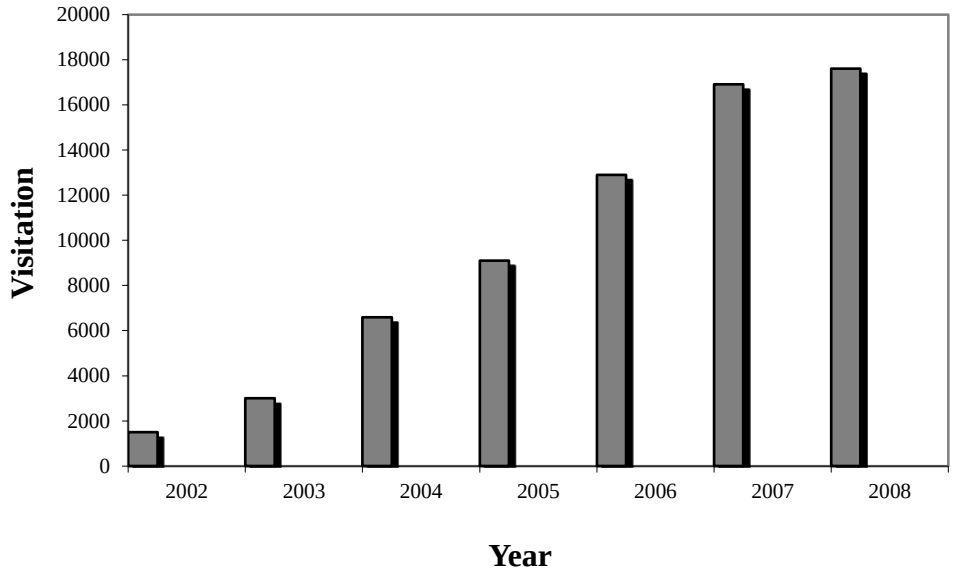

Figure 4.3. Growth of the tourism industry in terms of visitation over time (adapted from de la Parra, 2008).

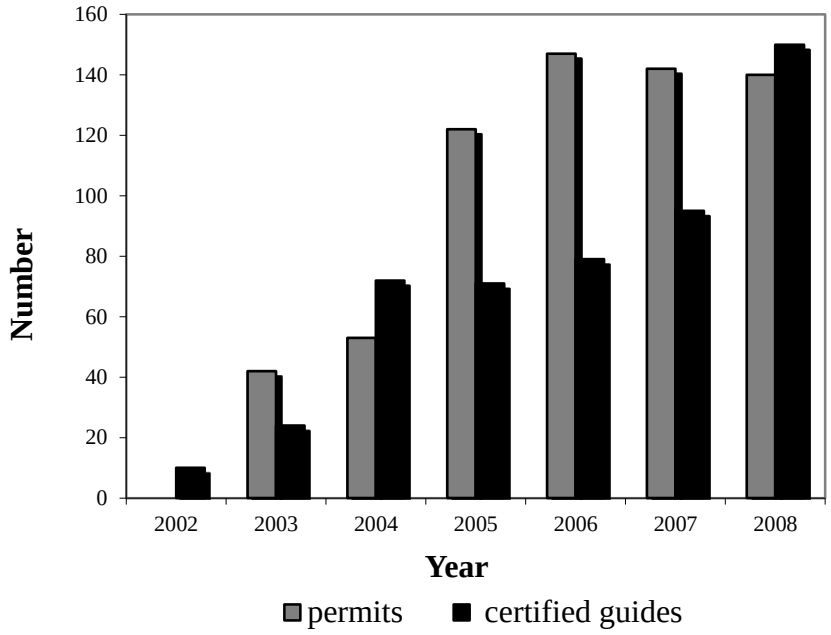

Figure 4.4. Growth of the tourism industry in terms of the number of permits and guides (adapted from de la Parra, 2008).

This unregulated growth is in stark contrast to the whale shark watching industry at Ningaloo Marine Park (NMP) in Western Australia, considered to be the gold standard for the management of this industry. The focus in Australia has been to limit entry into the industry in terms of both operators and tourists through licensing caps (14 permits) and high tour costs (US$378 per person), respectively, while still allowing for high net profits (US$6 million in 2006) and therefore a thriving whale shark tourism industry. Increasing the tour cost on Holbox would help decrease the high visitor numbers without affecting net profits and could help make the industry more sustainable in the long-term. It is important to note the vast differences in tourism volume to the surrounding area, with roughly 200,000 tourists visiting the Ningaloo Coast every year (Catlin & Jones, 2010) compared to the millions of visitors travelling to the Yucatan Peninsula every year (Hendricks, 2005). This proximity to such mass tourism destinations like Cancun and the

Mayan Riviera increases the risk of unsustainable industry growth on Holbox compared to NMP.

4.4.1.2. Specialization

Specialization analysis of whale shark tour participants on Holbox indicates that participants segregate into three subgroups, generalists (64.0%), intermediate shark tourists (28.7%), and specialists (7.3%) (Chapter 3). This breakdown suggests that whale shark tourism on Holbox is transitioning towards point C on the WTM curve, with a majority of generalist shark users participating in the tour and a very small number of specialists. The intermediate shark tourists were different from generalists only in that whale sharks were an important component of their decision to visit Mexico. However, they had similarly little experience in shark watching supporting the idea that specialization is transitioning towards a majority of generalists.

These results are similar to findings for the progression of specialization with site maturity at NMP in Australia. Catlin & Jones (2010) assessed the swim-with whale shark activities at NMP using Duffus & Dearden's (1990) WTM model. The authors compared their results to those of a previous socio-demographic assessment of the industry (Davis et al., 1997) and found an increase in generalist users.

4.4.1.3. Limits of acceptable change

Beyond visitation and specialization, the WTM model also incorporates LAC in assessing a tourism site's sustainability. Previous studies assessing the impacts of whale shark tourism on the community of Holbox identified Holbox's heavy reliance on its natural resources as the main driver of the local economy (e.g. Zenteno, 2007; Cepeda, 2008). The community of Holbox has two main livelihoods – fishing (shark, octopus, lobster)

and nature-based tourism (whale sharks, sport fishing, birds) (Cepeda, 2008). Consequently, a decrease in the health of the environment would have a devastating impact on the local economy and the quality of life of the community. Key stakeholders (community members, tour operators, government) have already listed a deteriorating ecosystem as an active threat to the community, mentioning a growing problem with garbage, overharvesting (not respecting size limits and closures) and tourism impacts on the whale sharks (e.g. noise, contamination, pollution, harassment of whale sharks, boat strikes, boat speed) as evidence of this threat (Cepeda, 2008). These results suggest that the community of Holbox, including whale shark tour operators, would not accept changes in the ecosystem that could result in the loss of their livelihoods.

Biological and social LAC relevant to the whale shark industry on Holbox are discussed below, including future needs to improve monitoring capabilities and adaptive management of the site.

4.4.1.3.1. Biological

Biological LAC refer to indicators that measure the level of impact the industry has on the target species and its environment, such as changes in population reproductive capacity and water quality. These indicators enable managers to monitor changes in population characteristics due to tourism activities and modulate policies to match the needs of the site in terms of key aspects of the activity, such as the appropriate number of operator licenses and the spatial and temporal distribution of tourism activities (e.g. number of tours, season, contact time with animals) (Higham et al., 2009).

However, there are challenges in applying these measurements to the tourism activities targeting whale sharks. The whale shark is a difficult species to study; they do

not require surface intervals to breathe and are typically found at depths of 100-200 m. Whale sharks also appear to segregate based on age and sex (e.g. Norman & Stevens, 2007) making it difficult to get a clear understanding of population size, structure, mortality and reproductive potential.

Recent studies have attempted to estimate changes in whale shark abundance using modelling with diverging results. For example, Bradshaw et al. (2007, 2008) perceived a decline in whale shark numbers at NMP (Australia), while Holmberg et al. (2008, 2009) found a slight increase in population abundance. These opposing results are due to the lack of sufficient population metrics for whale sharks (e.g. litter size, growth rate, female reproduction frequency, age-specific survival probability, age in years, age at first reproduction, longevity) (Holmberg et al., 2009) and problems with meeting model assumptions (e.g. closed population, equal capture probability of all individuals in the population) (Riley et al., 2010).

These issues highlight the difficulty in measuring and monitoring changes in whale shark population metrics due to tourism activities. However, indirect methods of assessment can provide some insight into the potential impacts of swim-with tours on the whale sharks. Whale sharks demonstrate avoidance behaviours, such as banking, violent shuddering and diving away, when faced with sufficient harassment levels (Colman, 1997; Norman, 1999; Quiros, 2007). According to Neil et al. (1975), harassment can be defined as any human activity ‘which increases the physiological costs of survival or decreases the probability of successful reproduction of wild animals’ (p. 1). Harassment is an important concern for whale shark tourism as many of the sites occur at known feeding (and potential breeding) grounds around the world, including Australia, the

Philippines, Mexico, Mozambique and Belize (Heyman et al., 2001; Colman, 1997; Quiros, 2007; de la Parra, 2008; Pierce et al., 2008).

Quiros (2007) assessed the impacts of whale shark tours on the sharks in Donsol, Philippines using direct observation of the interactions and established causal relationships between swimmer behaviour and the shark's response. Given swimmer behaviours (e.g. diving towards the shark, path obstruction, making physical contact, getting too close) elicited specific avoidance behaviours from the sharks (e.g. change in direction, diving, shudder response) (Quiros, 2007). Those sharks engaged in feeding behaviour or those that had been interacted with repeatedly were more likely to exhibit a dive response, thereby diverting energies from feeding to evasion behaviours (Quiros, 2007). These findings suggest that tourist harassment can significantly affect the long-term health and fitness of whale sharks. Further, Quiros (2007) concluded that an 80% compliance rate to the whale shark interaction guidelines led to noticeable negative short-term impacts on the whale sharks' behaviour.

In the current study, compliance to the 'no contact' rule was used as a proxy measure of the direct impacts the tourism industry has on the whale sharks of Holbox. Despite being told not to touch the sharks, of the 23% of tourists that admitted to making contact with a shark, 17.1% did so intentionally (Chapter 3). A further 42% of all respondents reported seeing at least one other person make contact with the sharks, with an average of 2 people being seen touching the shark per tour. This approximates a conservative compliance rate of 77% for the Holbox industry, as this estimate is based on self-reported data and participants may not have been willing to admit to violating the code of conduct. The estimated compliance rate is supported by a study during the 2007

season, which found a 60-70% compliance rate to the encounter guidelines (not just contact rates) based on a focus group with local whale shark tour operators (Cepeda, 2008). Regardless, a comparison of the current compliance rate (77%) to that of Quiros' (2007) study (80%) suggests that the current situation on Holbox is causing some harm to the visiting whale shark population.

Contact rates are but a proxy measure for direct impacts of swim-with activities on the whale sharks. It is critical to identify and measure indicators that signal early signs of significant impacts (e.g. changes in blood chemistry), as well as indicators that reflect an imminent threat to the population (e.g. decline in reproductive success) (Higham et al., 2009). The latter category of indicators requires more research to elucidate whale shark population metrics.

However, a potential method to measure warning indicators may already exist. Recent work on stingrays (chondrichthyans like whale sharks) demonstrated that haematological differences in stingray populations can be used as an estimate of physiological costs of wildlife tourism. Semeniuk et al. (2009) compared haematological characteristics (i.e. blood components) of stingrays at Stingray City Sandbar, Grand Cayman, a heavily touristed site, to those of a nearby, non-touristed population and found significant differences between the two populations in terms of key health indicators (e.g. hematocrit levels, total serum protein concentrations, oxidative stress).

Applying this method to the whale sharks of Holbox would be difficult, but feasible. This method requires a nearby control group to facilitate comparisons of whale shark haematological samples in the presence and absence of tourism activities. Finding a control group would be difficult for the whale sharks congregating off Holbox, especially

due to their highly migratory nature. Further, whale sharks do not require surface intervals to breathe making it difficult to locate and sample them. However, large aggregations of whale sharks (>100 individuals) have been observed feeding in the northern Gulf of Mexico during the same season (Coleman, 2010) and no tourism activities currently exist in the area. The latter aggregation could provide a viable control group for this type of study making it possible to measure differences in whale shark stress levels due to tourism activities. This method would also require confirmation of the specific haematological characteristics that are relevant to whale sharks and their corresponding stress levels. However, research into whale shark blood chemistry has already commenced (e.g. Dove et al., 2010) suggesting that haematological studies could be feasible in the near future.

4.4.1.3.2. Social

Social LAC must also be considered when assessing the impact and sustainability of nature-based tourism activities, as uncontrolled growth of an activity can have negative impacts on the tourists and the local community as well as the target species. Indicators that are used to assess social LAC include perceived crowding, satisfaction with tour services and features, as well as social benefits and economic stability of the activity. The social, economic and environmental impacts of whale shark tourism on the local community of Holbox have been studied using the sustainable livelihoods framework (Diaz-Amador, 2005; Cepeda, 2007) and an economic assessment of the sustainability of the industry (Zenteno, 2007).

These studies identified serious problems with the equitable distribution of benefits within the community, as well as with the social cohesion of the community

(Diaz-Amador, 2005; Zenteno, 2007; Cepeda, 2008; CONANP, 2008a). Cepeda (2008) assessed different types of capital (e.g. social, human, cultural, political, natural, financial and development) on Holbox using the Strengths, Weaknesses, Opportunities and Threats (SWOT) framework. She found that the increase in income from nature-based tourism activities, especially whale shark tourism, over the last 10 years has resulted in a deterioration of social, political and natural capital through inequitable distribution of benefits due to unfair competition. Cepeda (2008) concluded that the distribution of benefits, access and participation in the industry is not equal in the community creating conflicts that threaten the sustainability of the community.

Previous research looking at the poverty reducing powers of nature-based tourism activities in developing nations found that those groups of poor that were already better off tend to benefit most from these activities (e.g. Shah & Gupta, 2000; World Bank, 2007). These findings are supported on Holbox. Those operators who were already well off benefited more from whale shark tourism than the less well off operators (Cepeda, 2008). For example, Zenteno (2007) noted that the small tour operators (i.e. with one or two boats) on Holbox only had a 13.5% chance of breaking even during the 2006 season with average losses of US$44,928 after taxes, while the large operators (i.e. with three or more boats) only had a 13% chance of losing money and made after tax profits of US$351,300 on average for the season. These inequalities translated into a high turnover rate for smaller operators who could no longer offer whale shark tours due to debt (Zenteno, 2007).

The proximity of Isla Holbox to high volume tourism destinations (e.g. Cancun, Playa del Carmen, Cozumel) has also resulted in a thriving day tourism operation. These

day tours allow tourists staying in the Mayan Riviera and Playa del Carmen to swim with whale sharks on Holbox. The outcome is high visitation numbers with relatively low net profit to the island, since the majority of these day tourists do not provide any local economic benefits beyond the cost of the whale shark tour itself. The conservative estimated worth of the whale shark industry on Holbox using tour cost alone is approximately US$1.89 million[1]. However, the captains and guides only make approximately US$50 each per boat of seven tourists (although the larger operators pay up to US$90 per trip) resulting in an estimated total of US$251,429[2], which is just 13% of the estimated industry worth. Further, the involvement of third parties (e.g. hotels, dive shops, tour agencies) to bring the day tourists to Holbox has resulted in significant economic leakages to the community of Holbox, with a conservative estimate of losses set at 30% of the total profits or US$570,240[3].

The impacts of whale shark tourism on the tourists themselves is also important to consider as tour participants will be unwilling to spend money on an experience that is not satisfying. Importance-Satisfaction Analysis revealed tour participants were very satisfied with the proximity to sharks, quality of boats, length of trips, ease of snorkelling conditions, and the number of sharks encountered (Chapter 2). However, the analysis also revealed ten areas of concern: abundance of marine life and large fish, variety of marine

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[1] conservative estimate using visitor breakdown of 30% off-island and 70% on-island, with average tour costs for each subgroup at US$188 and US$73, respectively.

gross returns = (0.30x17,600x188) + (0.70x17,600x73) = 992,640 + 899,360 = 1.892 million

[2] conservative estimate using US$50 as amount paid to each captain and guide, or $100 per trip, and an average of 7 passengers per trip

gross salary = (0.30x17,600/7x100) + (0.70x17,600/7x100) = US$251,429

[3] Average cost of day tour is US$188, price paid to local operator is US$80

Estimated leakage = US$108x0.30x17,600 = US$570,240

life, number of boats and snorkelers, cost of trip, good underwater visibility, educational information, safety procedures, and commitment to the environment.

Perceived crowding is a crucial measure of impacts on tourists because tourists will not return to a site if crowding becomes too great (Duffus & Dearden, 1990). Crowding can be considered both in terms of number of boats and number of swimmers encountered (e.g. Roman et al., 2007; Bell, 2010; Paterson & Loomis, 2010). The interaction guidelines for the swim-with activities on Holbox stipulate that only two people plus the guide are allowed in the water at any one time with a shark (CONANP, 2008b). The interaction guidelines also stipulate only one boat is allowed per whale shark for a maximum of 30 minutes, while other boats must wait a minimum of 50 m away (de la Parra, 2008). A proposed addition to the interaction guidelines includes a section allowing multiple boats to share the shark by alternatively allowing their tourists to enter the water two at a time as long as all boats are in agreement (CONANP, 2008a).

The results of this study suggest that for at least a quarter of the time there were more than the allowable swimmers in the water, with up to ten swimmers encountered at once (Figure 4.5). Close to a quarter of respondents felt that the number of other snorkelers was too high, while a third reported feeling moderately to extremely crowded during their experience. These results suggest that crowding is becoming a serious problem on Holbox.

The rule requiring two swimmers plus the guide was intended to minimise problems with crowding, both of the tourists and the sharks, and ensure better monitoring of the participants' actions while they are near the shark. However, the likelihood of making contact with a whale shark was not correlated to the number of swimmers

encountered in the water (Chapter 3). Further, 20% of respondents felt moderately to extremely crowded even when the appropriate number of people was in the water, which suggests that something beyond the number of swimmers encountered is affecting perceived crowding.

Figure 4.5. Image of 10 swimmers interacting with a whale shark (photo: J. Ziegler).

The number of boats observed in the viewing area can also affect perceived crowding. For example, perceived crowding related to the number of vessels sharing whale sharks has emerged as a new concern at NMP in Australia (Catlin & Jones, 2010). The same appears to be true of Holbox. A third of respondents were unhappy with the number of other boats whale shark watching (Chapter 2). The latter is partially due to the industry practice of clustering boats when a whale shark is located, instead of seeking out new sharks. However, problems with boat numbers mainly stem from the high number of boat permits issued each season. During the 2008 season, 140 boat licenses were issued (de la Parra, 2008). Issues with crowding will only intensify as the number of licences continue to increase each season, with 207 issued in 2009 (Varillas, 2010) and 250 in 2010 (Camaz, 2010).

Beyond crowding, tourists were also dissatisfied with the abundance of marine

life and large fish, variety of marine life, good underwater visibility, and cost of trip. These problems are mainly related to issues of false advertising, involving images used to sell the tours that misrepresent the conditions on Holbox, as well as misrepresenting the likelihood of viewing other species (e.g. dolphins, manta rays, flying fish, turtles, yellow rays) and basic tour features (e.g. possibility of snorkelling at a local reef, quality and extent of meals) (Chapter 2).

Tour participants were also unhappy with the quality of educational information, safety procedures, and commitment to the environment during the whale shark trip (Chapter 2). These issues are due to a combination of language barriers (only 10% of guides speak more than one language), and training deficiencies (e.g. clearly linking specific human actions to whale shark stress). Captains and guides are provided with extensive training for in-water rescue and first aid and boats are required to have radios, as well as first aid kits (CONANP, 2008a). Further, the boats themselves are required to have four-stroke engines to limit pollution, as well as propeller guards to protect the sharks from injuries. However, this information is not passed on to tourists, mostly because of language barriers. The same can be said of educational information. In terms of commitment to the environment, tourists may be unhappy with specific whale shark interaction methods, such as encircling the shark with boats to prevent the shark's escape (Figure 4.6), dropping off tourists directly in the path of oncoming sharks, boats striking sharks, and boats moving at great speeds in areas where swimmers and/or sharks are in close vicinity.

Figure 4.6. Boats encircling whale shark off Holbox (photo: J. Ziegler).

These issues with both biological and social LAC further support the idea that the Holbox whale shark tourism industry is headed down an unsustainable path with its current management regime. Tourism activities are significantly affecting whale sharks in their critical feeding habitat, at least in the short term, thereby potentially influencing the long-term fitness of these individuals. The management approach of increasing tourism numbers and flooding the market with permits also sends the message that economic profit is more important than conservation of the whale sharks or tourist satisfaction. Thus, the industry appears to be absorbing these impacts on the whale sharks and increased crowding as a necessary aspect of expanding tourism activities, as predicted in the WTM model.

4.4.1.4. Overall placement of Holbox whale shark tourism on WTM curve

The preceding assessment places the Holbox whale shark industry nearing point C (Figure 4.7). Key evidence includes: the rapid growth of the industry followed by a

tapering off with only a 4% increase in visitation from 2007 (16,900) to 2008 (17,600); the majority of generalist users (>60%) compared to specialists (7.3%); the growing issues with crowding (33% feeling moderately to extremely crowded); and the significant negative impacts on the whale shark population (23% contact rate). These results suggest the whale shark tourism industry on Holbox is headed to collapse if it does not alter its current path.

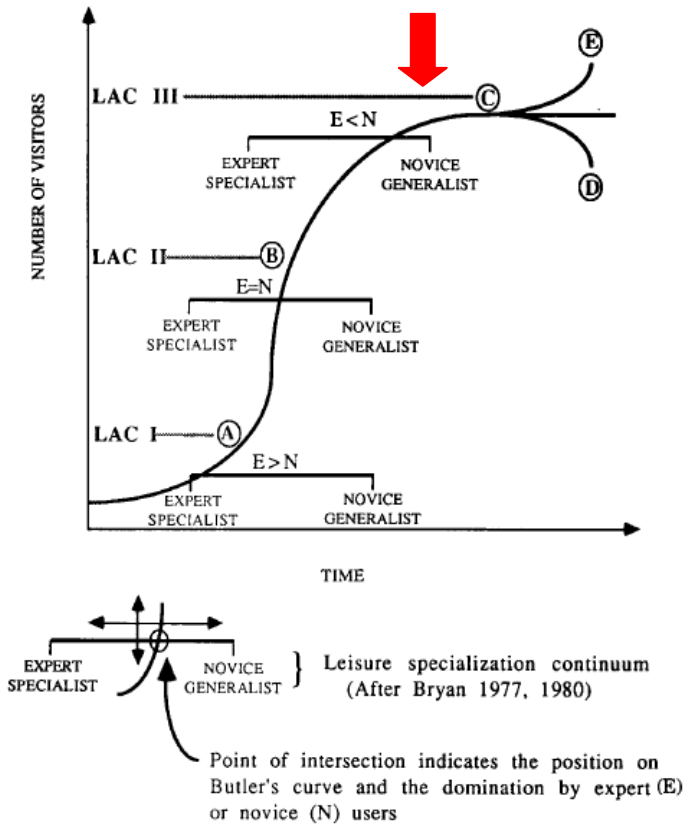

Figure 4.7. Status of the whale shark tourism industry on Holbox with respect to Duffus & Dearden's (1990) WTM framework.

4.4.2. Improving the sustainability of the industry

Many of the issues identified could be addressed by implementing a more sustainable management framework. Buckley (2009) states: 'ecotourism may be viewed as an

intervention in the tourism industry: an attempt to modify its mode of operation for reasons not entirely commercial' (p.643). Indeed, researchers have noted the potential to improve sustainability of wildlife or nature-based tourism by transitioning towards an ecotourism approach (e.g. Rodger et al., 2007). Weaver & Lawton (2007) undertook a literature review of ecotourism research and found a general consensus on the core values a tourism activity must satisfy in order to be considered ecotourism, if not the interpretation of these requirements. These core values are as follows:

1. be nature-based
2. include a focus on learning or education
3. be based on triple bottom line sustainability (i.e. ecological, socio-cultural, and economic)

Important facets of sustainability as it relates to nature-based tourism, wildlife tourism and ecotourism are economic and business viability, visitor satisfaction and education, and the impacts of tourism on wildlife and the environment (Rodger & Moore, 2004).

The ecotourism definition for the swim-with whale shark activities on Holbox provided in the proposed management plan does not address all three components of Weaver & Lawton's (2007) ecotourism definition:

> 'a type of environmentally responsible tourism, which consists of travelling to or visiting undisturbed natural areas with the goal of enjoying, appreciating and studying the natural attractions of the landscape or cultural manifestations to be found there. It is performed in a manner that promotes conservation, has low environmental impact and promotes

> the active involvement of, and is socio-economically beneficial to, the local people' (CONANP, 2008a, p.39).

The definition makes no mention of incorporating environmental interpretation or learning for the tour participants, nor does it make mention of how it plans on promoting conservation.

Studies have found a trend of operators making use of the ecotourism label as a means to take advantage of the greening of the marketplace (e.g. Wight, 1993; Krüger, 2005; Lansing & De Vries, 2007) and this may be the case on Holbox. The Holbox industry has elements of environmental responsibility in that the licensing scheme requires boats to have four-stroke engines and propeller guards. However, the number of boats and tourists that interact with the whale sharks, along with the high contact rates and lack of enforcement do not reflect environmental responsibility. The whale shark tourism industry also fails to promote whale shark conservation, as the briefings make no mention of threats the whale sharks face, nor means for tourists to get involved in conservation efforts, either directly (e.g. donation, labour, photo-identification library) or indirectly (e.g. beach clean-up, join environmental organization). Finally, the inequitable distribution of funds within the industry (e.g. Zenteno, 2007) and the significant economic leakages are not socio-economically beneficial to the local community.

Further, the whale shark industry on Holbox faces growing competition from the industry based out of Isla Mujeres and Cancun (Figure 4.1). These locations are a more convenient entry point for those tourists staying in the Mayan Riviera (i.e. day tourists visiting Holbox) and thus threaten to overtake Holbox as the new gateway to the whale shark population (Zenteno, 2007). The industry centred near Cancun has nearly

quadrupled its number of licenses from 40 in 2008 to almost 150 in 2010, suggesting that this transition may be quickly approaching. Furthermore, the aggressive sales techniques, bilingual guides and better financial capacity on Isla Mujeres poses an imminent threat to the future livelihoods of the local fishermen that participate in this activity on Holbox (Zenteno, 2007).

Dearden et al. (2007) evaluated the dive industry in Phuket, Thailand in terms of specialization and suggested management interventions to improve the sustainability of the activity in the face of increased competition, as well as user satisfaction with dive experiences. The authors recognized two potential paths for the dive industry, 1. maximize tourist numbers to maximize returns (the typical course of developing tourism sites), or 2. maximize the tour cost in order to reduce tour numbers while still retaining economic benefits. They recommended that the dive industry in Phuket target specialist users because they tend to stay longer, spend more money, and have a lower impact on the environment than the more generalist users. Consequently, management would be able to control the growth of the industry, and therefore impacts on the environment, while still maintaining economic benefits to the industry and community. Triple bottom line sustainability would thus be achieved.

This type of targeted marketing would be well suited for the industry on Holbox in the face of growing competition from Isla Mujeres. It would allow Holbox to target a specific subset of whale shark tourists and tailor the tour to their needs, while lowering visitation (and related perceived crowding problems) and improving economic returns to the community. Specialists and intermediate users placed the highest importance on whale sharks as a tourism attraction in Mexico (Chapter 3) and thus may be more likely

to spend more money and/or time pursuing this activity. Further, specialists were most sensitive to perceived crowding suggesting they may be more likely to seek out an 'authentic' experience in a more remote area compared to the more generalist tourists. Consequently, the restructuring of whale shark tourism on Holbox should involve targeting these user subgroups.

Holbox is a prime venue for the implementation of an ecotourism approach to whale shark tourism. As a tour operator on Holbox stated in Cepeda (2008), 'the industry's best chances at commercialization of the tour on Holbox is through the improvement of the quality of the tour, selling it as an ecotourism product on an island of fishermen, not a large scale tourism centre like Cancun, as the people of Cancun are predators, while the people of Holbox live alongside the whale shark' (p. 64). Holbox is more remote and much less crowded than Cancun, as it is an isolated island with a fishing village of approximately 1,500 inhabitants instead of a mass tourism destination like Cancun that attracts millions of visitors each year. Further, Holbox had not experienced extensive tourism prior to the arrival of the whale shark tourism industry in 2002 (Cepeda, 2008). The streets remain unpaved, cars are few in number, the main village consists of two blocks in each direction from the main square, captains and guides are mostly current and/or past local fishermen, and the friendliness and generosity of the locals remain. Further, the waters of Holbox also attract not only whale sharks (like in the Caribbean waters off Isla Mujeres) but also manta rays, turtles, dolphins, golden rays, flying fish and flamingos. Thus, the location's authentic feel along with the richness in its natural resources can provide a better quality experience to those interested in such an experience.

An ecotourism approach to whale shark tourism would also address many of the industry problems outlined above (e.g. crowding, impacts on the whale sharks, unequal distribution of benefits) (Section 4.4.1**)** and thus help the industry achieve triple bottom line sustainability. The ideal goal of ecotourism is to minimise negative environmental impacts, improve economic returns and provide tangible benefits to the local communities, while still providing an enjoyable tourism experience for participants. The whale shark tourism industry on Holbox would require a re-structuring of current management policies in order to achieve these goals. For example, the focus of the whale shark tourism industry at NMP (Australia) is on limiting entry to the industry through license caps and increased tour costs. The cost of the tour at NMP (US$378 per person) is more than five times that of the on-island cost for Holbox (US$73 per person), with only a fraction of the visitation (7,595 in 2006) and six times the economic returns to the region (US$6 million in 2006) (Catlin & Jones, 2010).

Holbox would first need to address problems with price discrepancies (tour cost ranges from US$60 - US$500 depending on travel method and point of origin, Chapter 2) before this approach could be implemented successfully as the larger, more established operators may still outcompete the smaller ones. A potential approach would be to use a system similar to the one in place for the whale shark tourism industry in Donsol, Philippines. This industry is centralized through the local tourism office. Tourists must first register with the tourism office, which then pairs the tourists with a captain and guide based on the rotation through an alphabetical list of registered captains and guides. Although the industry has 60 trained captains and 42 trained guides, with a further 18 guides to be trained for the 2011 season (WWF-Philippines, pers. comm.), the approach

ensures that each captain and guide gets an equal opportunity to provide a tour on any given day. The system is not perfect (e.g. over 170 boats and 700 tourists participated in whale shark tours on a single day during the 2010 season), however, it does address problems of inequitable distribution of benefits.

A similar system on Holbox could involve tourists registering with a central agency (e.g. CONANP), paying a higher fixed tour fee (e.g. US$150 foreigners, US$80 locals), and then being assigned a captain and guide using an alphabetical rotation through a list of registered guides and captains. The off-island tourists would make the required payments through the third party booking agency and then be assigned a captain and guide. There would be no need to lower the number of permits issued for the season, as not all boats will have the opportunity to go out each day. However, management will have to establish the acceptable number of boats within the whale shark viewing area (e.g. 40 boats per day), as the code of conduct currently stipulates that the number of boats should be limited but does not specify an actual number. The limit on boats would address issues with perceived crowding, while the centralisation of tour sales would address a substantial portion of the current problems with inequitable distribution of funds. This approach would still leave unresolved issues with economic leakage with respect to off-island tourists. However, the expanding industry on Isla Mujeres and Cancun may make this a moot issue in the near future, as it is a more expedient departure point for those tourists participating in day tours from the Mayan Riviera.

The re-structuring process must also incorporate an extensive conservation-based guide training and interpretation program to address industry problems with impacts on whale shark and the lack of a conservation ethic. The latter is especially important if

management is to target the more specialized users who had the highest contact rates and were significantly more likely to perceive the industry as having a positive impact on the environment and sharks than the generalists (Chapter 3).

The close nature of the interactions with whale sharks on Holbox (viewing distances of 2 m) demands a more stringent enforcement of the encounter guidelines. Proximity to wildlife is the most critical variable affecting wildlife stress during tourism encounters (Moscardo et al., 2001; Braithwaite & Reynolds, 2002; Weaver & Lawton, 2007). The minimum viewing distance between swimmers and whale sharks on Holbox is set at 2 m because of the poor visibility resulting from high concentrations of plankton in the water (Remolina Suarez et al., 2005). Increasing this distance is therefore not feasible for Holbox whale shark tourism like it is in other regions (e.g. Australia, Davis et al., 1997). Regardless of viewing distance, education and regulation may not be adequate means of reducing the high levels of interaction because close proximity to the target species is an integral part of this type of wildlife tourism activity (Rodger et al., 2007). Ninety percent of respondents on Holbox stated that proximity to whale sharks was the most important aspect of their whale shark experience (see Chapter 2). Thus, the industry on Holbox must also ensure optimal compliance to the interaction guidelines in place through improved guide training, which will improve guide vigilance and likelihood of intervening when inappropriate behaviours are observed.

The successful implementation of an ecotourism approach to whale shark tourism may provide an economic incentive for Holbox operators to follow interaction guidelines and enforce them in the whale shark viewing area. Curtin et al. (2009) suggest that responsible operators may be at an economic advantage over other less compliant

operators, thereby pushing the emergence of more responsible tourism opportunities. Not only will Holbox operators attract tourists willing to spend more money for a higher quality experience, the ecotourism approach may force whale shark tourism in the region (Isla Mujeres, Cancun) to transition to a more sustainable form in order to remain competitive within the market and result in the improved protection of the visiting whale shark population.

The declaration of the new Whale Shark Biosphere Reserve in 2009, along with its associated stricter regulations, fits within this transition to a more sustainable approach to whale shark tourism management. This designation provides CONANP with the authority to limit or ban the use of natural resources within the Biosphere Reserve, including whale shark tourism activities. Thus, CONANP has the power to implement the discussed changes if significant disturbance to the whale sharks is noted, as it is has been done here.

4.5. Conclusions

Shark tourism is viewed as potentially an important means of protecting threatened species, while also providing a sustainable livelihood for local communities (Dearden & Topelko, 2005). However, the very nature of this type of tourism requires that activities be sustainable and put the conservation of the species as the primary management goals. Furthermore, many of these activities target sharks in key feeding and/or breeding habitats. It is thus imperative that management ensures tourism is kept within sustainable limits. Assessing tourism sites based on management approaches can provide insights into the future sustainability of the activity, as well as identify key areas of weakness that must be addressed in order to achieve sustainability.

The assessment of the Holbox whale shark tourism industry using Duffus & Dearden's (1990) WTM framework suggests that this industry is reaching its tipping point if changes are not made to improve its management policies and design. Industry issues include: 1. crowding due to poor control of the industry's growth (visitation and number of operators), 2. significant impacts on the whale shark population due to poor compliance to interaction guidelines, and 3. the inequitable distribution of benefits within the community, including significant economic leakages. Thus, the activity does not appear to be sustainable in the long-term, nor is it helping achieve conservation goals for the threatened whale shark.

A transition to an ecotourism approach to whale shark tourism management would help address many of the issues identified in this paper. The ecotourism approach addresses triple bottom line sustainability as it recognises the need to minimise negative impacts on the target species by reducing the number of visitors and operators and improving environmental behaviour through an educational component, improving the quality of the tour and improving the socio-economic benefits to the local community. Potential changes to the Holbox industry include:

1. Controlling the growth of the industry through:
    - a focus on more specialised users
    - increased tour costs
    - setting a limit on the number of boats allowed within the whale shark viewing area
2. Reducing negative impacts on the whale sharks through
    - improved interpretation and vigilance by the guides

3. Equitable redistribution of economic benefits through
    - centralisation of tour sales (e.g. via CONANP)
    - rotation of an alphabetical list of certified guides and captains
    - fixed tour cost

The recent declaration of the Whale Shark Biosphere Reserve, which encapsulates the vast majority of critical whale shark habitat in the area, further empowers local management to address these issues and restructure the industry into a more sustainable form. The latter must be the primary management goal, as whale shark tourism activities on Holbox target a threatened species within its critical feeding habitat.

Chapter 5: Global scale threats to whale sharks and the implications for sustainable whale shark tourism activities

Humankind has not woven the web of life. We are but one thread within it. Whatever we do to the web, we do to ourselves. All things are bound together. All things connect. – Chief Seattle, 1855

Abstract

The rapid growth of whale shark tourism in the last decade coupled with the whale shark's status as a threatened species raises concerns over the sustainability of these tourism activities. However, long-term sustainability of whale shark tourism is dependent not only on the local scale management approach, but also the global scale issues affecting the targeted species (e.g. marine pollution, overharvesting, global climate change (GCC)). GCC is the most urgent threat facing the oceans today. The objectives of this paper are to assess the whale shark's vulnerability to GCC in order to address site-specific sustainability concerns of the tourism activity. Results suggest that GCC could have a significant impact on the size and distribution of whale shark aggregations in the future. Thus, the majority of whale shark tourism activities, which are based on whale sharks aggregating in vulnerable habitats, may be unsustainable in the long-term. The type of users and format of tours further supports an increased vulnerability to GCC. Diversifying the local economy of communities dependent on whale sharks could improve their resilience to a reduction and/or loss of whale sharks.

Keywords

Climate change, Marine pollution, Vulnerability assessment, Whale sharks, Wildlife tourism

5.1. Introduction

The long-term sustainability of wildlife tourism is dependent not only on the local scale management approach of the industry, but also the global scale issues threatening the targeted species (e.g. marine pollution, overharvesting, climate change) (Higham et al., 2009). To consider the tourism activity in a vacuum exempt from external influences beyond the local scale is short sighted, especially when considering the highly migratory nature of some of the species targeted by tourism activities (e.g. sea turtles, whales, whale sharks). Thus, a sustainability assessment of a given wildlife tourism activity should take into account the relevant large scale threats that could affect the targeted species.

Whale shark tourism is an example of an industry that must incorporate larger scale threats within management policies if sustainability is to be achieved. Whale sharks are a highly migratory species that form predictable feeding aggregations around the world (e.g. Australia, Philippines, Mexico, Belize) (Heyman et al., 2001; Meekan et al., 2006; Pine, 2007; de la Parra, 2008) and are the target of a growing tourism industry worth approximately US$66 million (Graham, 2004). Their migratory nature coupled with the whale sharks' status as a threatened species (World Conservation Union's (IUCN) Red List, Norman, 2005) make it imperative that an assessment of whale shark tourism sustainability account for these external threats.

Field et al. (2009) assessed the extinction risk of chondrichthyans (i.e. sharks, rays, and chimaeras) and concluded that they face three main threats: overexploitation, marine pollution, and global climate change (GCC). Whale sharks, like all sharks, are particularly vulnerable to these anthropogenic threats due to their K selected life history traits (e.g. slow growth, longevity, late age at sexual maturity) (Stewart & Wilson, 2005). Their highly migratory nature only compounds these effects, as a whale shark moving across multiple international boundaries may be exposed to a series of changing and/or cumulative threats with changing political regimes.

This paper will address the potential large-scale threats affecting the global whale shark population. Whale shark vulnerability to marine pollution (e.g. oil spills, plastics, chemicals) will be discussed, along with an assessment of their vulnerability to GCC based on habitat type (e.g. coral reef, pelagic, continental shelf) using Chin et al.'s (2010) Vulnerability Framework. The resilience of the whale shark tourism industry will then be assessed using Lambert et al.'s (2010) Resilience Framework. The impacts of

overexploitation on whale shark populations, although significant, have been discussed extensively (e.g. refer to Stacey et al., 2008 for review; Pravin, 2000; Anderson & Waheed, 2001; Hanfee, 2001; Alava et al., 2002; Chen & Phipps, 2002; Meekan et al., 2006; Bradshaw et al., 2007; 2008; Nelson & Eckert, 2007; Pine, 2007; NSF, 2010) and will not be included here. This is the first comprehensive assessment of whale shark vulnerability to GCC and marine pollution and provides insights into the sustainability of tourism activities and communities dependent on whale sharks for their livelihoods.

5.2. Global climate change

5.2.1. Global climate change and the marine environment

GCC is considered to be one of the greatest threats to global ecosystems and biodiversity (King, 2004; Thomas et al., 2004). The rise in greenhouse gas (GHG) concentrations has resulted in an estimated increase in global average temperatures of 0.2^{o}C per decade over the last 30 years (Hansen et al., 2006), and an increase in average temperatures of the ocean's surface layers by 0.6^{o}C over the last 100 years (IPCC, 2007). The predicted increases in sea surface temperatures, based on current or increased GHG emissions, is projected at 1.1^{o}C to 4.6^{o}C by 2100 from 1990 levels (Lambert et al., 2010). However, these estimates may underestimate future temperature changes, as current global emission rates and observed temperature changes are surpassing those used in the IPCC (2007) scenarios (Smith et al., 2010). Higher than predicted temperature changes would increase significantly the likelihood and extent of expected impacts (Smith et al., 2010).

Changes in ocean temperature are expected to have serious ancillary impacts on ocean functioning. These impacts include changes in ocean currents, ocean acidity, sea levels, nutrient levels, primary productivity, spread of disease and community structure

and function (IPCC, 2001; 2007; Berglund et al., 2007; Doney et al., 2009; Boyce et al., 2010; Brown et al., 2010). Table 5.1 summarizes these threats and the potential effects on ocean systems and functions.

Table 5.1. Review of global climate change drivers and their effects on ocean ecosystems.

Driver	Effect	Example	References
Ocean acidification: ↑ in ocean acidity due to ↑ absorption of anthropogenic CO_2 (↓ 0.02 pH units per decade in last 30 years; ↓ 0.1 pH units since pre-industrial period) (Hoegh-Guldberg & Bruno, 2010)	- reduced carbonate ions will affect species' ability to form calcium carbonate skeletons - alters larval fish behaviour and survival	e.g. reduced sea urchin fertilization success, development and larvae size with increasing concentrations of CO_2 (Kurihara & Shirayama, 2004; Brennand et al., 2010; Morita et al., 2010)	Orr et al. (2005); Dupont et al. (2008); Kurihara (2008); de Moel et al. (2009); McClintock et al. (2009); Munday et al. (2009a,b, 2010); O'Donnell et al. (2009, 2010); Parker et al. (2009); Walther et al. (2009); Lannig et al. (2010);
Light ↑ light and UV radiation linked to El Niño-related decrease in cloud cover/wave action	- increased UV penetration will affect primary production, bleach corals and negatively affect some larval fish	e.g. increased radiation significantly increased cellular death in Synechoccus, an important marine primary producer (Häder et al., 2007)	Martinez (2007); Guan & Gao (2008); Nahon et al. (2010)
Sea level rise ↑ water temperature will expand oceans and cause sea level to rise (0.18 to 0.59 m by 2100, IPCC 2007)	- destruction of key nursery habitat (e.g. mangroves, seagrass beds, marshes) - increased salinity of estuaries and rivers/creeks - increased vulnerability of coastal areas to flooding	e.g. reclamation of mangroves in Maldives has resulted in increased erosion (Jagtap et al., 2008)	FitzGerald et al., 2007; Gilman et al. (2008)
Precipitation ↑ variability in rainfall	- results in increased floods/droughts - reduced/increased salinity, which can affect corals and seagrasses - reduce the stability of coastal food webs	e.g. floods resulted in reduced salinity causing the loss of seagrasses and corals in Australia (Chin et al., 2010)	Kingsford & Welch, 2007
Severe weather	- destroy key habitat (e.g. mangroves, seagrass, corals) - affect species recruitment	e.g. models suggest increased activity over the North Atlantic and North Pacific, while a reduction in activity at high latitudes and the subtropics (Ulbrich et al.	Heupel et al. (2003); Cardoso et al. (2008); Crabbe et al. (2008); Fujii & Yamanaka (2008); Knutson et al. (2010)

		2008)	
Ocean circulation	- changes in ocean currents and strength of upwelling - stratification of ocean layers reducing nutrient availability, which could also affect primary production in the ocean	e.g. weakening of the Tropical Circulation in the Pacific Ocean (Vecchi et al., 2006)	Harley et al. (2006); Barth et al. (2007); Schmittner et al. (2008); Garreaud & Falvey (2009); Hearn et al. (2009); Bakun et al. (2010)
Temperature expected to increase by 1.1°C to 4.6°C in 2100 from 1990 levels (IPCC, 2007)	- reduced species fitness due to thermal stress - coral bleaching (i.e. stress response of corals to high temperatures is to eject the symbiotic zooxanthellae)	e.g. mass coral bleaching of the Caribbean in 2005 (Donner et al., 2007)	Marba & Duarte (2010); Wernberg et al. (2010)
	- reduction and/or shift in primary productivity, which the affects the higher trophic levels	e.g. global primary productivity reduced by 6% since 1980s (Gregg et al., 2003)	Beaugrand et al. (2001); Hays et al. (2005)
	- de-coupling of predator-prey relationships	e.g. mismatch of hatchling rhinoceros auklets and anchovy availability in northern Japan Sea (Watanuki et al., 2009)	Beaugrand et al. (2003); Edwards & Richardson (2004); Durant et al. (2007); Gremillet et al. (2008); Hoppe et al. (2008); Gaston et al. (2009)
	- spread of disease and/or invasive species	e.g. increased virulence of bacterial pathogens in gorgonians of the north-western Mediterranean linked to temperature increases (Bally & Garrabou, 2007)	Sokolow (2009); Travers et al. (2009); Van Brassem et al. (2009); Sorte et al. (2010a,b)

Vulnerability to these impacts will differ depending on habitat type (e.g. coastal, pelagic, continental shelf). Further, GCC drivers can have interactive (antagonistic, additive, and synergistic) effects with other environmental stressors (e.g. fishing, marine pollution) potentially worsening the impact on an already affected ecosystem (Crain et al., 2008).

GCC can also cause cumulative impacts if a particular species depends on multiple habitats, such as migratory species. Robinson et al. (2008) noted that although migratory species' greater mobility should enable them to track optimal habitat changes,

their dependence on specific habitat types at different locations and/or life history stages increases the likelihood of negative impacts. The latter occurs because GCC may differently affect different habitat types. Further, the potential reliance of different life history stages on particular habitat types increases the likelihood that migratory species will be negatively affected at some point in their life histories. Robinson et al. (2008) note that migratory species often time key life history stages (e.g. reproduction, growth) to peaks in resource availability in order to provide optimal conditions for the juveniles. However, the cues that migratory species use may be different from their prey resulting in a mismatch of trophic levels (Robinson et al., 2008).

Migratory species were found to be particularly vulnerable to increased temperatures, changes in food availability, mismatch in timing, and the loss of breeding habitat and reduced migratory abilities (Robinson et al., 2008). For example, some migratory species also rely on ocean currents to aid their trans-oceanic migrations (e.g. turtles, eels, capelin) (Kettle et al., 2006; Barabro et al., 2009; Mencacci et al., 2010). The weakening of currents or shift in their location may disrupt critical migratory routes and consequently the reproductive or feeding success of that species (Robinson et al., 2008).

Impacts of climate change have been studied in marine species, such as cephalopods (Chen et al., 2007; Pecl & Jackson, 2008), plankton (Falkowski & Oliver, 2007; Richardson, 2008; Beardall et al., 2009a,b; Boyce et al., 2010; Hallegraeff, 2010; Mackas & Beaugrand, 2010), sea turtles (McMahon & Hays, 2006; Hawkes et al., 2007; Mazaris et al., 2008; 2009; Witt et al., 2010), fish (Sims et al., 2004; Perry et al., 2005; Hsieh et al., 2008; 2009; Beaugrand & Kirby, 2010; Coleman & Koenig, 2010; Donelson et al., 2010; Wilson et al., 2010), seabirds (Le Bohec et al., 2008; Forcada & Trathan,

2009; Gremillet & Boulinier, 2009; Wolf et al., 2010), and marine mammals (Learmouth et al., 2006; Simmonds & Isaac, 2007; Azzelino et al., 2008; Simmonds & Eliott, 2009). Very little has been done to assess the impacts of GCC on sharks.

5.2.2. Global Climate Change and chondrichthyans

The ability of a species to respond to rapid changes in climate depends on two factors: behavioural plasticity (i.e. ability to modify behaviour to changes in the environment), and adaptive genetic variation (Robinson et al., 2008). Chondrichthyans (sharks, rays, chimaeras) are especially vulnerable to climate change due to their slow rates of evolution. Some shark species in today's oceans evolved 10 to 100 million years ago (Hubbell, 1996, p.18). and have low phenotypic plasticity, or the capacity of a single genotype to exhibit a range of phenotypes in response to variation in the environment (Whitman & Agrawal, 2009), which hinders their ability to adapt to rapid environmental changes (Harley et al., 2006; Visser, 2008; Daufresne et al., 2009; Chin et al., 2010). Sharks' K selected life history traits (long-lived, large size, late age at reproduction, long generation time) further affect their ability to adapt to environmental changes.

Chondrichthyans may be vulnerable to a range of physical, chemical, and ecological factors that can directly impact their physiology or indirectly affect their habitat, food or key ecological interactions (Chin et al., 2010). Direct effects that are most likely to affect sharks are temperature and water chemistry changes (e.g. salinity, pH, dissolved oxygen) (Field et al., 2009; Chin et al., 2010). Sharks and rays are expected to respond to GCC with shifts in distribution and changes in timing of migrations (Field et al., 2009). For example, the large-scale movements of basking sharks have been linked to thermal fronts while their small-scale movements are linked to food availability (Cotton

et al., 2005), which suggests that ectothermic planktivores' (e.g. basking sharks, whale sharks) response to GCC-caused changes may be to shift distributions to optimal thermal habitats (Sims et al., 2003).

Intensity of GCC impacts will differ among geographical locations depending on changes in ocean conditions and the sensitivity of the species (Roessig et al., 2004; Harley et al., 2006; Munday et al., 2008). Coastal marine systems have been identified as particularly vulnerable to the impacts of GCC (Harley et al., 2006; Chin et al., 2010) as warming trends are expected to be more intense in these areas compared to the open ocean (Harley et al., 2006). Migratory sharks will be particularly susceptible to the effects of GCC as they may require different types of habitat for different life history stages. For example, some sharks (e.g. blacktip reef shark, lemon shark, school shark) use mangroves and nearshore coastal habitats as nurseries for their pups (Heupel et al., 2007; Wetherbee et al., 2007). These habitats are expected to be more affected than others, such as the open ocean, resulting in the potential decline in the survival per age class and therefore the number of individuals that will reach sexual maturity.

Whale sharks are highly migratory, with one individual travelling over 13,000 km over a period of three years (Eckert & Nelson, 2001). Different age classes and sexes display site specificity for different habitat types/locations (e.g. Norman & Stevens, 2007; Ramirez-Macias, 2007; Riley et al., 2010). Habitats include open ocean (Wilson et al., 2006; Hsu et al., 2007), continental shelf (Brunnschweiler et al., 2009; Hueter & Tyminski, 2009; Kumari & Raman, 2010), coastal/inshore (Pravin, 2000; Nelson & Eckert, 2007), and coral reefs and ocean promontories (Heyman et al., 2001; Stewart & Wilson, 2005; Hobbs et al., 2009). Their reliance on various habitat types, specifically

coastal/reef habitats for food and potential nurseries, along with their planktivorous diet, increases the likelihood that GCC will significantly affect these sharks. For example, the predicted degradation of food webs stemming from reduced primary productivity and the weakening of upwelling events (Hearn et al., 2009) could significantly affect the whale sharks' survival. Stewart & Wilson (2005) noted the whale shark's particular vulnerability to coral bleaching events and rapid climate change as the biggest threats to whale sharks. Table 5.2 summarizes each of the potential climate change drivers that could affect whale sharks, the expected effect in sharks and/or the environment, and the whale shark's particular vulnerability to each driver.

Table 5.2. Potential impacts of global climate change on whale sharks on a global scale.

Driver	Effect	Vulnerability
Physiological		
Sea and air temperature	- increased metabolic rate - alter behaviour and movements - may be greater in estuarine, coastal/inshore, flat reef habitats	- wide temperature range (3 – 32^{o}C) - temperature changes unlikely to affect them directly - highly mobile so can seek optimal thermal habitat elsewhere
Ocean acidification	- sharks able to compensate for changes in pH via rapid pH buffering - potential increases in energy costs	- physiological ability to deal with changes in pH unknown
Precipitation	- changes in salinity due to variability in floods/droughts - coastal, estuarine habitats at risk	- unknown - highly mobile although appear to be dependent on certain habitats for particular life history stages
Large scale		
Ocean circulation	- increased current strength may lower thermohaline - reduce strength of upwelling currents	- could affect prey availability and migratory patterns
Temperature	- increase frequency and severity of coral bleaching - can affect nutrient cycling and therefore productivity	- prey availability related to corals (e.g. Ningaloo) - plankton availability (e.g. Donsol, Ningaloo, Holbox)

	- plankton shown to shift distribution in response to temperature changes	- spawning fish (e.g. Placencia, Isla Mujeres)
Sea level rise	- could cause range expansion/retraction for mangroves, seagrasses	- importance unknown to whale shark - high mobility means should be able to move to optimal habitat
Severe weather	- physical damage to coral - erosion and deposition of materials - habitats at high risk: mangroves, corals	- prey availability related to corals (e.g. Ningaloo)
Precipitation	- increased extremes in salinity (mangroves, corals) - increased pollutants (coastal) - changes in productivity dependent on freshwater (estuarine, coastal and inshore)	- prey availability related to corals (e.g. Ningaloo) and rivers (e.g. northern Gulf of Mexico) - increased pollutants could affect fitness in coastal habitats (e.g. Holbox, Donsol)
Light	- increased UV radiation - changes in nutrient cycling and productivity - coral bleaching	- prey availability related to corals (e.g. Ningaloo) and plankton (e.g. Holbox, Donsol)
Ocean acidification	- degradation of coral habitats - reduce skeletal development in some marine organisms reliant on $CaCO_3$	- could affect prey availability for those species reliant on $CaCO_3$ (e.g. coral spawn, crustacean zooplankton, larvae)

5.2.3. Applying the Vulnerability Framework

Chin et al. (2010) proposed a vulnerability framework to assess the vulnerability of chondrichthyans to GCC based on the ecological niche of the species. In order to apply this framework to a global assessment of whale shark vulnerability to GCC, the ecological group within Chin et al.'s (2010) framework was altered to represent each of the identified or potential critical habitats for whale sharks based on a literature review. As habitat choice appears to depend on sex and/or life history stage, this study was interested in determining which life history stages, if any, were particularly vulnerable to GCC.

Each component of overall vulnerability (i.e. exposure, sensitivity, rigidity) was ranked between 0 and 1.00 using the following system: 0.33 = low, 0.66 = moderate or 1.00 = high following the methodology suggested by Chin et al. (2010).

Step 1. Rate the exposure of each habitat type to the identified climate change drivers relevant to the scale/area used (Table 5.3).

This ranking addresses the likelihood that the specific climate change drivers will affect the given habitat and the magnitude of those impacts, regardless of whale shark presence.

Table 5.3. Exposure of the four key whale shark habitats to climate change drivers.

Driver	**Key whale shark habitats**			
	Coastal/inshore	**Reef**	**Shelf**	**Pelagic**
Direct				
Temperature	High	High	Moderate	Moderate
Ocean acidification	Low	Low	Low	Low
Precipitation	Moderate	Moderate	Moderate	Low
Indirect				
Ocean circulation	Moderate	Moderate	High	High
Temperature	High	High	Moderate	Low
Sea level rise	High	Low	Low	Low
Severe weather	High	High	Low	Low
Precipitation	High	Moderate	Moderate	Low
Light/UV radiation	Moderate	Moderate	Low	Low
Ocean acidification	High*	High	High*	High*

* due to the potentially severe impact of ocean acidification on zooplankton availability (Fabry et al., 2008)

Step 2. Assess the sensitivity and rigidity of the species to climate change within each of the critical habitats identified (Table 5.4).

Sensitivity

Sensitivity was assessed based on two criteria: rarity and habitat specificity. Rarity represents how rare the species is in terms of total abundance (Chin et al., 2010). Habitat specificity is a measure of how dependent a particular species is on a particular habitat type (Chin et al., 2010). If little is known about the species, the framework adopts a precautionary approach and assigns a ranking of high. Whale sharks were assigned a ranking of high for rarity and moderate to high for habitat specificity.

Whale sharks were considered to have high rarity because the global abundance of whale sharks is unknown (Stewart & Wilson, 2005), they number in the tens or hundreds, not thousands, at known aggregation sites worldwide, and only 2,800 individual whale sharks have been identified worldwide based on a leading photo-identification library (ECOCEAN, 2010). Studies have attempted to estimate whale shark population abundance at individual aggregation sites using photo-identification, tagging and population models (e.g. Meekan et al., 2006; Bradshaw et al., 2007; 2008; Holmberg et al., 2008; 2009; Rowat et al., 2009; Riley et al., 2010), but problems with meeting model assumptions (e.g. represent a closed population in which male and female adults, juveniles and neonates can be encountered) raise questions over the validity of these estimates (Holmberg et al., 2009; Riley et al., 2010). Genetic studies provide a better means of estimating global whale shark abundance and discerning population structure if issues with sample size and location are addressed. For example, Castro et al. (2007) used mitochondrial DNA analysis to estimate the whale shark's global effective population

size (i.e. abundance of breeding females) at 119,000 to 238,000, while Schmidt et al. (2009) used microsatellite DNA analysis to estimate effective population size at 27,401 to 179,794. These values are much higher than previously believed (Schmidt et al., 2009); however their accuracy is questionable because these studies relied on very small sample sizes (e.g. n=70, Castro et al., 2007; n=68, Schmidt et al., 2010) concentrated in only a few regions (e.g. Indo-Pacific versus the Atlantic). The current vulnerability assessment considers whale sharks to be rare due to these uncertainties.

Although whale sharks appear to utilize a range of habitat types, habitat specificity appears to depend on life history stage and sex. For example, offshore habitats and inshore/coastal habitats were identified as potential nursery habitats for whale sharks (e.g. Ramirez-Macias et al., 2007; Rowat et al., 2008). Neonate whale sharks are poorly developed for efficient movement (Martin, 2007) and are consequently unable to travel very far from the area of parturition (Rowat et al., 2008). There is therefore high habitat specificity at this life history stage. Immature whale sharks also appear to be very dependent on coastal, reef and shelf habitat for foraging activities (e.g. Graham & Roberts, 2007; Norman & Stevens, 2007; Rowat & Gore, 2007; de la Parra, 2008; Rowat et al., 2008; Brunnschweiler et al., 2009; Hobbs et al., 2009; Rowat et al., 2009; Riley et al., 2010). However, specificity for these habitats was ranked as low because it is assumed that if an area previously targeted due to predictable productivity events were to become less productive, the whale sharks would be able to move to more productive sites. Regardless, the overall sensitivity rating will be high because it is based on the highest ranking of its two components (i.e. rarity high so overall sensitivity ranking is high).

Rigidity

Rigidity is composed of four sub-categories: trophic specificity, immobility, physical/chemical intolerance and latitudinal change (i.e. temperature tolerance).

1. Trophic specificity

The whale shark's diet consists of shrimp forms (e.g. euphausiids, mysids, stomatopods) (Taylor, 1994; 1996; Wilson & Newbound, 2001; Wilson et al., 2001; Jarman & Wilson, 2004), copepods (Clark & Nelson, 1997), crustacean larvae (e.g. crabs, shrimps, gastropods, bivalves) (Nelson & Eckert, 2007; Meekan et al., 2009), arrow worms (i.e. chaetognathia) (Taylor, 2007); fish eggs (e.g. cubara and dog snapper) (Heyman et al., 2001; Motta, 2009), jelly fish (Heyman et al., 2001), coral spawn (Norman, 1999), and small fishes (e.g. anchovy, squid, sardines) (Duffy, 2002). However, there is disagreement over whether or not whale sharks do target nektonic prey such as small fishes (e.g. Wilson, 2002; Nelson & Eckert, 2007). Consequently, the whale shark does not appear to have significant adaptive capabilities for prey switching (Chin et al., 2007). Whale sharks were ranked as highly specific in terms of their diet in all habitat types because they are obligate filter feeders and besides switching between various types of planktonic prey, they do not have much adaptive room available to them if it were to disappear.

2. Immobility

Whale sharks are highly mobile organisms, capable of travelling thousands of kilometres in the span of a few months (e.g. Eckert & Stewart, 2001). Their immobility is therefore ranked as low for juvenile and adult whale sharks. Neonate sharks, however, are not capable of these movements (Martin, 2007) and would therefore be highly vulnerable to climate change effects within nursery areas. These potential nursery areas (coastal/inshore, pelagic) were ranked as moderate to allow for the lower mobility of neonates within habitats also used by adults and larger immature whale sharks.

3. Physical/chemical intolerance

Overall sharks have a wide tolerance to physical and/or chemical changes to their environment (Field et al., 2009; Chin et al., 2010). Whale shark intolerance to these changes was therefore ranked as low.

4. Latitudinal range

Latitudinal range, as a proxy of temperature tolerance, was ranked as low for all habitat types as whale sharks have a wide temperature tolerance (Table 5.2). The only potential exception is neonates. The occurrence of whale sharks in higher latitudes was linked to the random movement of warm water gyres (Turnbull & Randell, 2006) and may not have been possible otherwise, as exemplified by the rare sightings of whale sharks in higher latitudes (e.g. Wolfson, 1986; Coad, 1995; Ebert et al., 2004). The whale shark's upper temperature limit is also unknown, although they have been found in waters with

temperatures upwards of 32^{o}C (Eckert & Stewart, 2001). Consequently, latitudinal range may be much less than believed. If so, the rankings should be moderate to high.

Regardless of these issues, the whale shark's rigidity was ranked as high in all four habitats due to their high trophic specificity.

Table 5.4. The sensitivity and rigidity of whale sharks to climate change in each of its critical habitats.

Driver	**Key whale shark habitats**			
	Coastal/inshore	**Reef**	**Shelf**	**Pelagic**
Sensitivity				
Rarity	High	High	High	High
Habitat specificity	High*	Low	Low	High*
Overall rating	**High**	**High**	**High**	**High**
Rigidity				
Trophic specificity	***High***	***High***	***High***	***High***
Immobility	Moderate*	Low	Low	Moderate*
Physical/chemical intolerance	Low	Low	Low	Low
Latitudinal range	Low	Low	Low	Low
Overall rating	***High***	***High***	***High***	***High***

* due to potential site of primary and secondary nursery areas, neonates have poor mobility and require certain habitat types

Step 3. Calculate the overall vulnerability of whale sharks by multiplying the three components (exposure, sensitivity, rigidity).

Overall vulnerability was calculated by multiplying the three component scores for each of the GCC drivers resulting in three potential categories of vulnerability: Low (0.00 to 0.33), Moderate (0.34 to 0.66), and High (0.67 to 1.00) (Table 5.5). This calculation is based on two logic rules: 1. if any of the component scores is ranked as low, then the overall vulnerability to that particular climate driver must be low as demonstrated in Table 5.5, and 2. high overall vulnerability is only possible when all three components

are ranked as high (Chin et al., 2010). The one exception to this rule is if all three component scores are ranked as moderate. This situation results in an overall vulnerability score of 0.29 or low (0.00 – 0.33) when logically it should fall within the moderate category (Chin et al., 2010). Consequently, vulnerability to that GCC driver is ranked as moderate.

Table 5.5. Potential outcomes of component integration to determine species vulnerability rating (adapted from Chin et al., 2010).

	Sensitivity x Rigidity					
	L x L	**L x M**	**L x H**	**M x M**	**M x H**	**H x H**
Exposure						
High (H)	**Low** 0.33x0.33x 1.00 = 0.11	**Low** 0.33x0.66x 1.00 =0.22	**Low** 0.33x1.00x 1.00 = 0.33	**Moderate** 0.66x0.66x 1.00 = 0.44	**Moderate** 0.66x1.0x 1.0 = 0.66	**High** 1.0x1.0x1.0 =1.0
Moderate (M)	**Low** 0.33x0.33x 0.66 = 0.07	**Low** 0.33x0.66x 0.66 = 0.14	**Low** 0.33x1.0x0. 66 = 0.22	**Moderate** 0.66x0.66x 0.66 = 0.29*****	**Moderate** 0.66x1.0x 0.66 = 0.44	**Moderate** 1.0x1.0x0.66 = 0.66
Low (L)	**Low** 0.33x0.33x 0.33 = 0.036	**Low** 0.33x0.66x 0.33 = 0.07	**Low** 0.33x1.0x 0.33 = 0.11	**Low** 0.66x0.66x 0.33 = 0.14	**Low** 0.66x1.0x 0.33 = 0.22	**Low** 1.0x1.0x 0.33 = 0.33

* although < 0.33, considered moderate as all three components ranked as moderate

According to the analysis, the GCC drivers most likely to affect whale sharks are temperature (both directly and indirectly) and ocean circulation**.** Whale sharks are most vulnerable to climate change in coastal/inshore habitats, which may also be critical nursery habitat, followed by reef, shelf and pelagic habitats. The greatest impact of GCC appears to be the indirect impacts on their prey. Ocean circulation relates primarily to upwelling, which is an important factor in prey availability for a planktivore like the whale shark. Furthermore, ocean acidification was also ranked as having a significant impact on whale sharks in reef habitats due to the whale shark's dependence on coral reefs for associated productivity events (e.g. Australia, Belize). Severe weather is most likely to affect primary productivity by damaging important habitat, such as corals.

Table 5.6. Overall vulnerability of whale sharks to direct and large-scale climate change drivers in each of their potential habitats.

Driver	Key whale shark habitat			
	Coastal/inshore	**Reef**	**Shelf**	**Pelagic**
Direct				
Temperature	High	High	Moderate	Moderate
Ocean acidification	Low	Low	Low	Low
Freshwater input	Moderate	Moderate	Moderate	Low
Indirect				
Ocean circulation	Moderate	Moderate	High	High
Temperature	High	High	Moderate	Low
Sea level rise	High	Low	Low	Low
Severe weather	High	High	Low	Low
Freshwater input	High	Moderate	Moderate	Low
Light/UV radiation	Moderate	Moderate	Low	Low
Ocean acidification	High	High	High	High

5.2.4. Global climate change and marine tourism

Studies have also attempted to ascertain the impact of GCC on nature-based tourism activities (e.g. Uyarra et al., 2005; Craig-Smith et al., 2006; Gössling & Hall, 2006b; Learmonth et al., 2006; Scott et al., 2007; MacLeod, 2009; Nyaupane & Chhetri, 2009). Lambert et al. (2010) assessed the potential impact of GCC on cetaceans and their respective tourism industries. The authors concluded that increases in sea surface temperatures could cause changes in the range of species distribution, occurrence and abundance of individuals and timing and length of migrations; effects on reproductive success and mortality levels; and changes to community composition and structure (Lambert et al., 2010). The authors also highlighted particular whale-watching tourism sites that may be more vulnerable to GCC, including polar regions, those targeting temperature-sensitive species, and migratory species. Tourism sites can therefore expect to experience changes in the presence and/or frequency of targeted species, as well as their seasonality (Lambert et al., 2010).

Lambert et al. (2010) proposed a resilience framework to assess the vulnerability of a given wildlife tourism industry to the potential impacts of GCC. The authors assessed site vulnerability using three criteria: (1) the likelihood of observing the targeted species, (2) tourist type, and (3) the type of wildlife tour offered. The first criterion, likelihood of observing the targeted species, addresses the biophysical impacts of GCC on the target species and should ideally be based on mathematical models estimating changes in species distribution and abundance under different climate change scenarios (Lambert et al., 2010). Tourist type provides insight into changes in future tourism numbers at a given site based on changes in the targeted species' occurrence. Lambert et al. (2010) suggest that tourist specialization is a good indicator of the differences in motivations for participating in a given activity, such that specialized tourists dedicated to the given tourism activity will be more likely to return to a site despite a reduced chance of observing the targeted species compared to a more generalized tourist. The type of tour offered (e.g. specialized whale watching tour versus generalized marine tour) can also provide insight into the resilience of a given site to the effects of GCC. For example, a more specialized tour may be more susceptible to loss of visitation because of the decline in the targeted species. However, the motivations of tourists participating in the tour could also affect the success of different tour types, such that specialized tourists may be less likely to be deterred in the face of reduced sightings of the targeted species (Lambert et al., 2010). Applying this resilience framework to whale shark tourism activities can provide important insights into future management and planning needs for this activity.

5.2.4.1. Likelihood of observing whale sharks

Sustainability of wildlife tourism depends on a returning, healthy target population (Higham et al., 2009; Lambert et al., 2010). Thus, incorporating the potential impacts of GCC within whale shark tourism management for a particular site is very important. Future research is needed to provide a more accurate assessment of the potential impacts of GCC on whale shark abundance and occurrence in terms of mathematical modelling based on different climate scenarios. However, the assessment completed in section 5.2.3 provides an initial assessment of whale shark vulnerability to GCC and highlights the high likelihood of impacts on tourism activities targeting whale sharks in vulnerable habitats (e.g. coastal and reef habitats). These impacts could include a shift in whale shark abundance and occurrence at many of the tourism sites based on seasonal aggregations of whale sharks resulting in a decline in whale shark sightings.

5.2.4.2. Tourist type

The assessment of specialization of tourists within whale shark tourism is incomplete. However, initial assessments in Mozambique (Pierce et al., 2010), Australia (Catlin & Jones, 2010) and Mexico (Chapter 3) suggest that more established sites (e.g. Australia, Mexico) have a higher proportion of generalists than newer, harder to access sites (e.g. Mozambique). These results suggest that GCC will negatively affect the more established sites because these tourists are not highly motivated to swim with whale sharks and are unlikely to return to the site if whale sharks were no longer present. For example, 85.1% of respondents on Holbox, Mexico stated they would not return to Holbox if whale sharks were no longer present (Chapter 2). However, a comparison of whale shark tourist specialization level with likelihood of returning to Holbox if whale sharks were not

present found no significant difference between different tourist types (Chapter 3). The latter result suggests that regardless of specialization, the industry on Holbox will undergo significant losses in visitation if whale sharks were to disappear.

5.2.4.3. Tour type

Whale shark tours are by nature highly specialized. They specifically target whale sharks, with some employing planes to locate and interact with whale sharks (e.g. Australia, Catlin & Jones, 2010). This specialization could hinder the industry's ability to adapt to changes in whale shark occurrence due to GCC. Lambert et al. (2010) note that tour specialization could also improve an industry's ability to locate the target species and may therefore be better able to adapt to changes in species abundance and distribution.

5.2.4.4. Implications for sustainable livelihoods

Many of the local communities providing swim-with whale shark tours rely on this activity as the main source of economic revenue, especially in less-developed countries (e.g. Mexico, Philippines) (Pine, 2007; Cepeda, 2008). Isla Holbox, Mexico is an example of a community whose economy is heavily dependent on whale shark tourism. An assessment of Holbox using the Sustainable Livelihoods Approach revealed that the local economy relies mainly on whale sharks and fishing (Cepeda, 2008). With commercial fishing currently on the downswing in the area due to a significant reduction in commercially important species (Diaz-Amador, 2005; Cepeda, 2008), the local economy of Holbox will become even more dependent on the three-month whale shark season.

The lack of alternative livelihoods in the area makes Holbox extremely vulnerable to changes in whale shark abundance, such as those resulting from GCC. This

vulnerability has already been observed in the 2009 and 2010 seasons when whale sharks aggregated in large numbers outside the newly designated Whale Shark Biosphere Reserve (a protected area that is meant to encapsulate its entire critical habitat in Mexican Atlantic waters) (Varillas, 2010). This anomaly occurred due to changes in current systems in the region resulting in large concentrations of fish eggs being held in one area for an extended time period (Marine Meganet, 2010). The potential movement of whale sharks away from Holbox's waters demonstrates the vulnerability of this community's tourism to GCC and suggests that these activities may not be sustainable in the long-term. For example, if the whale shark's new range under GCC is not within reasonable limits (e.g. greater than 2 hour boat ride from Holbox or in open ocean), local operators will be unable to afford the gas required to locate the whale sharks nor the quality of boat needed to venture into rough, open seas. Thus, changes in whale shark occurrence will likely have a great effect on the Holbox whale shark tourism industry, regardless of potential benefits of tour specialization or tourist type.

These findings highlight the need to diversify local livelihoods to improve resilience to changes resulting from GCC-related impacts. Holbox's natural resources are its primary strength and fishing and tourism are its primary livelihoods. However, problems with declining fisheries due to overexploitation of available stocks limit alternative livelihood options. A potential alternative could include a more generalized nature-based tour that opportunistically targets available animals, instead of specifically targeting a single species. Changes in species occurrence under GCC also open up the possibility of new animals moving into Holbox waters, thereby providing novel tourism and/or extraction opportunities.

5.3. Vulnerability to marine pollutants

GCC is one of many potential large-scale threats affecting the world's whale sharks. Marine pollution is another pressing concern for this species. Pollution can have direct effects by altering water quality or indirect effects through habitat degradation (Field et al., 2009). The following section will focus on the vulnerability of whale sharks to chemicals (e.g. endocrine disruptors, organochlorides, heavy metals), plastics and oil.

There is no published assessment of vulnerability of whale sharks to marine chemicals (although research is currently being conducted regarding the prevalence of pollutants in whale sharks of the Gulf of Mexico, Hueter & Tyminski, 2009). Impacts are likely, however, considering the likelihood of exposure (e.g. Pethybridge et al., 2010) and severity of impacts observed in other shark species. For example, cadmium (a heavy metal) has been shown to inhibit spermatogenesis in male sharks (McClusky, 2008), while polychlorinated biphenyls (PCBs) have been shown to reduce fertility in females (Field et al., 2009).

Gelslhchter et al. (2007) assessed the vulnerability of sandbar sharks and blacktip sharks to pollutants (PCBs and organochloride pesticides) in major nursery areas of the U.S. Atlantic Coast and Gulf of Mexico. The authors found that the concentrations of pollutants present in the juvenile sharks posed a significant risk to these species, especially because these chemicals are known to affect growth and sexual maturation in fish. This region is important whale shark feeding (and potentially breeding) habitat suggesting that whale sharks are currently exposed to harmful levels of chemicals.

Bioaccumulation is an important concern in these areas, as whale sharks are known to target areas of high primary productivity associated with freshwater inputs,

such as the mouth of the Mississippi River in the northern Gulf of Mexico (Hueter et al., 2009), as well as the Donsol river in the Philippines. These rivers contain high levels of pollutants from run-off (e.g. agriculture, sewage). Consequently, whale sharks are susceptible to ingesting and accumulating chemicals, such as organochlorides (e.g. organochlorine pesticides, OCPs; PCBs), heavy metals (e.g. cadmium, mercury), and endocrine disruptors found within these rivers.

Endocrine disruptors are artificial estrogen mimics originating from human contraceptives and other environmental contaminants that cause the feminization of males in aquatic species (Iguchi et al., 2001). Endocrine disruption has been noted in marine fish (Scott et al., 2006; 2007), as well as the prevalence of potential endocrine disruptors in many species including sharks (e.g. Storelli et al., 2006; Silva et al., 2007; Haraguchi et al., 2009). The mechanisms by which these compounds affect the sexual development and function of sharks are poorly understood (Katsu et al., 2010). However, recent work suggests that whale sharks are vulnerable to endocrine disruptors. Katsu et al. (2010) assessed the susceptibility of whale sharks to environmental estrogens through the cloning of their estrogen receptor and characterizing its interactions with steroidal and other environmental estrogens. The authors found that whale sharks demonstrated estrogen-dependent activation of transcription, as well as sensitivity to various environmental contaminants (e.g. 17ß-estradiol, bisphenol A, nonylphenol, octylphenol, DDT) (Katsu et al., 2010). These results suggest that the whale shark may be susceptible to the effects of feminization.

Whale sharks are also susceptible to accidentally ingesting and/or getting entangled in plastics and other types of marine litter (e.g. ghost nets). Marine litter is

defined as ‘any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment’ (UNEP, 2009, p.13). Whale sharks are extremely susceptible to net entanglement (Pravin, 2000; Nelson & Eckert, 2007), which suggests that they are highly vulnerable to the significant number of ghost nets in the oceans today. For example, over a 100 tons of fishing gear was removed from two remote northern Hawaiian Islands in 2002 and a further 90 tonnes were collected the following year (UNEP, 2005).

However, plastics are by far the biggest threat. Plastics are believed to make up 89% of the garbage in the world’s oceans, with an estimated 8 million pieces dumped every day (UNEP, 2005). Further, the amount of plastics produced in the last decade is roughly equivalent to the total amount produced during the twentieth century, with production expected to reach over 300 million tons in 2010 (Martinez, 2010). Plastics are not biodegradable resulting in the greater proportion of plastics in the ocean compared to other types of marine litter (Kostigen, 2008). Plastics also adsorb hydrophobic chemicals (e.g. dichlorodiphenyltrichloroethane, DDT; hydrocarbons), which are then introduced into the food chain via bioaccumulation (Kostigen, 2008).

The extent of the marine litter problem is difficult to assess, both in terms of the amount of garbage present as well as its geographical range. However, it is clear that this problem is quite significant. Researchers have identified areas of high concentrations of garbage in the Pacific (Kostigen, 2008; Martinez, 2009) and Atlantic (Law et al., 2010) oceans. These areas are quite extensive in size. For example, the ‘Great Pacific Garbage Patch’ covers an area nearly twice the size of the continental Unites States extending from 926 km off the coast of California across the northern Pacific to Japan and is

expected to double in size within the next decade if society's reliance on disposable plastics is not reduced (Marks & Howden, 2008). Further, the location of these garbage patches is likely to affect whale sharks during their migrations. Law et al. (2010) found that the highest concentrations of plastics in the Atlantic were between 22^{o} and 38^{o}N (within the whale shark's range), with one area estimated to contain approximately 580,000 pieces m^{-2}.

The Pacific patch is located within the North Pacific Gyre, which is a converging point of several current systems (e.g. California Current, North Equatorial Current, Kuroshio Current) thousands of miles wide (Kostigen, 2008). Whale sharks are known to migrate from western Mexico waters across the Pacific towards Tonga (Eckert & Nelson. 2001). They are also thought to have critical nursery habitat within the Gulf of California, which is affected by the California Current (the latter current is responsible for the upwelling events and primary productivity in the area). The confluence of plastics and critical whale shark habitat and/or migratory routes suggests that whale sharks may be exposed to significant amounts of small particulate plastic over their lifetime. Ingestion of these plastics can cause blockages, reduce health, increase bioconcentration of environmental toxins (plastics adsorb toxins) and potentially lead to death.

A final large-scale threat to whale sharks is that of the expanding industry in marine oil and gas extraction. Although the rigs used to extract gas and oil may have impacts on marine species, oil exploration can have more direct impacts, as exemplified by the recent disaster in the Gulf of Mexico with British Petroleum's (BP) Deepwater Horizon accident on April 20^{th}, 2010. Ranked as the worst environmental catastrophe in United States history (Levy & Gopalakrishnan, 2010), the leak resulted in the release of

4.9 million barrels of oil (205.8 million gallons) (BBC, 2010b) over the 87-day period the leak remained uncapped, with only 800,000 barrels recovered (BBC, 2010a).

Located 64 km southeast of the Louisiana coast, the oil spill is likely to have severe negative impacts on the environment, as this region of the Gulf of Mexico is home to sensitive Gulf marshland habitat, as well as critical nursery (e.g. bluefin tuna) and foraging habitats (e.g. Kemp's Ridley sea turtles, sperm whales, hammerhead sharks, sailfish, wahoo, tiger sharks, whale sharks, dolphins) for many marine species (Wiegler, 2010; Craig, 2010). It is also home to two National Marine Sanctuaries (NMS), the Florida Keys National Marine Sanctuary and the Flower Garden Banks National Marine Sanctuary, both of which provide critical coral reef habitats (Craig, 2010).

Potential direct impacts of the oil spill include death due to ingestion of oil or smothering. By the end of July, 777 dead or injured turtles had been reported, along with 67 dolphins (Wiegler, 2010). Whale sharks are extremely likely to ingest oil during their normal foraging behaviour in the Gulf of Mexico as they are filter feeders (Coleman, 2010; McConnaughey, 2010), but the exact impact is impossible to know because they will sink if they die from oil ingestion (Coleman, 2010). A large aggregation of 100 whale sharks was observed 60 miles west of the oil spill (Coleman, 2010), while three whale sharks were observed swimming in oil streamers a few miles from the spill suggesting they are not avoiding the oil (McConnaughey, 2010). Whale sharks can also be affected if their gills become covered in oil (Wiegler, 2010). Tagging work was completed in order to track the whale sharks' movements and assess the likelihood of oil ingestion (Coleman, 2010). This disaster has the potential to have serious impacts on the Atlantic population of whale sharks (e.g. Holbox, Belize, Honduras) not only because of

its location (i.e. 40 miles southeast of the mouth of the Mississippi River Delta, a known feeding area) (McConnaughey, 2010), but also its timing. The accident coincided with the yearly arrival of hundreds of whale sharks off the coast of Holbox, Mexico to feed in the plankton-rich waters.

Indirect impacts are also a problem. The critical breeding habitats of whale sharks within the Gulf of Mexico and the Atlantic are not known. However, their regular appearance at the Flower Garden Banks NMS, as well as the mouth of the Mississippi River suggests they depend on the primary productivity of the area for critical foraging habitat. Therefore the impacts of oil on this habitat, including coral reefs, could have serious repercussions for the whale shark's future fitness.

The impacts of the oil spill will continue despite the source of the spill being contained due to the long decomposition rates for oil. Part of the problem is due to the use of the oil dispersant Corexit 9500A (BBC, 2010b). Dispersants are used to mitigate impacts on critical nearshore habitats, such as coastal marshes by breaking down the oil into smaller oil particulates (Lin & Mendelssohn, 2004). However, their use also makes it harder to skim or trap the oil resulting in persistence in the environment and continued negative impacts on marine species, especially to the embryonic, larval and juvenile stages of fish and crustaceans (Schor, 2010) and coral reefs (Graham, 2010). Furthermore, the United States Environmental Protection Agency found that the dispersant Corexit 9500A is moderately toxic to early life stages of molluscs, crustaceans and fish (George-Ares & Clark, 2000) as well as more toxic than the oil itself (toxic at 2.61 ppm vs 11 ppm) (Taylor, 2010).

5.4. Conclusions

The sustainability of wildlife tourism is dependent on not only a properly managed industry at the local level. One must also take into account the potential global scale threats affecting the targeted species, especially when that species is endangered and/or highly migratory (Bejder et al., 2010; Lambert et al., 2010). Whale sharks fall within this category of risk. Whale sharks are one of the most highly migratory species in the world (e.g. Eckert & Stewart, 2001), yet very little is understood of their biology and ecology. An assessment of vulnerability to potential environmental threats, such as GCC and marine pollution, is therefore an important need to help protect the species, as well as manage the associated tourism industries.

The results outlined in this paper suggest that GCC could have a significant impact on whale sharks due to their reliance on specific habitat types at different life history stages. Whale shark populations reliant on coral reef and coastal/inshore habitats (juvenile males, young) are particularly vulnerable to GCC. The whale sharks' increased vulnerability to GCC in these habitats coupled with the fact that whale sharks are expected to alter their distribution to seek out optimal habitats suggests that whale shark aggregations will change in the next century. Thus, the majority of whale shark tourism activities, which are based on whale sharks aggregating in these vulnerable habitats, are unlikely to be sustainable in the long-term. Tourist and tour type can affect the particular site's resilience to changes in whale shark occurrence due to GCC.

Whale sharks are also susceptible to impacts from marine pollution. Relevant pollutants include chemicals (e.g. endocrine disruptors, pesticides, heavy metals), marine debris (e.g. plastics, nets), and oil. The combined direct (ingestion, entanglement, reduced

reproductive capacity) and indirect (habitat loss, food web changes) effects suggest these pollutants could significantly affect the health of whale shark populations and cause a further reduction in numbers.

Whale sharks are already an endangered species (Norman, 2005). Consequently, it is critical that any tourism management plan incorporate these large-scale threats within calculations of appropriate tourism growth and impacts. Diversifying the local economy of communities dependent on whale sharks could improve their resilience to a reduction and/or loss of whale sharks from these threats.

Chapter 6: Summary: Conclusions, Recommendations and Contributions

6.1. Introduction

The purpose of this study was to assess the sustainability of whale shark tourism on Isla Holbox, Mexico through an analysis of visitor preferences and satisfaction with environmental and tour features, impacts of the tourism industry on both whale sharks and the local community, current management strategies, and actual and potential global scale threats to whale sharks. This chapter provides an overview of the major findings of this research and makes recommendations for the improved management of the industry, as well as outlines research limitations and future needs.

Sharks are among the most threatened taxonomic groups in the world today. Nearly 60% of shark species are considered threatened at some level due to continued problems with overharvesting (Fowler, 2010). Shark tourism is viewed as one means of converting communities targeting sharks for consumptive use into wildlife tourism destinations through the provision of significant economic benefits (Topelko & Dearden, 2005). However, some researchers have raised concerns over the level of impacts that wildlife tourism has on the target species and argue that it is just another form of consumptive use (Orams, 1999).

These concerns over impacts and the potential consumptive nature of wildlife tourism activities underline the importance of ensuring shark tourism activities are sustainable in the long term. The latter is especially important when tourism activities target threatened species within their critical feeding habitat, such as the whale shark.

Whale shark tourism is a growing sector of shark tourism. Although typically a

solitary species, the whale shark forms large, seasonal feeding aggregations at several locations worldwide (e.g. Mexico, Australia, Belize, Philippines, India) (Colman, 1997; Heyman et al., 2001; Pine, 2007; de la Parra, 2008; Kumari & Raman, 2010). These predictable aggregations have led to an explosion in whale shark tourism since the early 1990's and the establishment of the whale shark as one of the most-watched sharks in the world today.

Dearden et al. (2008) examined whale shark watching and the different models that have evolved in terms of industry structure, organization and potential sustainability. The authors concluded that management of this growing industry varies markedly from site to site, ranging from little to no regulations in Thailand to interaction guidelines and licensing caps in Australia and Belize. As the whale shark establishes itself as a flagship species worldwide, visitation numbers will only increase.

This confluence of species vulnerability and increased tourism volume could be an indicator of an ecological and economic problem for whale shark tourism. Duffus and Dearden (1990) suggest that uncontrolled growth of a wildlife tourism site may lead to the disappearance of the targeted species as a result of excessive environmental impacts, and reduced visitation as a result of poor visitor experience. The latter problem highlights the necessity of clearly understanding both the human and biological dimensions of a given wildlife tourism activity (Duffus & Dearden, 1990).

Research on whale sharks has focused on their biology and ecology (e.g. Graham et al., 2006; Meekan et al., 2006; Martin, 2007; Nelson & Eckert, 2007; Rowat & Gore, 2007; Holmberg et al., 2009; Schmidt et al., 2009; Motta et al., 2010). However, studies examining the social dimension of shark tourism (e.g. tourist expectations/satisfactions,

impacts on the target species, management preferences) have been largely neglected for whale sharks.

The current study was undertaken because the whale shark tourism industry on Isla Holbox, Mexico was identified as having the largest and fastest growing whale shark tourism industry in the world (Dearden et al., 2008). If this growth is allowed to continue unchecked, there is the potential for the industry to reach unsustainable levels resulting in the collapse of both the ecosystem and the local economy (Enosse et al., 2001; Neto, 2003; Dearden et al., 2007). Therefore, how the whale shark tourism industry is being managed on Holbox is critical to its long-term sustainability.

In order to assess the sustainability of whale shark tourism on Isla Holbox, Mexico, this study took a holistic approach focusing on the following issues:

(1) visitor preferences and satisfaction with environmental and tour features

(2) user specialization and differences in actual and perceived environmental impacts, and preferences for management interventions

(3) integrating tourism growth, user specialization and limits of acceptable change (LAC) (biological and social) within a sustainability framework, and

(4) the vulnerability of whale sharks to large-scale environmental threats (e.g. global climate change and marine pollution) and its potential impact on whale shark tourism sites

This chapter is divided into five sections: section 6.2 provides a summary of the major research findings from each chapter of the thesis, section 6.3 provides a summary of the major management recommendations, section 6.4 addresses the contributions of this

research to the literature and management, and section 6.5 addresses the limitations of this research and future research needs.

6.2. Summary of findings

6.2.1. Visitor preferences and satisfaction with environmental and tour features (Chapter 2)

The objectives of this chapter were to understand the motivations and satisfactions of whale shark tour participants on Isla Holbox, Mexico in order to assess the success of the industry in meeting customer expectations of environmental and setting features. The Importance-Performance (IP) and gap analyses identified ten features requiring management attention: abundance of marine life and large fish, variety of marine life, number of boats and snorkelers, good underwater visibility, cost of trip, information provided by the boat crew, safety procedures on boats, and commitment to the environment by the boat crew. These areas of concern reflect four larger problems identified on Holbox, namely false advertising, lack of educational information, perceived crowding, and tour cost.

(1) False advertising

Tour operators and third parties (hotels, dive shops, tour agencies) use images from Southeast Asia and Australia to sell the whale shark tour on Holbox. The latter would not be an issue if the water conditions were similar between the sites. However, they vary drastically. The waters off Holbox have much lower visibility (at times less than 1 m) due to very high concentrations of plankton. Understandably, tourists are unhappy with

underwater visibility when they have been sold a tour based on images of deep blue seas with excellent visibility.

Problems with the abundance and variety of marine life also reflect problems with false advertising. Several tour agencies make promises regarding the availability and frequency of encounters with other marine life (e.g. manta rays, turtles, dolphins, golden rays, eagle rays, flying fish) to make the tour more appealing to tourists even though the likelihood of seeing these species cannot be guaranteed. Thus, many tourists are enticed to go on these tours with unrealistic expectations regarding the species diversity of the area resulting in reduced satisfaction with the environmental features of the tour.

(2) Educational information

Whale shark tour participants were unhappy with the quality of information provided by the boat crew. The vast majority of whale shark tour operators do not provide an educational component to their whale shark tours and the ones that do, do not provide adequate information. Information typically provided focuses on the encounter guidelines and disregards the inclusion of critical threats to whale sharks and ways to get involved in conservation efforts. The poor educational component is partially due to language and cultural barriers, reflecting the low degree of schooling of the majority of captains and guides.

(3) Perceived crowding

Visitors were dissatisfied with the number of boats and snorkelers within the whale shark viewing area off Holbox. Encounter guidelines stipulate that only two swimmers accompanied by a guide are allowed to interact with a shark. However, results suggest that more than the allowed number of swimmers were interacting with a shark at least a

quarter of the time, with up to ten people in the water at once. Operator disregard for the allowed number of swimmers may be behind the high dissatisfaction with the number of encountered snorkelers, as 80% of respondents supported the current limit of two swimmers and guide. The uncontrolled growth of the industry and the lack of a limit on the number of boats allowed within the viewing area (despite encounter guidelines stipulating this number should be controlled) may explain participant dissatisfaction with the number of boats. Operator actions also increase perceived crowding as boats tend to converge on already located sharks instead of seeking out new ones.

(4) Tour cost

During the 2008 season, cost varied from US$40 to over US$500 depending on the operator used, as well as the starting point of the tourists (i.e. day versus on-island tourist) and transport used (i.e. van, airplane). Yet the more expensive tour prices did not necessarily correspond to a higher quality experience. Thus, dissatisfaction with tour cost may reflect a problem of value for money spent and further issues with false advertising, not a problem with the actual tour cost.

6.2.2. User specialization and environmental impacts (Chapter 3)

The objectives of this chapter were (1) to suggest key criteria that could be used to distinguish among various shark user groups based on specialization, and (2) to assess whether differences in specialization could help explain the variability observed in pro-environmental behaviours and support for management interventions. Major findings were as follows:

- Whale shark participants on Isla Holbox, Mexico subdivided into three user groups: generalists (64.0%), intermediate shark tourists (28.7%), and specialists (7.3%)
- Specialists tended to be older, with higher dive training, a greater knowledge of sharks and the threats they face, more sensitive to crowding, and use an underwater camera compared to both generalist and intermediate users, supporting previous specialization work with scuba divers (e.g. Dearden et al., 2007)
- However, specialists were significantly more likely to touch the sharks, significantly less likely to perceive any negative environmental impacts of the tourism activities and significantly more satisfied with the current management approach compared to other user groups
- Contact rates with the whale sharks appear to be linked to underwater camera use and were mostly accidental in nature; intentional contact was related to environmental knowledge.

6.2.3. Assessment of the sustainability of the whale shark tourism industry on Isla Holbox, Mexico (Chapter 4)

The purpose of this chapter was to assess the current status and future sustainability of the whale shark tourism industry on Isla Holbox, Mexico using Duffus & Dearden's (1990) Wildlife Tourism Model (WTM). The model uses user specialization, industry growth and LAC to infer industry sustainability. The results of the analysis suggest that the Holbox whale shark industry is nearing collapse on the WTM curve. Key evidence includes:

(1) Tourism Growth

The growth of the whale shark tourism industry on Holbox approximates Duffus & Dearden's (1990) WTM curve, with fairly low visitation when it was first established (point A), followed by a dramatic increase in visitors from 6,000 to over 17,000 as the site became better known from 2004 to 2008 (approximating a transition through point B to C), and finally a tapering off as the site approaches its carrying capacity with visitation only increasing by 4% from 2007 levels in 2008 (point C).

(2) Specialization

The breakdown of user specialization of whale shark tour participants on Holbox suggests that whale shark tourism on Holbox is transitioning towards point C (collapse) on the WTM curve, with a majority of generalist shark users participating in the tour and a very small number of specialists.

(3) Limits of acceptable change

Social

Results suggest that for at least a quarter of the time there were more than the allowable swimmers in the water, with up to ten swimmers encountered at once. Close to a quarter of respondents felt that the number of other snorkelers was too high, while a third reported feeling moderately to extremely crowded during their experience. Further, 20% felt extremely crowded even when the appropriate number of swimmers were in the water potentially reflecting problems with the number of boats (23.4% dissatisfied) allowed within the whale shark viewing area.

Another issue identified is the significant leakage of economic benefits (approximately 30% of total profits) off Holbox due to growing day tourism opportunities

bringing in tourists from nearby mass tourism destinations (e.g. Cancun, Playa del Carmen, Cozumel). The outcome is high visitation numbers with relatively low net profit to the island, since the majority of these day tourists do not provide any local economic benefits beyond the cost of the whale shark tour itself. Local operators only receive approximately 13% of the total profits of approximately US$1.81 million.

Beyond crowding, tourists were also dissatisfied with the abundance of marine life and large fish, variety of marine life, good underwater visibility, cost of trip, the quality of educational information, safety procedures, and commitment to the environment during the whale shark trip.

Biological

Compliance with the 'no contact' rule was used as a proxy measure of the direct impacts of the tourism industry on the whale sharks of Holbox based on Quiros' (2007) assessment of whale shark tourism impacts in Donsol, Philippines. The latter study suggested that even with an 80% compliance rate to encounter guidelines led to noticeable negative short-term impacts on the whale sharks' behaviour. In the Holbox study, 23% of tourists admitted to making contact with a shark. A further 42% of all respondents reported seeing at least one other person make contact with the sharks, with an average of 2 people being seen touching the shark per tour. This approximates a conservative compliance rate of 77% for the Holbox industry, as this estimate is based on self-reported data and participants may not have been willing to admit to violating the code of conduct. Comparison of the current compliance rate (77%) to that of Quiros' (2007) study (80%) suggests that the current situation on Holbox is causing some harm to the visiting whale shark population.

These results suggest that the Holbox whale shark industry is nearing point C on the WTM curve and is headed to collapse if it does not alter its current path.

6.2.4. Large-scale threats and their potential impact on whale shark tourism on Isla Holbox, Mexico (Chapter 5)

The objective of this chapter was to assess the whale shark's vulnerability to potential large-scale threats, such as global climate change (GCC) and marine pollution, in order to address site-specific sustainability concerns of the tourism activity.

(1) Global climate change

Using Chin et al's (2010) Vulnerability Framework, the GCC drivers most likely to affect whale sharks were temperature (both directly and indirectly) and ocean circulation**.** The analysis suggests that whale sharks are most vulnerable to climate change in coastal/inshore habitats, which may also be critical nursery habitat, followed by reef, shelf and pelagic habitats. The greatest impact of GCC appears to be the indirect impacts on their prey. Ocean circulation relates primarily to upwelling, which is an important factor in prey availability for a planktivore like the whale shark. Furthermore, ocean acidification was also ranked as having a significant impact on whale sharks in reef habitats due to the whale shark's dependence on coral reefs for associated productivity events (e.g. coral spawning, Australia; mass fish spawning, Belize). Severe weather is most likely to affect primary productivity by damaging important habitat, such as corals.

(2) Marine pollution

Results suggest that marine pollution (oil spills, toxins and marine litter) could have a significant impact on the size and distribution of whale shark aggregations in the future.

The majority of whale shark tourism activities, which are based on whale sharks aggregating in vulnerable habitats, may be unsustainable in the long-term.

(3) Implications for Sustainable Livelihoods

An assessment of the resilience of Holbox's whale shark tourism industry to GCC using Lambert et al.' (2010) Resilience Framework suggests that Holbox is extremely vulnerable to changes in whale shark occurrence. High tour specificity, low tourist specialization and the limitations of Holbox tour operators in accessing whale sharks suggest that the industry on Holbox may not be resilient to future changes in whale shark occurrence.

These results suggest that tourism industries targeting whale sharks at feeding aggregations may be affected significantly through the displacement of whale sharks mostly due to reductions in prey availability.

6.3. Management recommendations

(1) Apply the precautionary principle in management interventions

The whale shark's status as a threatened species, along with the occurrence of tourism activities in critical feeding (and potential breeding) habitat, makes implementing a precautionary approach more critical for whale shark conservation and long-term sustainability of the associated tourism activities. The implementation of the precautionary principle on Holbox could take the form of limiting the number of visitors and the number of boats in the whale shark viewing area (e.g. license caps, increased tour cost, cap on number of boats allowed within the whale shark area at a time, temporal

closures), as well as making a greater effort to ensure compliance with the encounter guidelines (e.g. improved guide training, interpretation program).

(2) Re-structure industry

The whale shark tourism industry on Holbox would require a re-structuring of current management policies to an ecotourism approach in order to achieve sustainability. This re-structuring could involve centralising tourist registration at a single location (e.g. CONANP), fixing the cost of the tour at a higher rate (e.g. US$150 foreigners, US$80 locals), and assigning tourists to boats using an alphabetical rotation through a list of registered operators.

This approach would not require placing a cap on the number of permits issued for the season, as not all boats will have the opportunity to go out each day. However, management will have to establish the acceptable number of boats within the whale shark viewing area, as the code of conduct currently does not stipulate the allowable number of boats, despite stating it should be controlled. The limit on boats would address issues with perceived crowding, while the centralisation of tour sales would address a substantial portion of the current problems with inequitable distribution of funds. The latter would eliminate problems with questionable business practices (e.g. underhanded competition, false advertising). This approach would still leave unresolved issues with economic leakage with respect to off-island tourists.

The industry on Holbox should target intermediate and specialist users as they placed the highest importance on whale sharks as a tourism attraction in Mexico and thus may be more likely to spend more money and/or time pursuing this activity.

The government's successful implementation of an ecotourism approach to whale

shark tourism may provide an economic incentive for Holbox operators to follow interaction guidelines and enforce them in the whale shark viewing area as responsible operators may be at an economic advantage over other less compliant operators.

(3) Improved guide training programme

Management must improve operator support for the encounter guidelines. The latter can be accomplished through improving the guide training programme to address issues with leadership, interpretation, compliance and language barriers to further the conservation potential of whale shark tourism activities. Improved understanding of the risks of unsustainable tourism activities in the whale sharks' critical feeding habitat, as well as language and leadership training will help ensure that guides do intervene when inappropriate behaviours are observed and use appropriate practices themselves.

(4) Incorporate an educational component for tourists

A well-conceived and implemented interpretation program could ultimately improve tourist compliance with the encounter guidelines and thus the environmental impact of whale shark tourism activities on the sharks. The latter is especially important if management is to target the more specialized users who had the highest contact rates and were significantly more likely to perceive the industry as having a positive impact on the environment and sharks than the generalists. Restructuring the guidelines and interpretation program on Holbox could include:

- incorporating an explanatory approach in the encounter guidelines clarifying the reasons for any constraints (e.g. no contact rule, mandatory use of life vests), and
- a short, but in-depth briefing that outlines the interaction guidelines, impacts of inappropriate tourist behaviours (including cumulative impacts, especially of

underwater photographers), the threats whale sharks face and ways in which tourists can help in their conservation (e.g. the global whale shark photo-identification library spearheaded by ECOCEAN, 2010).

(5) Diversify the local economy

The heavy reliance of the community of Holbox on whale sharks increases the risk of economic collapse if/when whale sharks no longer return to Holbox. Based on the results of the vulnerability to global scale environmental threats (e.g. GCC, marine pollution), the likelihood of actual changes in whale shark occurrence and abundance is very likely. It is therefore important for the community of Holbox to diversify their economy to include other livelihoods, including other more general forms of nature-based tourism that take advantage of available species.

6.4. Contributions of this research

This study provides valuable contributions to the research literature, including:

(1) a greater understanding of tourist motivation and satisfaction within marine wildlife tourism, and shark tourism in particular, including the application of Importance-Performance analysis within a wildlife tourism context

(2) a first look at shark tourist specialization and its links to environmental impacts and management preferences

(3) an assessment of whale shark tourism sustainability using an integrated, interdisciplinary model that addresses both social and biological dimensions of sustainability

(4) support for the applicability of Duffus & Dearden's (1990) Wildlife Tourism Model as a viable approach of ascertaining the sustainability of a given wildlife tourism site

(5) the first comprehensive assessment of whale shark vulnerability to GCC based on habitat type and to marine pollution and its implications for whale shark tourism sites

(6) demonstrates the utility of using self-reported contact rates with the target species to estimate the actual impacts of tourism activities when intensive methods are not feasible either due to time or monetary constraints

6.5. Limitations and areas for future research

(1) The current study only assessed the sustainability of whale shark tourism out of Holbox; however, growing whale shark tourism industries out of Cancun and Isla Mujeres also target the same population of whale sharks. Time constraints made sampling all whale shark sites during the three-month field season impossible. Thus, this research only provides part of the picture and future studies should assess all whale shark tourism sites in order to get a better understanding of the industry and its impacts on the whale sharks and the communities.

(2) Survey attributes limited the potential sampling population. The surveys were only provided in English and Spanish, however there were a significant number of tourists from Europe (e.g. Germany, Netherlands, France) who could not complete the survey due to language barriers. Further, Spanish surveys were only available half-way through the sampling period thereby preventing national visitors to participate in the research. This language barrier is important for future research focusing on tourist perspectives.

Survey length was also an issue in terms of response rates as tourists did not remain near the main dock upon return from the whale shark tour. The 20 minute survey was therefore prohibitive for many tourists and inadvertently favoured day tourists who had more free time to spend completing the surveys. Providing surveys to small hotels and agencies on Holbox offering whale shark tours to on-clients was an attempt to compensate for this imbalance in response rates. Future research would benefit from limiting the length of surveys to a maximum of 10 minutes.

(3) The use of a survey as the primary research instrument has both advantages and limitations. Although surveys do not allow the in-depth exploration of issues such as can be gained from structured/unstructured interviews and/or focus groups, this approach can allow the exploration of a range of topics. The broad range of issues of interest within this study supports the selection of a survey as the primary research instrument. Further, surveys can allow the identification of attributes of a larger group based on the results of a subsample of that population (given sufficient sample size) (Salant & Dillman, 1994), as well as allow the use of statistical analysis to explore the relationships between relevant variables (Rea & Parker, 1992). The exploration of motivations and satisfaction, as well as the relationship between specialization and environmental attitudes and behaviours supports the use of surveys. The use of in person observation of tourist-whale shark interactions provided depth to some of the issues raised in the surveys.

(4) The biological LAC component of the sustainability framework is based on self-reported contact rates. Although this approach provides some insights into the potential impacts of the tourism activity based on more quantitative research methodologies at other whale shark tourism sites (e.g. Quiros, 2007; Pierce et al., 2010), a direct in-water

approach assessing contact rates and associated behaviours would provide a greater understanding of the actual tourism impacts on the whale sharks. Further, biological indicators of stress (e.g. haematological indicators, Semeniuk et al., 2009) need to be developed for whale sharks in order to get a more complete understanding of actual impacts of tourism activities on the species. There is also a need to better understand the long-term physiological impacts of the tourism activities on whale sharks (e.g. reproductive rate). However, the latter is difficult because so much still remains unknown about whale shark biology and ecology, including where they breed, their migration routes, and the global population structure.

(5) This study provides insights into the sustainability of current management policies of the Holbox tourism industry. However, long-term monitoring of the industry and the effect of changes in management policies is an important aspect of an adaptive approach to management, which itself is a prerequisite for sustainability. Future research needs include a monitoring program assessing changes in both social (e.g. crowding, compliance, operator support for code of conduct) and biological (e.g. impacts on whale sharks) dimensions of LAC, as well as the better integration of science within management decision-making (e.g. determining the social-biological carrying capacity of the industry).

6.6. Summary

Whale shark tourism on Isla Holbox, Mexico appears to be approaching its tipping point. If the Mexican government continues to favour ever greater economic development over the conservation of whale sharks, the industry may collapse, and sooner rather than later. Taking into account the high vulnerability of whale sharks to large-scale threats such as

overharvesting, GCC and marine pollution, the implications of uncontrolled tourism growth for the local community and the long-term health of the global whale shark population could be catastrophic.

The declaration of the new Whale Shark Biosphere Reserve in 2009, along with its associated stricter regulations, fits within a precautionary approach that focuses on transitioning to a more sustainable form of whale shark tourism. This designation provides CONANP with the authority to limit and/or ban the use of natural resources within the Biosphere Reserve, including whale shark tourism activities. Thus, CONANP has the power to implement the discussed changes if significant disturbance to the whale sharks is noted, as it is has in this study.

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Appendix I Human Research Ethics Board Certificate of Approval

University of Victoria

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Human Research Ethics Board
Certificate of Approval

Principal Investigator	Department/School	Supervisor
Jackie Ziegler Master's Student	GEOG	Dr. Philip Dearden

Co-Investigator(s):

Project Title: **Understanding the sustainability of whale shark tourism: a global perspective**

Protocol No.	Approval Date	Start Date	Expiry Date
08-117	06-Jun-08	06-Jun-08	05-Jun-09

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

This Certificate of Approval is valid for the above term provided there is no change in the protocol. Extensions and/or amendments may be approved with the submission of a "Request for Annual Renewal or Modification" form.

Dr. Richard Keeler
Associate Vice-President, Research

08-117 Ziegler, Jackie

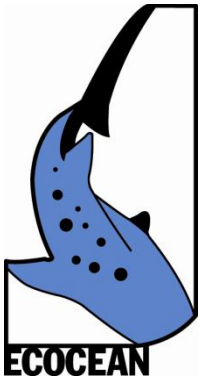
Appendix II Holbox whale shark survey

Whale Shark Tourism Research

ECOCEAN and the Marine Protected Area Research Group (MPARG) at the University of Victoria, Canada, are conducting research on a number of management aspects of the whale shark tour industry to help contribute to its sustainability, and we would appreciate a small portion of your time in filling out this questionnaire.

This project is one of several that will be undertaken worldwide by ECOCEAN and MPARG to assist in conservation goals and the long-term sustainability of these industries. We are using the same questionnaire at each location to facilitate comparison, so you might find that some choices for answers do not apply at your location.

Your cooperation in completing this **anonymous** questionnaire and in contributing to the sustainability of this wildlife interaction experience is greatly appreciated. Please note that this survey is intended for people 18 years or older and one per person. When you have finished answering the questions, please seal the completed questionnaire in the envelope provided and return to the appropriate person.



Whale Shark Viewing in Holbox

In order to protect the whale sharks and provide for a positive participant experience, it is important for us to know your motivations and expectations for your whale shark viewing trip.

Q.1 When did you decide to participate in a whale shark tour on Holbox?

1. BEFORE I LEFT HOME FOR MY TRIP
2. WHEN I ARRIVED ON HOLBOX
3. OTHER (please specify) _____

Q.2 How did you find out about the whale shark tours on Holbox?

1. GUIDE BOOK
2. TOURISM CENTRE
3. MAGAZINE
4. WORD OF MOUTH
5. NEWS ARTICLE
6. INTERNET
7. OPERATOR BOOTH/DIVE SHOP
8. HOTEL
9. OTHER_____

Q.3 If you are not from Mexico how important was seeing whale sharks in your decision to visit the country?

1. NOT AT ALL IMPORTANT
2. SLIGHTLY IMPORTANT
3. QUITE IMPORTANT
4. EXTREMELY IMPORTANT
5. NOT SURE

Q.4. Is Holbox your main destination for this trip to Mexico?

1. YES
2. NO

If not, where are you staying in Mexico?

1. CANCUN
2. PLAYA DEL CARMEN/MAYAN RIVIERA
3. OTHER (**please specify) _____**

Q.5 If whale shark tours were <u>not present</u> on Holbox, would you still have visited Holbox?

1. YES, we would have spent the <u>SAME amount of time/number of days</u> on Holbox
2. YES, but we would have spent <u>FEWER days</u> on Holbox
3. NO, we would <u>not have taken this trip</u> to Holbox

Q.6 While visiting Holbox, which of the following other recreation activities will you be participating in?

1. SNORKELING
2. SCUBA DIVING
3. SWIMMING
4. BOATING
5. SEA KAYAKING
6. HIKING/WALKING
7. CAMPING
8. BIRD WATCHING
9. OTHER (PLEASE SPECIFY) _____

Q. 7 How did you book this whale shark viewing trip?

1. DIRECTLY WITH A WHALE SHARK TOUR OPERATOR
2. THROUGH A TOUR AGENT
3. OTHER (please specify) _____

Q.8 Is seeing whale sharks on Holbox (please circle number beside statement):

1. THE MAIN REASON FOR YOUR VISIT TO HOLBOX?
2. A PLANNED ACTIVITY ON YOUR VISIT TO HOLBOX?
3. AN UNPLANNED ACTIVITY ON YOUR VISIT TO HOLBOX?

Whale Shark Viewing Motivations

In order to provide a high quality whale shark viewing experience, it is helpful to understand why people participate in whale shark tours.

Q. 9 How IMPORTANT are the following motivations in making you want to go whale shark watching? (Please circle number.)

		NOT AT ALL IMPORTANT	UNIMPORTANT	NEUTRAL	IMPORTANT	VERY IMPORTANT
		⇩	⇩	⇩	⇩	⇩
A	Interest in marine flora and fauna……	1	2	3	4	5
B	Seeking adventure…..……..	1	2	3	4	5
C	Interested in underwater photography……	1	2	3	4	5
D	Interest in sharks……	1	2	3	4	5
E	Interest in whale sharks…..……	1	2	3	4	5
F	To explore new environments	1	2	3	4	5
G	To expand my knowledge…….	1	2	3	4	5
H	To develop my skills and abilities……	1	2	3	4	5
I	Image of the activity (glamorous, adventurous, exciting)……	1	2	3	4	5
J	To be with friends …….....	1	2	3	4	5
K	To escape demands of everyday life……..……	1	2	3	4	5
L	Other (please specify) _____	1	2	3	4	5

Q.10 Now thinking of the opportunities provided on your whale shark watching trip today, please indicate how <u>SATISFIED</u> you are with the following:

	OPPORTUNITIES PROVIDED TODAY	VERY UNSATISFIED	SOMEWHAT UNSATISFIED	NEUTRAL	SOMEWHAT SATISFIED	VERY SATISFIED
		⇩	⇩	⇩	⇩	⇩
A	Interest in marine flora and fauna……	1	2	3	4	5
B	Seeking adventure…..……..	1	2	3	4	5
C	Interested in underwater photography……..	1	2	3	4	5
D	Interest in sharks……	1	2	3	4	5
E	Interest in whale sharks……	1	2	3	4	5
F	To explore new environments ……..	1	2	3	4	5
G	To expand my knowledge….	1	2	3	4	5
H	To develop my skills and abilities…….…….	1	2	3	4	5
I	Image of the activity (glamorous, adventurous, exciting)……..……	1	2	3	4	5
J	To be with friends/associates ……	1	2	3	4	5
K	To escape demands of everyday life…….……	1	2	3	4	5
L	Other _____	1	2	3	4	5

Your Whale Shark Watching Trip

In order to ensure a high quality visitor experience, it is helpful to understand the types of features you desire on your whale shark watching trip in Holbox.

Q.11 Please state how IMPORTANT/UNIMPORTANT the following environment and setting features are to your whale shark experience at Holbox. (Please circle number.)

	Environment and setting features	NOT AT ALL IMPORTANT ⇩	UNIMPORTANT ⇩	NEUTRAL ⇩	IMPORTANT ⇩	VERY IMPORTANT ⇩
A	Easy snorkeling conditions …….	1	2	3	4	5
B	Good underwater visibility …..…	1	2	3	4	5
C	Number of whale sharks seen	1	2	3	4	5
D	Proximity to whale sharks ….	1	2	3	4	5
E	Variety of marine life ……..……	1	2	3	4	5
F	Abundance of marine life …….	1	2	3	4	5
G	Abundance of large fish ……..…	1	2	3	4	5
H	Number of other snorkelers ….	1	2	3	4	5
I	Number of boats …….……	1	2	3	4	5

Q.12 Of the features listed in Q.11, which are the MOST IMPORTANT to you? (Please write the corresponding letter from Q.11 in the space provided.)

Most important _____ Second most important _____

Q.13 To help us understand what you liked or didn't like about the whale shark watching ENVIRONMENT at Holbox, please indicate how SATISFIED you were with the following aspects of your trip. Please circle a number beside each statement that best reflects your feelings.

	Environment and setting features	VERY UNSATISFIED ⇩	SOMEWHAT UNSATISFIED ⇩	NEUTRAL ⇩	SOMEWHAT SATISFIED ⇩	VERY SATISFIED ⇩
A	Easy snorkeling conditions …….	1	2	3	4	5
B	Good underwater visibility …….	1	2	3	4	5
C	Number of whale sharks seen	1	2	3	4	5
D	Proximity to whale sharks ….	1	2	3	4	5
E	Variety of marine life ……..……	1	2	3	4	5
F	Abundance of marine life ……..	1	2	3	4	5
G	Abundance of large fish ……..…	1	2	3	4	5
H	Number of other snorkelers ….	1	2	3	4	5
1	Number of boats …….……	1	2	3	4	5

Q.14 Taking into consideration all the environment and setting features listed above, how would you rate your overall level of satisfaction with the whale shark watching environment at Holbox?

1. VERY UNSATISFIED
2. SOMEWHAT UNSATISFIED
3. NEUTRAL
4. SOMEWHAT SATISFIED
5. VERY SATISFIED

Q.15 Please state how IMPORTANT/ UNIMPORTANT you feel the following SERVICES are to your shark watching experience at Holbox (Please circle number):

	Services	NOT AT ALL IMPORTANT ⇩	SOMEWHAT IMPORTANT ⇩	QUITE IMPORTANT ⇩	EXTREMELY IMPORTANT ⇩	NOT SURE ⇩
A	Information provided by boat crew …….	1	2	3	4	5
B	Commitment to the environment by boat crew …….	1	2	3	4	5
C	Safety procedures on boat …….	1	2	3	4	5
D	Length of trips …….....	1	2	3	4	5
E	Quality of marine transportation services ……	1	2	3	4	5
F	Cost of trip ……..……	1	2	3	4	5

Q.16 Now thinking about the SERVICES you enjoyed on your tour, please indicate how SATISFIED you were with each of the following (please circle number):

	Services	VERY UNSATISFIED ⇩	SOMEWHAT UNSATISFIED ⇩	NEUTRAL ⇩	SOMEWHAT SATISFIED ⇩	VERY SATISFIED ⇩
A	Information provided by boat crew …….	1	2	3	4	5
B	Commitment to the environment by boat crew …….	1	2	3	4	5
C	Safety procedures on boat …….	1	2	3	4	5
D	Length of trips ……..	1	2	3	4	5
E	Quality of marine transportation services ……	1	2	3	4	5
F	Cost of trip ……..……	1	2	3	4	5

Q.17 Taking into consideration the services <u>listed above</u>, how would you rate your <u>overall</u> level of satisfaction with the <u>services provided</u>?

1. VERY UNSATISFIED
2. SOMEWHAT UNSATISFIED
3. NEUTRAL
4. SOMEWHAT SATISFIED
5. VERY SATISFIED

Q.18 <u>Taking both services AND the quality of the environment into account</u>, how would you rate your <u>overall</u> level of satisfaction with your shark watching experience at Holbox?

1. VERY UNSATISFIED
2. SOMEWHAT UNSATISFIED
3. NEUTRAL
4. SOMEWHAT SATISFIED
5. VERY SATISFIED

Q.19 Based on the quality of your experience, would you <u>RECOMMEND</u> whale shark watching at Holbox to others?

1. NO
2. YES

<u>The Social Setting</u>

Q.20 <u>During your experience</u>, what was the maximum number of people with a whale shark at any one time?

_____ people

Q.21 <u>After your experience</u>, how many people do you feel should be in the water with a whale shark at any one time?

_____ people

Q.22 Thinking about the total number of other snorkelers you encountered in the water today, please indicate on the scale how crowded you felt. (Please circle ONE number on the scale.)

1	2	3	4	5	6	7	8	9
NOT AT ALL CROWDED		SLIGHTLY CROWDED			MODERATELY CROWDED			EXTREMELY CROWDED

Q.23 How important is the opportunity to learn about whale sharks to you?

1. NOT AT ALL IMPORTANT
2. SLIGHTLY IMPORTANT
3. QUITE IMPORTANT
4. EXTREMELY IMPORTANT
5. NOT SURE

Q.24 How would you rate your opportunity to learn about whale sharks at Holbox?

1. VERY POOR
2. POOR
3. NOT SURE
4. GOOD
5. VERY GOOD

Q.25 Please indicate how you feel about the encounters you experienced on your whale shark watching trip, by circling the appropriate number beside each statement.

	Did you feel that:	**TOO FEW** ⇩	**TOO MANY** ⇩	**ABOUT RIGHT** ⇩
A	The number of other people snorkeling was	1	2	3
B	The number of tourists on your boat was	1	2	3
C	The number of other boats shark watching was.....	1	2	3
E	The number of staff on the boat was	1	2	3

Shark Watching Experience

Q.26 What is the highest scuba diving certification that you have completed (or equivalent)?

1. None
2. Open Water
3. Advanced
4. Rescue
5. Dive Master
6. Instructor
7. Other_____

Q.27 How would you describe your level of experience in snorkeling?

1. NOVICE
2. INTERMEDIATE
3. ADVANCED
4. EXPERT

Q.28 Did you take an underwater camera with you on the whale shark tour?

DISPOSABLE 1. YES 2. NO ☐

NONDISPOSABLE 3. YES 4. NO

Q.29 Have you ever participated in an <u>ORGANIZED</u> shark tour before?

1. NO
2. YES

If so, please use the following table to indicate the TYPE of shark(s) you have encountered, the LOCATION(s) of the encounter and the NUMBER of encounters you have had.

Region		Shark Species	Number of times
1			
2			
3			
4			

Q.30 How would you describe your level of experience in shark watching?

1. NOVICE
2. INTERMEDIATE
3. ADVANCED
4. EXPERT

Q.31 How would you describe your level of knowledge about sharks?

1. LITTLE
2. INTERMEDIATE
3. ADVANCED
4. EXPERT

Q.32 Whale sharks are the largest shark in the world. Do you know which species is the second largest?

Q.33 Sharks currently face several serious threats at a global scale. Please list them.

Q.34 How many days in total will you spend on Holbox during this visit?

_____ DAYS

Q.35 On how many different days did you go swimming with whale sharks?

_____ DAYS

Q.36 How would you rate the importance of whale sharks as a tourist attraction for you?

1. NOT AT ALL IMPORTANT
2. SLIGHTLY IMPORTANT
3. VERY IMPORTANT
4. EXTREMELY IMPORTANT
5. NOT SURE/ UNDECIDED

Economics

Q.37 What was the cost of your whale shark tour today?

US$_____ for ___ people

Q.38 Was your trip to Holbox booked as part of a package tour?

1. NO
2. YES

If YES, what was the cost of the tour in $US _____, and roughly what proportion was devoted to covering your costs on Holbox including whale shark watching? _____%

Q.39 Do you feel that the cost of an individual whale shark tour is

1. TOO LITTLE
2. ABOUT RIGHT
3. TOO MUCH

Q.40 In some parts of the world whale shark watchers pay much higher amounts for their whale shark experience. Regardless of what you paid for your whale shark tour, what is the maximum you are willing to spend ($US) on a single whale shark tour at Holbox?

1. $50-$100
2. $101-$150
3. $151-$200
4. $201-$250
5. $251-$300
6. $301-$350
7. $351-$400
8. >$400

Q.41 Would you be willing to make a donation if the money was used directly for whale shark conservation?

1. NO
2. YES If so, how much more US$_____

Impacts on Whale Sharks

In order to manage the whale shark viewing area to ensure satisfactory environmental conditions AND a healthy, undisturbed population of whale sharks that provides visitors with positive experiences, it is helpful for us to understand the impacts you feel whale shark swim-with tours have on the environment and the whale sharks themselves.

Q.42 Please indicate to what extent you feel the following potential benefits and negative impacts of whale shark swim-with tours have on the environment and the whale sharks themselves. (Please circle number.)

		STRONGLY DISAGREE	SOMEWHAT DISAGREE	NOT SURE	SOMEWHAT AGREE	STRONGLY AGREE
		⇩	⇩	⇩	⇩	⇩
A	Negative impact on whale sharks……	1	2	3	4	5
B	Negative impact on other marine life……..……..	1	2	3	4	5
C	Negative impact on water quality ……..……..	1	2	3	4	5
D	Provides economic support for the protection of whale sharks ……	1	2	3	4	5
E	Provides education to participants, which helps protect the whale sharks ……..……	1	2	3	4	5
F	Garbage/Waste	1	2	3	4	5
G	Crowding (too many people at viewing area causes more harm) ……..…….	1	2	3	4	5

Q.43 Please list any other potential negative impacts or benefits you feel whale shark swim-with tours have on the environment and/or the whale sharks.

Q.44 Overall, do you feel the impact of whale shark viewing tours on the environment and whale sharks is:

1. VERY NEGATIVE
2. SOMEWHAT NEGATIVE
3. SOMEWHAT POSITIVE
4. VERY POSITIVE
5. NOT SURE

Q.45 Did you make physical contact with a whale shark?

1. NO
2. YES

If you made contact with the whale shark, was it – (circle all numbers that apply)

1. an entirely accidental contact
2. because the whale shark deliberately moved towards you
3. your curiosity about the texture of its skin
4. your desire to be close to the animal
5. the excitement of touching such a large animal
6. interference from another snorkeler
7. other reasons (please specify)_____

Q.46 Did others in your group make contact with a whale shark?

1. NO
2. YES

If so, how many others made contact with a whale shark? _____

Q.47 Are you aware of any regulations concerning whale shark watching at Holbox?

1. NO
2. YES

If yes, could you explain these regulations:

Q.48 Do you feel these regulations are adequate?

1. NO
2. YES

About You

Finally, we are interested in learning a bit about you. It is helpful for us to understand the type of people who travel to Holbox for whale shark watching.

Q.49 Could you please tell me <u>your individual</u> normal average annual income (before tax and in $US)?

1. Less than 10,000
2. 10,000 - 19,000
3. 20,000 – 30,000
4. 31,000 – 50,000
5. 51,000 - 75,000
6. 76,000 - 100,000
7. Greater than 100,000

Q.50 Could you please state your gender?

1. MALE
2. FEMALE

Q.54 What is your nationality? _____

Q.55 What is your country of residence? _____
If Mexico, what state are you from? _____

Q.56 Could you please tell me your age?

1. UNDER 25 YEARS
2. 26-35 YEARS
3. 36-45 YEARS
4. 46-55 YEARS
5. 56-65 YEARS
6. OVER 65 YEARS

Q.57 What is the highest level of education you have completed?

1. GRADE/PRIMARY SCHOOL
2. HIGH SCHOOL
3. COLLEGE/UNIVERSITY
4. TRADE OR APPRENTICESHIP
5. OTHER (PLEASE SPECIFY) _____

Q.58 Who did you come on this whale shark watching trip with? (Please circle all that apply.)

1. ALONE
2. FAMILY
3. FRIENDS
4. OTHER (please specify) _____

Q.59 Are there any other aspects of the whale shark watching experience at Holbox that you would like to bring to our attention (including regulation, areas of improvement)?

THANK YOU FOR YOUR CO-OPERATION

For information regarding this survey please visit www.ecocean.org or contact jackie.ziegler@gmail.com

Appendix III Questionnaire Results – Raw Data Tables

Q1. When did you decide to participate in a whale shark tour on Holbox?

When decision made	% of respondents
Before leaving home	52.7
When arrived in Playa	34.0
When arrived in Holbox	3.6
When arrived on Cozumel	3.6
When arrived in Cancun	3.3
When arrived in Tulum	1.3
When arrived in Akumal	1.3
When arrived in Placencia	0.3

Q2. How did you find out about whale shark tours to Holbox?

Sources	% of respondents
Operator booth/Dive shop	31.3
Internet	27.0
Word of Mouth	26.1
Tourism center	12.1
Hotel	11.6
Guidebook	6.9
TV	2.9
Previous trip to Holbox	2.4
Magazine	1.5
CONANP	0.4
News article	0.3

Q3. If you are not from Mexico how important was seeing whale sharks in your decision to visit the country?

Importance	% of respondents
not at all important	45.1
slightly important	18.8
quite important	17.1
extremely important	17.7
not sure	1.4

mean: 2.11
sd: 1.20

Q4. Is Holbox your main destination for this trip to Mexico?

Main destination?	Percent
Yes	**6.6**
No	**93.4**
Playa/Mayan Riviera	58.0
Cozumel	14.4
Trip – backpacking	10.6
Akumal	5.2
Cancun	4.3
Puerto Aventuras	2.3
Tulum	2.0
DF	0.6
Guadalajara	0.3
Merida	0.3
Chiapas	0.3

Q5. If whale shark tours were not present at Holbox, would you still have visited Holbox?

	Percent
No	85.1
Yes, same amount of time	10.6
Yes, fewer days	4.4

Q6. While visiting Holbox, which of the following other recreational activities will you be participating in?

Activity	Percent
Swimming	13.0
Snorkeling	8.3
Hiking/walking	7.7
Boating	6.0
Bird watching	3.4
Fishing	3.4
Sea Kayaking	1.8
Shopping	1.7
Golf cart island tour	0.9

Q7. How did you book this whale shark viewing trip?

Location of booking	Percent
Dive shop	42.9
Through a tour agent	41.1
Directly with a whale shark tour operator	14.9
Internet	1.0

Q8. Importance of whale shark tour on Holbox

Seeing whale sharks on Holbox	Percent
Main reason	86.0
Planned activity	9.8
Unplanned activity	4.1

Q9. Importance of motivations to participate in whale shark tour.

Motivations	Percent					mean	sd
	not at all important	unimportant	neutral	important	very important		
interest in whale sharks	1.0	1.0	13.7	35.1	49.1	4.30	0.820
to expand my knowledge	0.8	2.1	13.6	38.5	45.0	4.25	0.825
to explore new environments	1.0	1.8	13.7	43.9	39.5	4.19	0.814
interest in marine fauna and flora	2.8	2.3	16.5	34.4	43.9	4.14	0.967
seeking adventure	1.6	4.7	14.3	40.1	39.3	4.11	0.925
interest in sharks	2.1	3.9	24.1	36.6	33.2	3.95	0.959
image of activity	15.3	8.8	27.5	24.7	23.6	3.32	1.34
to escape demands of everyday life	16.6	14.2	26.3	23.7	19.2	3.15	1.34
interested in underwater photography	14.4	16.2	31.9	22.9	14.7	3.07	1.25
to develop my skills and abilities	12.3	19.9	34.9	20.7	12.1	3.00	1.18
to be with friends/family	21.5	13.4	29.1	20.7	15.4	2.95	1.35

Others (write-in response) (< %)

- snorkeling
- lifetime/unique experience
- curious
- interest in marine biology
- everybody talks about and wants to participate in these conversations
- overcome fear
- visit Yucatan, proximity to cenotes and Mayan sites

Q10. Satisfied with motivations:

Motivations	Percent					mean	sd
	very unsatisfied	somewhat unsatisfied	neutral	somewhat satisfied	very satisfied		
interest in WS	0.0	2.7	5.0	27.6	65.3	4.56	0.688
to explore new environments	0.8	0.8	14.5	34.9	49.1	4.31	0.805
seeking adventure	0.8	3.5	15.8	29.1	50.8	4.26	0.909
interest in sharks	1.1	4.9	19.1	29.4	45.6	4.13	0.960
to expand my knowledge	1.6	4.2	19.8	33.6	40.7	4.08	0.956
interest in marine fauna and flora	1.6	5.3	20.6	30.3	42.2	4.06	0.990
image of activity	5.6	2.9	33.0	26.3	32.2	3.76	1.11
to escape demands of everyday life	6.4	4.0	35.0	23.3	31.3	3.69	1.14
to develop my skills and abilities	2.7	7.6	46.1	22.8	20.9	3.51	0.992
to be with friends/family	6.7	5.6	42.5	20.7	24.5	3.51	1.12
interested in underwater photography	5.1	6.9	44.9	25.0	18.1	3.44	1.026

Q11. Importance of environmental and setting features encountered on whale shark tour

Environmental setting/features	Percent					mean	sd
	not at all important	unimportant	neutral	important	very important		
proximity to whale shark	0.0	0.3	6.6	36.1	57.0	4.50	0.632
good underwater visibility	1.3	1.8	9.4	43.6	43.8	4.27	0.809
number of whale sharks seen	0.3	2.9	14.0	46.0	36.9	4.16	0.788
variety of marine life	1.6	6.1	24.9	39.4	28.0	3.86	0.948
easy snorkelling conditions	2.6	7.6	21.4	47.0	21.4	3.77	0.957
number of other snorkelers	4.0	5.1	20.7	35.9	34.3	3.56	1.147
abundance of large fish	3.5	7.6	27.4	40.7	20.9	1.16	1.00
number of boats	3.2	4.9	20.3	35.1	36.5	3.41	1.203
abundance of marine life	4.0	6.5	28.2	38.2	23.1	3.29	1.075

Q12. Top environmental and setting features

Environmental/setting features	Percent
proximity to whale sharks	26.0
number of whale sharks seen	21.6
good underwater visibility	17.0
number of other snorkelers	10.3
number of boats	7.7
variety of marine life	6.0
easy snorkelling conditions	4.8
abundance of marine life	3.9
abundance of large fish	2.6

Q13. Satisfaction with environmental setting/features

Environmental and setting features	Percent					mean	sd
	Very unsatisfied	Somewhat unsatisfied	neutral	Somewhat satisfied	very satisfied		
proximity to whale shark	0.8	1.1	1.9	16.3	79.9	4.73	0.630
number of whale sharks seen	1.6	5.6	9.9	21.0	61.8	4.36	0.982
easy snorkelling conditions	0.8	4.3	15.1	31.0	48.8	4.23	0.914
number of other snorkelers	4.6	14.2	27.0	29.0	25.1	3.56	1.147
good underwater visibility	4.6	18.3	18.9	33.2	25.1	3.56	1.180
abundance of large fish	6.4	11.7	33.3	24.4	24.2	3.48	1.163
variety of marine life	4.4	15.8	29.2	30.6	19.9	3.46	1.109
number of boats	7.0	16.4	27.9	26.1	22.6	3.41	1.203
abundance of marine life	6.3	13.2	40.8	24.5	15.2	3.29	1.075

Q14. Overall satisfaction with environmental/setting features

Satisfaction	Percent
very unsatisfied	5.3
somewhat satisfied	2.9
neutral	2.9
somewhat satisfied	23.5
very satisfied	60.2

mean: 4.62
sd: 1.470

Q15. Importance of tour services

Tour Services	Percent					mean	sd
	not at all important	un-important	neutral	important	very important		
commitment to environment	0.0	0.3	10.7	30.4	58.5	4.47	0.697
information provided	0.0	1.4	11.1	42.6	45	4.31	0.722
safety procedures on boat	0.0	2.4	12.5	41.7	43.4	4.26	0.768
quality of marine transportation	0.0	1.7	10.1	49.1	39.0	4.25	0.706
length of trips	0.3	3.1	17.1	51.7	27.6	4.03	0.779
cost of trip	0.3	3.1	20.2	46.3	30.0	4.02	0.813

Q16. Satisfaction with tour services

Tour Services	Percent					mean	sd
	very unsatisfied	somewhat unsatisfied	neutral	satisfied	very satisfied		
quality of marine transportation	1.1	2.2	11.8	34.9	50.0	4.31	0.842
commitment to environment	1.3	4.0	15.5	30.0	49.1	4.21	0.940
length of trips	1.9	4.3	17.0	35.7	41.1	4.10	0.958
safety procedures on boat	1.1	6.7	17.5	33.4	41.2	4.07	0.976
information provided	6.7	15.7	15.2	29.6	32.8	3.66	1.264
cost of trip	2.7	15.1	29.3	31.2	21.8	3.54	1.072

Q17. Overall satisfaction with tour services

Satisfaction with tour services	Percent
very unsatisfied	6.2
somewhat unsatisfied	6.7
neutral	4.8
somewhat satisfied	37.0
satisfied	45.3

mean: 4.09
sd: 1.149

Q18. Overall satisfaction with environmental features and tour services

Overall satisfaction	Percent
very unsatisfied	5.3
somewhat unsatisfied	5.3
neutral	2.9
somewhat satisfied	29.3
satisfied	57.3

mean: 4.28
sd: 1.101

Q19. Recommend the whale shark tour?

Recommend	Percent
yes	94.7
no	5.3

Q20. Maximum number of people encountered in the water at one time

Number of people encountered	Percent	n
2-3	74.5	278
4	5.1	19
5	7.0	26
6	8.8	33
7	1.3	5
8	1.6	6
10	1.6	6

mean: 3.496
sd: 1.581

Q21. Maximum number people should be allowed in the water at one time

Number of people should be	Percent
0	1.6
1	0.3
2	27.5
3	58.8
4	6.7
5	2.1
6	1.9
8	0.5
10	0.3

mean: 3.06
sd: 3.612

Q22. How crowded felt based on the number of other snorkelers encountered

Crowding	Percent
Not at all crowded	
1	34.0
Slightly crowded	
2	20.4
3	10.5
4	11.3
Moderately crowded	
5	6.4
6	7.8
7	5.9
Extremely crowded	
8	1.3
9	2.4

mean: 2.89
sd: 2.002

Q23. Importance of learning experience

Importance of learning experience	Percent
not at all important	1.1
unimportant	15.3
neutral	44.3
important	37.2
very important	2.1

mean: 3.24
sd: 0.772

Q24. Quality of learning opportunity on Holbox

Learning opportunity	Percent
very poor	4.8
poor	16.2
not sure	18.1
good	44.9
very good	16.0

mean: 3.51
sd: 1.0881

Q25. Satisfaction with tour features

Tour feature	Percent			mean	sd
	too few	too many	about right		
number of snorkelers	3.8	21.1	75.1	2.71	0.530
number of tourists on boat	3.0	13.9	83.1	2.80	0.469
number of other boats	2.2	33.7	64.1	2.62	0.529
number of staff on boat	3.5	4.6	91.9	2.88	0.417

Q26. Highest dive certification

Dive certification	Percent
none	38.9
open water	30.4
advanced	18.1
rescue	3.2
dive master	2.9
instructor or above	6.6

Q27. Self-rate snorkeling experience

Snorkeling experience	Percent
novice	18.0
intermediate	34.0
advanced	33.0
expert	15.0

Q28. Underwater camera use

Camera type	Percent
nondisposable	36.3
disposable	35.5

Q29. Participated in organized shark tour

Participated in tour	Percent
No	**79.9**
Yes	**20.1**
Regions	
Caribbean	65.2
North America	62.9
Australia/New Zealand	21.3
Central America	18.0
South America	9.0
Southeast Asia	7.9
Africa	5.6
South Asia	2.2
Europe	1.1
Species	
Reef shark	52.8
Nurse shark	38.2
Bull shark	19.1
Whale shark	16.9
Hammerhead	14.6
Black tip	12.4
Great white	6.7
White tip	6.7
Lemon	5.6
Blue	4.5
Leopard	4.5
Tiger	2.2
Frequency	
1	46.1
2-10	39.9
11-20	4.5
21-49	3.4
50+	3.4

Q30. Self-rated level of experience in shark watching

Experience level	Percent
novice	77.4
intermediate	16.1
advanced	6.0
expert	0.5

Q31. Level of knowledge of sharks

Level of knowledge of sharks	Percent
little	44.9
intermediate	46.0
advanced	8.6
expert	0.5

Q32. Name the second largest shark species

	Percent
Correct	11.6
Incorrect	88.4

Q33. Name three threats facing sharks

Score	Percent
0	17.6
1	10.5
2	20.6
3	22.5
4	13.4
5	11.4
6	3.9

Q34. Average number of days spent on Holbox

	mean	sd
number of days on Holbox	4.108	28.145

Q35. Average number of days swam with whale sharks

	mean	sd
number of days went swimming with WS	0.166	0.446

Q36. Importance of whale shark as tourist attraction

Importance	Percent
not at all important	3.5
slightly important	19.9
very important	37.3
extremely important	35.4
not sure	3.8

mean: 3.16
sd: 0.908

Q37. Cost of whale shark tour in US$

Cost of trip (US$)	Percent
0-100	13.9
101-150	6.3
151-200	60.9
>200	18.9

mean: 167.72
sd: 46.39

Q38. Whale shark tour part of package tour?

	Percent	min	max	mean	sd
Yes	**23.8**				
cost of tour (US$)		100	2700	508.1	580.69
No	**76.2**				

Q39. Satisfaction with cost of tour

	Percent
too little	0.5
about right	58.6
too much	30.1

Q40. Maximum willing to spend on whale shark tour

Cost of tour (US$)	Percent
50-100	17.0
101-150	24.8
151-200	32.9
201-250	14.2
251-300	8.1
301-350	0.8
351-400	1.4
>400	0.8

Q41. Willing to donate if used directly for whale shark conservation

	Percent
No	**34.8**
Yes	**65.2**
amount	
less than US$20	21.4
US$20-49	37.0
US$50-99	26.6
greater than US$100	15.0

mean = 70.53
sd= 379.24

Q42. Perceived benefits and negative impacts of whale shark tours on the whale sharks and surrounding environment

Impacts	**Percent**					**mean**	**sd**
	strongly disagree	somewhat disagree	not sure	somewhat agree	strongly agree		
provides economic support for the protection of WS	2.3	4.3	22.9	46.1	24.4	3.86	0.913
provides education to participants, which helps protect WS	2.8	10.8	17.6	39.8	29.0	3.81	1.059
crowding	5.7	17.8	22.6	32.7	21.2	3.46	1.173
negative impacts on WS	9.1	16.3	40.3	25.7	8.6	3.08	1.061
garbage/waste	12.6	23.2	30.2	19.1	15.0	3.01	1.237
negative impact on water quality	12.6	28.0	27.1	24.0	8.3	2.87	1.159
negative impact on other marine life	12.6	24.6	36.9	18.3	7.7	2.84	1.104

Q43. Other potential impacts and/or benefits of whale shark tourism activities (open-ended questions)

Type of impact/benefit	% of respondents
Benefits	
• Raises awareness and educates visitors	12% (11)
• Low stress activity	2% (2)
• Economy	3% (3)
Negative Impacts	
• Potential for unsustainable development	9% (8)
• Stress for sharks (noise, too many boats and snorkelers, boat strikes)	23% (21)
• Long-term changes in whale shark behaviour and occurrence	18% (16)
• Water pollution (gas/oil, garbage, sunblock)	22% (20)

Q.44. Overall impact of tourism on whale sharks and environment

Impact	Percent
very negative	2.2
somewhat negative	30.9
somewhat positive	27.9
very positive	20.6
not sure	18.4

mean: 3.22
sd: 1.138

Q45. Made physical contact with a whale shark and if so why.

Made contact	% of respondents who made contact
No	**76.7%**
Yes	**23.3%**
Accidental	*82.4%*
• an entirely accidental contact (61)	
• because the whale shark deliberately moved towards you (30)	
• interference from another snorkeler (3)	
• tail movement (6)	
Intentional	*16.7%*
• your curiosity of texture of skin (9)	
• your desire to be close to the animal (6)	
• the excitement of touching such a large animal (4)	
• to see if you could get a reaction (1)	

Q46. Did others in the group make contact with a whale shark?

Others made contact	Percent
No	**58.4**
Yes	**41.6**
number of people who made contact	
1	47.1
2	33.1
3	11.8
4	5.9
5	1.5
7	0.7

Q47. Are you aware of regulations concerning whale shark watching on Holbox?

Aware of regulations	Percent
No	**35.2%**
Yes	**64.8%**
do not touch whale sharks	77.4
stay 2 m away from sharks	37.4
use biodegradable sunblock	24.9
only 2 swimmers plus the guide	21.2
no flash photography	17.1
boats must stay 10 m from sharks	16.7
lifejacket mandatory	11.1
no waste/garbage	9.0
no feeding fish	8.1
no scuba	6.9
controlled entry	6.5
avoid tail	3.9
no fishing/resource extraction	3.4
be respectful and do not harass	3.2
no surface diving	2.9
no chasing shark	2.5
only with licensed crew	2.2

Q48. Are the regulations adequate?

Regulations adequate	Percent
No	13.8
Yes	86.2

Q49. Individual average annual income

Income	Percent
< 10,000	11.0
10,000-19,000	6.0
20,000-30,000	11.6
31,000-50,000	20.1
51,000-75,000	16.6
76,000- 100,000	13.8
> 100,000	21.0

Q50. Gender

Gender	Percent
male	49.7
female	50.3

Q51. Nationality

Nationality	Percent
American	45.1
English	9.7
Dutch	8.3
Mexican	6.8
French	5.0
Canadian	4.7
Belgian	2.9
Danish	2.9
Australian	2.7
Austrian	2.4
Italian	2.1
Polish	0.9
Brazilian	0.6
Portuguese	0.6
Swedish	0.6
Argentinian	0.3
Chinese	0.3
Cuban	0.3
Hungarian	0.3
Indian	0.3
Japanese	0.3
New Zealand	0.3
Romanian	0.3
Slovak	0.3
Swedish	0.3
Swiss	0.3

Q52. Country of residence

Nationality	Percent
United States	45.6
Mexico	10.2
Quintana Roo (16)	
Mexico City (9)	
Jalisco (2)	
Tabasco (2)	
Veracruz (2)	
Yucatan (2)	
Monterrey (1)	
Nuevo Leon (1)	
UK	9.3
Holland	7.8
Canada	3.8
France	3.8
Belgium	3.2
Denmark	2.9
Germany	2.9
Australia	2.3
Austria	2.0
Italy	2.0
Brazil	0.6
Portugal	0.6
Sweden	0.6
Thailand	0.6
Argentina	0.3
China	0.3
Korea	0.3
Poland	0.3
Qatar	0.3
Slovakia	0.3

Q53. Age

Age	Percent
< 25	16.6
26-35	35.6
36-45	20.7
46-55	20.2
56-65	5.5
> 65	1.4

Q54. Education level

Education level	Percent
Grade/primary school	0.8
High School	18.7
College/university	65.8
Trade or apprenticeship	4.7
Graduate degree	9.9

Q55. Who did you come on the whale shark trip with?

	Percent
Family	49.6
Friend(s)	37.4
Partner	17.7
Alone	9.1

Q56. Are there any other aspects of the whale shark watching experience you would like to bring to our attention?

Category of Comment	% of those who provided a comment
Tour Services	**69 (53%)**
Environmental education	45 (35%)
Food	5 (4%)
Language barrier	4 (3%)
Better equipment (life vests, boat ladder)	2 (2%)
Cost	2 (2%)
Transit (difficulty of access)	2 (2%)
Public restrooms	1 (1%)
Photography/video option	1 (1%)
Authenticity of tour (locals as guides)	1 (1%)
Guides	6 (5%)
• helpful	3 (2%)
• did not enforce rules	1 (1%)
• followed rules	1 (1%)
• could be more helpful	1 (1%)
Environmental and Setting Features	**60 (47%)**
Positive	***12 (9%)***
Enjoyed trip	7 (5.4%)
Species richness (e.g. mantas, flying fish, dolphins, turtles)	5 (4%)
Negative impacts	***42%***
focus on sustainable practices	15 (12%)
• provide more money for conservation	6 (5%)
• ensure rules are followed to reduce stress on sharks	3 (2%)
• increased research into impacts of tourism activities on sharks	3 (2%)
• delicate balance between conservation and exploitation	2 (2%)
• limit contact time with sharks	1 (1%)
too many boats and/or snorkelers	12 (9%)
sharks are stressed	5 (4%)
did not respect rules (approach distances, blocking path, touching sharks, number of swimmers and/or boats)	3 (2%)
discontinue interaction activities with sharks	2 (2%)
Pollution	2 (2%)
Other	***9 (7%)***
Enjoyed trip	7 (5%)
Be allowed to touch sharks	2 (2%)