

**Coral Bleaching and Dive Operators in the Caribbean:
Perceptions of Environmental Change**

by
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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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Abstract

Dive tourism is a growing and important industry which is often reliant on a high quality natural environment. As dive tourism's significance grows due to its economic and ecological impacts on many tropical destinations, it is important to understand how this special-interest tourism may be affected by environmental change. Mass coral bleaching episodes, a phenomenon with potentially severe implications for the health of coral reef ecosystems, have been increasing in intensity and frequency over the last three decades. This has begun to affect the enjoyment of visitors and the prosperity of individuals and dive tourism businesses that depend on reefs. Therefore, the purpose of this project is to explore the perceptions, opinions and adaptation strategies of dive operators in the Caribbean regarding coral bleaching and its effects on their business and dive tourism.

This study was guided by an exploratory, sequential, mixed methods design and consisted of two phases: phase 1, a semi-structured interview, followed by phase 2, a web-based survey. The interviews for the initial phase were done with seven Tobago dive operators in January 2011 to gain perspectives and insights from local dive operators before the web-based survey was sent out. The themes that emerged from the interviews include: a lack of government action, locals and reefs, bleaching and business, and moving forward.

A larger regional web-based survey was chosen for a second phase of the study to test operator opinions across the Caribbean. In total 318 operators were contacted, with 90 completing the survey. The results were varied, but the overall consensus was that coral bleaching is an important issue, but at the present time a lack of reef protection is more important. Into the future the issues of coastal development and climate change become more prominent. Based on the 2010 coral bleaching event, which was projected by NOAA to rival that of the 2005 mass bleaching, the 2010 paled in comparison. The operators said it was not as severe as previous bleaching events and that it in fact did not have any impact on their business.

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CHAPTER ONE AN INTRODUCTION

1.0 Study Background

Dive tourism is a growing and important industry which is often reliant on a high quality natural environment. As dive tourism continues to grow in significance due to its economic and ecological impacts on many tropical destinations, it is important to understand how this special-interest tourism may be affected by environmental change (Gössling et al., 2008). In particular, coral bleaching caused by increasing ocean water temperatures has become a major environmental concern for dive tourism, and it is the purpose of this study to examine dive operators' perceptions of these dramatic events and the implications for their businesses and destinations.

Mass coral bleaching, a visually spectacular phenomenon with potentially severe implications for the health of coral reef ecosystems, the enjoyment of visitors, and the prosperity of individuals and businesses that depend on the reef, stands to greatly affect dive tourism in the Caribbean (Marshall & Schuttenberg, 2006). Mass bleaching events have been documented in the literature since 1982, with the most recent event taking place in 2010 (Eakin, 2010; Wilkinson & Souter, 2008). The occurrence of the 2010 bleaching event makes research on tourism and coral bleaching timely, as operators can comment on their experience with past as well as present bleaching.

Climate change and its impact on the tourism industry came to the forefront of academic research interest in recent years (Scott & Becken, 2010). For this study, climate change will be defined as “any change in climate overtime, whether due to natural variability or as a result of human activity” (Intergovernmental Panel on Climate Change (IPCC), 2007, p. 6). As coral bleaching is a form of environmental change caused by a change in climate, environmental

change for the purposes of this paper will be defined as issues such “as climate change, modifications of global biogeochemical cycles, land alternations, the loss of non-renewable resources, unsustainable uses of renewable resources, species extinctions and reductions in biodiversity” (Hall & Lew, 2009, p. 196). For this research, coral bleaching will be used as an indicator of climate change occurring in the region.

Some destinations rely heavily on tourism, and should climate change affect them negatively the change could be detrimental to the local community, the economy and ultimately tourism-based livelihoods (Scott, McBoyle & Minogue, 2007). Scott et al. (2008) state that climate change will have far reaching consequences for tourism businesses and destinations. This holds true for dive operators, since dependence upon specific coral reefs creates an inherent inflexibility for their business (Marshall et al., 2009). It is therefore somewhat surprising that there are so few studies examining the impacts of climate change on reef-diving operators in regards to the future and sustainability of tourism (Timothy & Ioannides, 2002).

1.1 Significance of the Study

Operators, if consulted at all, have been asked in conjunction with tourists about coral bleaching (see Gössling, et al., 2008; Dearden, Bennett and Rollins 2006 and Cesar, 2000). There is little work published on dive operators opinions and perceptions of coral bleaching and it is important to study this topic because dive operators apparently stand to lose much from these recurring mass bleaching episodes because their business is dependent upon healthy reefs. Their experience with the reefs also gives them a unique perspective on climate change and its effect on both corals and their businesses.

Another issue raised by Gössling et al. (2008) and Davis and Tisdell (1995) states that tourists may not be able to comment about the healthy state of reefs since many are untrained

observers. Also, divers must have a reference point in time and space in order to compare a change in reef quality and health, and without this reference point their comments and opinions become irrelevant. However, dive-tour operators have a longer time frame and extensive experience with specific reef systems and should be able to compare changes over time. In this case, this research contributes to the growing body of literature on climate change and its effects on tourism, from the supply side of tourism, the dive-tour operator.

Gaps often occur in research on tourism and climate change in developing nations, in which tourism plays a large part in national economies (Scott and Becken, 2010; Scott et al., 2008). A great deal of dive tourism occurs in these areas, particularly in the Caribbean region. Therefore, examining dive operator perspectives' on coral bleaching will evaluate how such businesses are affected by changing climates and environmental conditions.

1.2 Purpose Statement

This thesis has an overall purpose with seven related research questions. The purpose of this research is to explore the perceptions, opinions and adaptation strategies of dive operators in the Caribbean regarding coral bleaching and its effects on their country, business and dive tourism.

1.3 Research Questions

1. What are operators' perceptions and opinions of past, present and future bleaching events?
2. How have coral bleaching events have affected dive operators' business?
3. How do operators perceive tourists' response to coral bleaching?
4. How are operators responding to this change of coral bleaching in comparison to other current and future business threats?

5. What strategies do dive operators feel are most effective in protecting coral reefs and their operations from coral bleaching?
6. What are some barriers operators' face when adapting to coral bleaching?
7. What avenues of communication operators use when acting on and obtaining information about coral bleaching?

1.3 Outline of the Study

The following section will provide a brief overview of the chapters in this thesis. Chapter 2 contains a literature review which provides a background for the study. It will discuss many topics, including dive tourism; tour operators; corals and climate change, and associated topics such as coral bleaching; sea surface temperatures; coral adaptations to bleaching; tourism in the Caribbean; small and medium enterprises in tourism; sustainable tourism; destination image; and tourism's relationship with climate change.

Chapter 3 provides details on data collection for the study. It provides a brief background on the methods and methodology, the research sites, the sample, data collection techniques and data analysis. The fourth chapter presents the results and discussion of the semi-structured interviews with Tobago dive operators. It also addresses data collection and some of the characteristics of the Tobagonian dive operators. The results this chapter discusses encompass the themes that arose during data analysis. These include: lack of government action, locals and reefs, bleaching and business and moving forward. This is followed by Chapter 5, which discusses the analysis and general results of the web-based survey which was sent out to dive operators Caribbean wide.

The final chapter provides an answer to each of the research questions guiding the study, as well as an overall conclusion to the study, with some observations. This is followed by some limitations and suggestions for future research.

CHAPTER TWO LITERATURE REVIEW

2.0 Introduction

The literature reviews a series of topics relevant to this research on dive tourism and coral bleaching. This chapter highlights and discusses the Caribbean region; Caribbean tourism; dive tourism; tour operators; coral reefs and tourism; the economic valuation of corals; coral reefs; climate change and coral reefs, and associated topics such as coral bleaching; sea surface temperatures; coral adaptations to bleaching; additional threats to reefs; coral resistance and resilience; tourism's relationship with climate change; destination image; sustainable tourism; and finally small and medium enterprises.

2.1 Caribbean Region

For this research, the Caribbean Region is defined as the countries that are listed in the Caribbean Tourism Organization's tourism statistics, as well as those that are listed as allied members on the CTO website. For a complete listing of countries please see Appendix A. The region has a population of 60 million people and is made up of countries that speak English, French, Spanish and Dutch, due to their history of European colonization (Daye, Chambers & Roberts, 2008). Please see Figure 1 for a map of the region.

2.1.1 Tourism in the Caribbean

The words Caribbean and tourism seem synonymous with each other, often conjuring up the image of pristine beaches, palm trees, and relaxation. Tourism is considered to be one of few limited options to develop economies and sustain individual livelihoods in the Caribbean (Burke & Maidens, 2004). Tourism started in the Caribbean in the late 19th century when people from around the globe began to visit the Bahamas and Jamaica (Wilkinson, 2009). But tourism was not prevalent in the region until the 1960s, when commercial airplanes and airports made islands

more accessible. This led to rapid growth in tourism economies (Gössling, 2003). Presently the Caribbean is seen as one of the most tourism dependent regions of the world and is considered a premier destination, attracting 7% of the world's tourist arrivals in 2004 (Bryant, 2007; Duval, 2004; Jayawardena, 2002).

Figure 1. Map of the Caribbean Region



Caribsave (2010)

With tourism being a major enterprise, its contribution to Caribbean economies must be emphasized (Wilkinson, 2009; Bryant, 2007). In 2010 the travel and tourism industry was expected to account for 12.8 % (US\$39.4 billion) of the area's gross domestic product, while it was expected to employ 10.8 % of the population (1,829,000 jobs) (WTTC, 2010). The statistics presented above reveal how dependent the area is on the travel and tourism industry, and if the industry were to decline, the people involved would surely experience some level of hardship (Haywood & Jayawardena, 2004).

The reason tourism has become so prominent in the economies of Caribbean nations is that other exports in the region, such as agriculture, have declined, and tourism has the greatest potential to create employment, expand GDP, attract capital investment and increase foreign

exchange earnings (Bryant, 2007; Duval, 2004; Jayawardena, 2002). The reason tourism is the dominant economic force is that the other more traditional sectors of agriculture, mining and manufacturing have become stagnant as Caribbean nation's preferred status with former colonial nations collapsed (Bryant, 2007; Jayawardena, 2002). The primary tourism market for the Caribbean is North America, predominantly the United States, followed by Europe (CTO, 2009; Daye, Chambers & Roberts, 2008).

As climate change is supposed to affect coastal areas on a greater scale than other land based locations, coastal tourism, which drives much of Caribbean tourism, may experience more hardships than other forms of tourism. This includes two of the fastest growing sectors in the industry and region, scuba diving and snorkeling, as well as tourism focused on those who prefer to sit or swim at the region's numerous beaches (Spalding, 2004). This dependence on coastal resources means that the future of Caribbean tourism is reliant on sustainable practices and environmental conservation to maintain the natural features that attract tourists. If they are not conserved or protected the industry on which the region depends could falter (Duval & Wilkinson, 2004). Also, because the travel and tourism industry is competitive and sensitive to slight fluctuations in world markets, which could result from climate change or political instability, the loss of its economic contributions to Caribbean nations would be devastating (Haywood & Jayawardena, 2004).

2.2 Dive Tourism

As a growing sport, scuba diving's popularity is expected to continue (Dimmock, 2007; World Tourism Organization, 2001; Davis & Tisdell, 1995). This means a potential economic boost for dive tourism. The United Nations World Tourism Organization (UNWTO) describes dive tourism as "persons travelling to destinations with the main purpose of their trip being to

partake in scuba diving” (p. 85). The attraction of the destination is almost exclusively related to its dive qualities rather than any other factor, such as the quality of the accommodation or land based attractions (WTO, 2001, p. 85).

Because dive tourism can only occur in certain locations across the globe, it is important to realize that if the sports' growth and development is to continue, care must be taken to conserve the locations divers find most appealing. In comparison with tourism in general, dive tourism typically occurs along the coasts of tropical countries, and these marine areas are limited (Orams, 1999; VanTreeck & Schumacher, 1998). Although marine areas are within what seems like a vast expanse of ocean, the marine environments that are targeted are relatively small, covering a mere 0.3 % of the total ocean surface, making them a finite resource (WTO, 2001; Orams, 1999).

Dive tourism is a high value product, as divers, often travelling to unique locations, typically spend 60-80% more than other tourists (Burke & Maidens, 2004). Not only do the divers spend money diving, they also spend money on non-diving goods and services including accommodation, dining and various forms of entertainment such as shopping and visiting cultural attractions (Tabata, 1992). Burke and Maidens (2004) suggest that on average a diver visiting the Caribbean spends US\$2,100 per visit, compared to the average tourist who spends US\$1,200.

2.2.1 Dive Tourism in the Caribbean

Dive tourism in the Caribbean plays a role in the region's tourism industry, and forms the basis of many nations' economies because it is seen as a profitable activity and an important niche market (Hawkins et al., 1999; Birkeland, 1997). For instance, in 1998 the Caribbean attracted about 57% of the world's divers, and it was forecast that in 2005 dive tourism would

generate US\$1.2 billion annually (Caribbean Latin American Action 1998 as seen in Cesar, 2003). To further illustrate dive tourism's importance, in 1993 the Cayman Islands generated US\$280 million from tourism and of this, US\$84 million was spent by dive tourists for both diving and non-diving activities (Madigan Pratt & Associates, 1995).

2.2.2 Diver Characteristics

This section covers some of the characteristics of divers certified with the Professional Association of Diving Instructors (PADI). PADI was chosen since it is the largest dive certification organization worldwide and has been certifying divers, dive instructors and giving PADI 5 Star Resort designation since 1966 (PADI, 2010). As of 2008, PADI had certified 17,532,116 divers since its inception (PADI, 2010). From the years 2002 to 2008, the average age of males taking their certification was age 30 and for females it was 27, for an average age of 29 (PADI, 2010). The highest percent of continuing education certifications occur in the Americas with 29%, with Europe second at 20%. The highest number of entry level certifications is in the Americas with 34% and Asia Pacific with 24 % (PADI, 2010). It should be noted is that once obtained, certification does not expire and there is no requirement for upgrade beyond the entry level certification (David & Tisdell, 1995).

In 2000 a study was conducted by The Leisure Trends Group on the American scuba diving market. These results are included here, as the Caribbean is one of the most popular regions for American divers to visit, with 85% of trips sold by retailers being to the Caribbean (The Leisure Trends Group, 2000). It was found that of those divers surveyed, 87% of them took a week or longer resort package holiday on their latest trip (The Leisure Trends Group, 2000).

2.2.3 Types of Divers

Within dive tourism, there are various types of divers with different preferences, along with different types of dives that may occur. There are generally three types of dives. According to Zakai and Chadwick-Furman (2002) these consist of an introductory dive, which is an uncertified diver being guided by a diving instructor, followed by course dives, with a student in an open water course, and finally a guided dive which is certified divers being guided by a diving instructor or a dive master.

As for the various types of divers and their preferences, this varies depending on the location. In Phuket, Thailand and El Nido, Philippines more specialized divers care more about the dive site quality and much less about the dive master and the other activities being offered, and as such are often disappointed by the state of the selected dive sites (Dearden, Bennett & Rollins, 2006; Cesar, 2000). Those who partake in holiday or resort diving are defined by Gössling et al., (2008) as “divers with little knowledge of the state of the local environment” (p. 88). This type of diver is a growing component of the industry, which may be beneficial as diving destinations are exposed to various climatic and environmental changes, as these divers often are diving for the first time and wish to gain dive experience and are less concerned about the pristine environmental conditions (Gössling et al., 2008; Davis & Tisdell, 1995).

2.2.4 Important Dive Site Characteristics

For divers, there are important attributes that constitute an ideal dive site. The World Tourism Organization (2001) found that divers look for five attributes when assessing a dive site: “clear water, good visibility, plenty to do and see underwater, good diving facilities (close to dive sites and lodging) and dive centre staff who speak the diver’s language” (p. 86). Other studies found that divers prefer sites that have a natural reef in good condition, a variety of fish

and other marine life, adventure, excitement and good visibility (Ditton, Osburn, Baker & Thailing, 2002; Mundet & Ribera, 2001; Ngazy, Jiddawi & Cesar, 2000). Pendelton (1994) found that environmental quality, the topography of the site and travel times to the site were key factors in predicting divers' use of the area. Finally, Uyarra, Watkinson and Cote (2009) found that the level of enjoyment the divers experienced was dependent on the site conditions and the diver's recollection of the site. In summary, divers prefer sites with good visibility, much to do and see, and reefs that are in good condition and are a reasonable distance to travel to.

2.2.5 Diver Impact on Reefs

Much diving occurs in marine protected areas, making management in the tourism industry extremely important for protecting natural areas because “the production and consumption occur at the same time and divers may directly cause the damage” (Lindgren, Palmlund, Wate & Gössling, 2008). It is often seen as the operator's role to monitor and correct the behaviour of divers (Lindgren, Palmlund, Wate & Gössling, 2008).

Various studies found that contact with the corals was the most predominant type of reef damage caused by divers (Worachananant, Carter, Hockings & Reopanichkul, 2008; Barker & Roberts, 2004; Zakai & Chadwick-Furman, 2002; Roupheal & Inglis, 1997; Harriot, Davis & Banks, 1997; Medio, Ormond & Pearson, 1997). For example, two studies done in Australia by Roupheal and Inglis (1997) and Harriot, Davis and Banks (1997) found that 97% and 78%, respectively, of the damage they observed was from diver fins, though the damage was thought to be unintentional. The majority of the damage was done by inexperienced divers, and as the number of logged dives increased the damage per person decreased (Worachananant, Carter, Hockings & Reopanichkul, 2008). Some of the damage witnessed during observation was

broken coral fragments, especially on branching corals (Worachananant, Carter, Hockings & Reopanichkul, 2008; Roupheal & Inglis, 1997; Harriot, Davis & Banks, 1997).

There have been many suggestions to minimize diver damage to coral reefs. Some suggestions range from more diver education to limiting the number of dives per reef per year. A less popular suggestion is to have areas designated according to experience level. For example, Worachananant, Carter, Hockings and Reopanichkul (2008) suggest that if reducing contact with coral is “desired then beginner divers should be confined to sites dominated by resistant coral species and as they increase in experience sites dominated by fragile coral types may be made available with less risk of damage to the corals” (p. 660). Perhaps the most popular suggestion is that of diver education, which would inform divers of their responsibilities in a briefing before heading out to the dive site (Worachananant, Carter, Hockings & Reopanichkul, 2008; Barker & Roberts, 2004; Zakai & Chadwick-Furman, 2002; Medio, Ormond & Pearson, 1997). However, this educational approach can only be implemented if there is cooperation between the operator, their employees, and the divers themselves (Worachananant, Carter, Hockings & Reopanichkul, 2008). To summarize, Zakai and Chadwick (2002) have compiled the following recommendations to help alleviate diver stresses on coral reefs: limiting the annual number of dives that occur on reefs; requiring that all dives be led by guides; that training courses and introductory dives take place away from fragile reefs; that recreational pressure be transferred to artificial reefs; and finally to improve the educational component of dive certification courses by having divers take sessions on how to behave around coral reefs.

2.2.6 Dive Tourism and Marine Protected Areas

Dive tourism often relies on marine protected areas (MPA) for its operations, as these are usually the most pristine dive sites (Harriott, Davis & Banks, 1997; Davis & Tisdell, 1995). Often dive operators have a permit which allows them to utilize the area, which also serves to regulate the operators (Davis & Tisdell, 1995). In New South Wales (NSW), Australia, divers pay dive operators a fee and the money is returned to the NSW Fisheries department and is seen as a contribution to management and research (Harriot, Davis & Banks, 1997). In Saba, a Caribbean nation, the money collected by the dive operators allows park management to keep a record of how many dives have occurred and where in the park they took place (Hawkins, Roberts, Kooistra, Buchan & White, 2005). With dive tourism becoming more popular and with much of the activity taking place in MPAs dive tourism can be seen as one way to finance these protected areas (Fabinyi, 2008).

For many operators MPAs are valuable, as many allow for recreational use alongside conservation (Harriott, Davis & Banks, 1997). However, there are also some mixed feelings about MPAs from operators. Some dive operators in the Philippines feel that MPAs are created for monetary gain and there is little “incentive to actually protect the area and the ‘conservationist spin’ that was placed on the project was nothing more than a sham hiding the desire on the part of local government and communities to make money out of the dive tourism industry” (Fabinyi, 2008, p. 902). Again these Philippine operators see the development of MPAs as the government looking for ‘easy money’ and not actually caring about conservation (Fabinyi, 2008).

Another issue with the establishment of MPAs is that they can attract increasing numbers of visitors which may lead to overuse and a reduction in the attraction value (Harriott, Davis &

Banks, 1997; Hawkins & Roberts, 1997). This is the issue faced by dive operators who are competing in a business environment and who need to generate profit and provide value to their clients while at the same time protecting the natural site (Dimmock, 2007). It is seen by Done (2001) that it is in the best interests of the operators to practice ecological sustainability in their practices because high quality natural resources are essential if businesses are to prosper.

With many user groups vying for use of the MPAs, there will be competing ideas as to what should and should not be occurring within its boundaries (Dimmock, 2007; Davis & Tisdell, 1995). For example, local fishers may not agree with dive operators using the area because it may reduce the amount of fish they are able to harvest.

2.3 Tourism Operators

Dive tourism operators provide services to a niche market, catering to those who come to an area to partake in diving activities. Dive operators are defined by Tabata (1992) as those “which have a retail store offering a variety of services, including tours and dive tour operators who principally offer shore or boat dives” (p. 175).

For dive tourism providers and tourism providers in general, the idea of partnerships and cooperation is more attractive, as the tourism offerings are becoming more numerous and varied (Haywood & Jayawardena, 2004; Jayawardena, 2002). The consensus is that stand alone strategies are no longer a viable way to operate, and that the most attractive offerings to tourists consist of different businesses contributing to one package deal (Haywood & Jayawardena, 2004).

Not only do tour operators need to collaborate with other aspects of the tourism industry, they are being forced to turn their attention to becoming experience providers which are anticipated to create memories and increase the return customer base (Dwyer, Edwards, Mistills,

Roman & Scott, 2009). Along with the role of becoming experience providers, operators are perceived to either strengthen or weaken the destination's brand and value creation (Haywood & Jayawardena, 2004).

Tourism providers must also play a role in promoting sustainable tourism through awareness of environmental problems and by taking steps to help protect finite coral resources (Curtin & Busby, 1999). Small operators can act as a link between tourists and the local community, making this type of enterprise critical to achieving sustainable tourism (Horobin & Long, 1996). However, to achieve this sustainability, the destination as a whole, as well as all of its operators, must subscribe to sustainable principals through conduct and business practices (Dwyer, Edwards, Mistills, Roman & Scott, 2009). It is only logical that operators commit to sustainable practices for themselves and future tour operators of the area, because once the finite coral resource has deteriorated and lost attractiveness, the recovery of the destination may be long, or non-existent (Jayawardena, 2002).

Operators in Thailand are fearful that the dive industry there will become overrun with recreational divers who care much less about site quality. This will cause the various operators to undercut each other to capture this business, eventually leading to the down fall of the industry. Therefore operators are looking to concentrate on highly specialized divers who spend more money and time at a destination (Dearden, Bennett & Rollins, 2006). However, in the Philippines, the resorts are focusing on honeymooners and less experienced divers because of a poor image as the result of coral degradation (Cesar, 2000).

In a study done by Dimmock (2007) on New South Wales, it was found that for all dive managers contacted, routine travel destinations were an "essential and fundamental" part of their operations (p. 74). This finding seems consistent throughout other studies, as dive operators

seem to form a habit, preferring to visit the same sites on a continual basis. In Saba, a study done by Hawkins, Roberts, Kooistra, Buchan and White (2005), found that “dive operators were very conservative in their movements and normally took divers to the same places” (p. 377). In Hawaii, Tabata (1992) conducted a study to ascertain operators' dive site preferences, and found that the operator generally decided that the sites to be visited coincided with the experience of the divers, leading one to believe the every time a group of beginner divers came aboard they would be visiting the same site as the previous groups of novice divers. Generally, operators utilized sites that were favourable to both novice and experienced divers, but there is a need to understand why dive operators choose or show preference to certain sites (Tabata, 1992).

One final issue that is addressed here is that of climate and environmental change in relation to dive operators, as they are the group that stands to lose much from this phenomenon. For the cases presented in this section, the dive operators were sampled alongside divers. It was pointed out by Gössling Hall and Scott (2009) that “all tourism businesses and destinations will need to adapt to climate change in order to minimize associated risks and capitalize upon new opportunities, in an economically, socially and environmentally sustainable manner” (p. 110). Dive operators and organizations can be one of the first to point out the change in the marine environment and they can become informants to the public, government and their constituents (Lindgren, Palmlund, Wate & Gössling, 2008). As well, these organizations can raise awareness in hopes of implementing change at the individual, regional, national or international level (Lindgren, Palmlund, Wate & Gössling, 2008).

When discovering how concerned tourism operators are with climate change, Scott et al, (2008) found that generally there are low levels of concern and minimal planning to combat its coming effects. One reason for this may be that the alterations associated with climate change

may come at a rapid pace, leaving little time for operators to implement gradual and perhaps expensive adaptation strategies (Dwyer, Edwards, Mistills, Roman & Scott, 2009).

Finally, in a study done by Gössling et al.(2008) in Mauritius they found that dive operators did observe changes, but they felt that the changes would not be detrimental to the dive industry, nor did they believe that dive tourists would be disappointed because they would not know what was previously there and what they could have seen. However, hope remains with dive centers that have existed for a longer period of time and have been run by the same people, as they have developed a sense of place and understanding of the threats to reefs, often leading to a “greater interest in and engagement with environmental management” (Lindgren, Palmlund, Wate & Gössling, 2008, p.134).

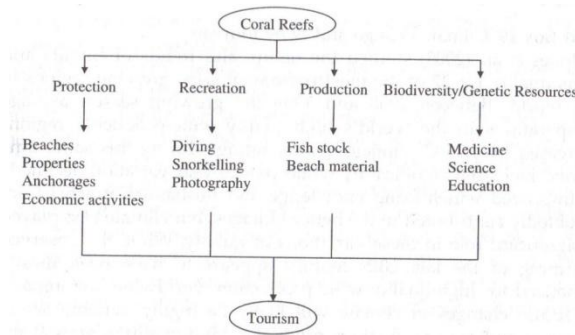
One area where climate change may benefit some and be unfortunate to others in competing for patrons is the extent to which climate change affects other competing destinations (Scott et al., 2008). Different tourism approaches to commonly visited areas will result in shifts in the way competition is waged in the tourism industry. The vulnerability and natural beauty of coral reefs will make them a significant area of concern for people and organizations throughout the tourism industry.

2.4 Coral Reefs and Tourism

The relationships between coral reefs and dive tourism are extensive (see Figure 2). There are many concerns associated with the use of corals for tourism and the following section will seek to address some of them. One issue is that there is really no environmental price paid by divers for visiting a reef, and what tourists do pay is quite cheap. This undervaluing of the resource may lead to over use and further degradation (Davis & Tisdell, 1995). If deterioration in reef quality reduces the reef’s ability to provide services where necessary, this could result in

negative social and economic impacts (Marshall & Schuttenberg, 2006). However, these impacts are dependent on the tourists' level of awareness and the appearance of the reef (Marshall & Schuttenberg, 2006).

Figure 2. Tourism dependencies on coral reefs



Source: Jackson (2002)

One of the most obvious concerns is that of coral reef degradation resulting from environmental change (WTO, 2001). As well, the stress the tourists themselves place on the reefs is also a cause for concern, as tourism-related activities, especially dive tourism, can be a contributing factor to coastal and marine habitat degradation, which impacts coral reefs, mangroves and seagrass (Craig-Smith, Tapper & Font, 2006; VanTreeck & Schumacher, 1998). The depletion of reefs and other marine resources can potentially affect tourism, especially in regards to those tourists who come specifically to see the reefs (Craig-Smith, Tapper & Font, 2006). Coral damage as a result of scuba diving could be detrimental to some, because in order to limit the damage one strategy would be to limit or restrict divers, which would not be cost-effective for business (VanTreeck & Schumacher, 1998). If this environmental damage continues coral reefs will lose the numerous species they are home to, many of which are often specific attractions for divers. Therefore, the link between coral reefs and dive tourism is prominent (Burke & Maidens, 2004; VanTreeck & Schumacher, 1998).

Although dive tourism is growing, there is concern that it is contributing to the degradation of coral communities, both biologically and aesthetically (Worachananant, Carter, Hockings & Reopanichkul, 2008). The biodiversity and visual appeal of tropical coral reefs in shallow water make them a major draw for tourism (Hawkins, Roberts, Kooistra, Buchan & White, 2005). As a result of corals being a major attraction, it is important that they are managed effectively in order to maintain their aesthetic appeal (Tratalos & Austin, 2001). If diving goes unmanaged, coral could be compromised and lose their value as a dive site (Hawkins et al, 1999; Davis & Tisdell, 1995). Although corals can be a draw for tourism, tourism can also be a threat to reefs. In addition to the negative impacts of dive tourists, the impact of tourism infrastructure development on nearby land can also place harmful effects on reefs (Jobbins, 2006).

However, should the quality of the reefs deteriorate, the satisfaction of tourists may decline, which may have negative impacts on local tourism businesses (Marshall & Schuttenberg, 2006). The deterioration of the reefs may also induce a 'last chance' type of tourism, where visitors come to see the reefs before they 'disappear' (Eijgelaar, Thaper & Peeters, 2010; Lemelin, Dawson, Stewart, Maher & Lück, 2010). The deterioration of reefs may also have the opposite effect, and tourists may come for a different purpose, that being to come and see the reefs before they 'disappear' (Andersson, 2007).

2.5 Economic Valuation of Reefs

Many coral reefs have become prime tourist destinations and as a result they became an economic resource (Buddemeier, Kleypas & Aronson, 2004). Not only are these reefs a valuable ecosystem for nature, they are also a source of food, income and protection for the people who depend on them (Cesar, Burke & Pet-Soede, 2003; Moore & Best, 2001). Some of the goods and services reefs provide include tourism, fisheries and pharmaceuticals (Cesar, Burke & Pet-Soede,

2003; Moore & Best, 2001). Cesar, Burke and Pet-Soede (2003) project that on an annual basis coral reefs across the globe provide goods and services worth US\$30 billion a year, which is substantial, considering they cover less than 1% of the earth's surface. Of this US\$30 billion, tourism and recreation contributes approximately US\$9.6 billion (Cesar, Burke & Pet-Soede, 2003). Of course, it is integral to understand what the economic benefits of coral reefs are and what may be at stake financially as these reefs continue to be affected by change (Hoegh-Guldberg, 2004).

2.6 Coral Reefs

Coral reefs have been called the 'rainforests of the marine world' due to their biological productivity, species diversity, location in regions of poverty and high population growth rates, and their vulnerability to future degradation (Payet & Agricote, 2006; Hoegh-Guldberg, 2004; Bryant, Burke, McManus & Spalding, 1998; Birkeland, 1997; Paulay, 1997).

Coral reefs are unique ecosystems that are three dimensional shallow water structures composed of mainly reef-building corals that are both biological (the coral community) and geological (the reef structure) in nature (Bellwood, Hughes, Folke & Nystrom, 2004; Buddemeier, Kleypas & Aronson, 2004, Vernon, 2000). Often reefs are referred to as colonies, which simply refers to a "group of corals that is physiologically connected" (Lasker & Coffroth, 1999, p. 93). There are various types of colonies, such as:

- Branching colonies, which occur when branches are formed during growth
- Encrusting colonies, which are those that have thin colonies and are closely attached to the substrate
- Arborescent colonies, which are tree like in growth form
- Explanate colonies, which spread horizontally as the corals fuse into a solid plate

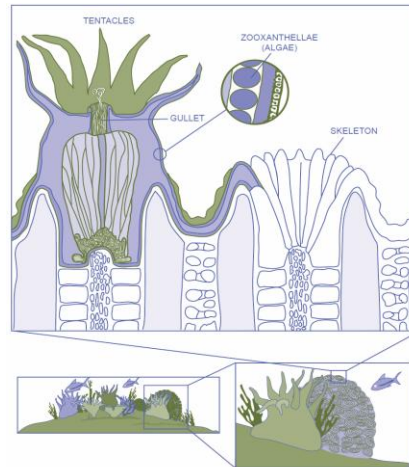
- Massive colonies, which are solid and are typically similar in dimensions in all directions (Vernon, 2000).

These colonies are built by thousands of coral polyps, and each of these polyps has a simple tube shaped body and circular mouth (Spalding, 2004). Polyps have no brain, but do have a nervous system, similar to a net, which helps them to control their body wall, which contains the muscles and tentacles (Spalding, 2004). Most of these polyps reproduce through budding, which occurs when the existing polyp splits in two and grows a new polyp on its side where both remain attached (Spalding, 2004). When there are many budding polyps, they combine their bodies together and build skeletons, eventually forming a reef (Spalding, 2004). When a polyp dies, another will grow in its place by attaching itself to the older skeleton (Spalding, 2004). See Figure 3 for a visual representation of a typical reef building coral.

This next section is a very brief synopsis of the relationship corals have with their live-in partner zooxanthellae. The reef itself is constructed of limestone, which is secreted as a very thin material by corals (Buddemeier, Kleypas & Aronson, 2004). The reefs themselves are made up of reef-building corals that live as one with a single-celled microalgae called zooxanthellae (Grimsditch, & Salm, 2006; Buddemeier, Kleypas & Aronson, 2004). The zooxanthellae provide up to 95% of the corals' carbon requirements, as well as most of their colour (West, 2001). This relationship between the zooxanthellae and the coral itself is mutually beneficial, as the coral obtains food from photosynthesis, and the zooxanthellae survives from the nutrients released into the water by the coral. This mutual benefit is believed to be the reason for such rapid growth in corals (Grimsditch, & Salm, 2006; Buddemeier, Kleypas & Aronson, 2004). Although individual corals may grow quickly, the reef itself builds slowly like a mountain range,

which is built over a substantial period of time, with the most active part of the reef only growing four metres in 1,000 years (Spalding, 2004).

Figure 3. A Typical Reef Building Coral



Source: Buddemeier, Kleypas & Aronson, 2004

The most common type of reef found along coasts is a *fringing reef*, which occurs when corals have built up shallow platforms in the brightest waters near land, where the outer edge of the reef is slightly steeper. This is where the most active growth on the reef occurs (Spalding, 2004; Spalding, Ravilious & Green, 2001, Vernon, 2000). A second type of reef is a *barrier reef*, which lies offshore and is separated from the land by a lagoon (Spalding, 2004; Spalding, Ravilious & Green, 2001, Vernon, 2000). Barrier reefs are usually on the edge of a continental shelf facing deep water (Spalding, 2004; Spalding, Ravilious & Green, 2001, Vernon, 2000). An example of such a reef is Australia's Great Barrier Reef, which is located along Queensland coast off the eastern side of Australia. *Bank barrier reefs* are similar to barrier reefs, except they are long reefs that are offshore and lack the deep lagoon that runs between the reef and the shore (Spalding, 2004; Spalding, Ravilious & Green, 2001, Vernon, 2000). This type of reef is more common in the Caribbean (Spalding, 2004; Spalding, Ravilious & Green, 2001). *Coral atolls* are "ringed shaped reefs surrounding a lagoon found rising up from deep oceanic water" (Spalding,

2004, p. 15). Like atolls, *bank* or *platform reefs* rise from “deep oceanic waters, but lack clear circular structures” (Spalding, 2004, p. 15). In the Caribbean, these are more common than true atolls (Spalding, 2004). Finally, there are *patch reefs*, which are reefs in shallower water that are sometimes found in areas where ringed or barrier reefs are also located (Spalding, 2004; Spalding, Ravilious & Green, 2001, Vernon, 2000).

Each type of reef generally consists of nine zones. These include: a *Reef Lagoon*, which is a body of water reaching two to three meters deep and is enclosed between the land and offshore coral reef (Spalding, 2004). These can have muddy or clear water, and often support seagrass beds (Spalding, 2004). A *shoreline reef* may be sandy, rocky or even muddy, while a *back reef* is the area on the short slope from the lagoon up to the reef flat (Spalding, 2004). A *patch reef* rises up in clearer lagoon waters, where calm conditions allow the growth of large and intricate coral formations (Spalding, 2004). *Reef flats* consist of a shallow band running from the shore which has been built by corals, and may be dominated by bare rocks, sand patches, and seas grasses, where at times a few corals are found (Spalding, 2004). The *spur and groove* exists on many reefs where “there is moderate to strong wave action, and the shallower part of the reef slope may be deeply incised with channels (grooves), running between high buttresses (spurs)” (Spalding, 2004, p. 16). A *reef crest*, the shallowest part of the reef, is often marked by breaking waves, and the *reef front, reef slope or fore reef* is beyond the reef crest where the coral slopes down into deeper water. This is where the greatest concentrations of life are found (Spalding, 2004). The ninth zone of the reef is the *reef wall*, which is a reef slope that ends abruptly with a “very steep to vertical wall of rock, falling to depths of 100 meters or more” (Spalding, 2004, p. 16).

2.7 Coral Locations

Warm, shallow, coral reefs are concentrated in tropical areas around the globe such as Australia, the Caribbean, Indonesia, Mexico, the Southern United States and various parts of the African continent (Spalding, 2004). Corals are found in over 100 countries, mostly in the less economically developed tropical regions at depths of less than 100 metres, where they co-exist with large human populations who occasionally lack the financial resources to manage them. (Moore & Best, 2001; Birkeland, 1997; Wilkison & Buddemeier, 1994). Throughout these 100 countries, coral reefs are supporting “at least a million described species of animals and plants, and another 8 million coral reef species are estimated to be as yet undiscovered” (Moore & Best, 2001, p. 5).

2.7.1 Caribbean Reefs

The Caribbean is one of the regions of the world that is home to coral reefs, and with its “long continental coasts and broad scattering of islands, is one of the great centres of coral reefs” (Spalding, 2004, p. 11). There is an estimated 26,000 square kilometres of coral reefs located in the Caribbean region, which together with the Atlantic regions account for 7.6% of the world’s coral total (Burke & Maidens, 2004; Spalding, Ravilious & Green, 2004). The most commonly occurring reef structures are bank barrier, fringing, and patch reefs, although barrier reefs occur off Belize and the Bahamas, and atoll-like structures are found in Belize (Glovers Reefs), the Bahamas (Hogsty Reef) and Venezuela (Los Roques) (Wilkinson & Buddemeier, 1994).

This region is home to the Mesoamerican Reef, the largest reef in the Americas and only second in size in the world after Australia’s Great Barrier Reef (World Wildlife Fund (WWF), 2010). The reef spans 1,000 kilometres from the northern tip of Mexico’s Yucatan Peninsula, along the coast of Belize and Guatemala, finally ending in Honduras (WWF, 2010).

The Caribbean has also been labelled a “biodiversity hot spot”, meaning it is an area of high species richness that is also under high threat (Bryant, Burke, McManus & Spalding, 1998). Globally, the Caribbean is a large hotspot, with approximately 18% of Caribbean reefs exhibiting high coral reef fish species counts that are at high risk (Bryant, Burke, McManus & Spalding, 1998).

Most of the coral in the Caribbean are colonies, meaning they are built by thousands of coral polyps, and because of this connectivity a threat to one reef area can become a threat to many (Burke & Maidens, 2004; Spalding, Ravilious & Green, 2004). Buddemeier, Kleypas and Aronson (2004) have mentioned that “the Caribbean region has been particularly hard hit by problems” (p.5). One problem is the small geographical size of the Caribbean, which puts the coral reefs at particular risk from the threat of expanding human populations and resource exploitations (Wilkinson & Buddemeier, 1994).

2.8 Climate Change and Coral Reefs

There is now no doubt that climate change will cause further degradation to coral reef communities in some locales (Buddemeier, Kleypas & Aronson, 2004). Tropical coral reefs are the most sensitive marine ecosystems in the world to climate change, and they are already being degraded as a result (Wilkinson & Souter, 2008). The following sections discuss those climate change issues that are the most threatening to coral reefs, such as coral bleaching, an increase in sea surface temperatures (SST) and ocean acidification (Simpson et al, 2009; Wilkinson & Souter, 2008; Mimura et al., 2007). As well, the other impacts to corals as a result of climate change are discussed, including coral disease, tropical storms and sea level rise (Wilkinson & Souter, 2008; Mimura et al., 2007; Aronson & Precht, 2006). These climate change issues are each independent threats, yet when they act in unison the damage to coral reefs can be quite

severe (Simpson et al, 2009; Buddemeier, Kleypas & Aronson, 2004). These climate change impacts can be categorized in to acute and chronic stresses. Acute stresses are short-term events, like tropical storms, while chronic stresses act over a longer period of time and are associated with more gradual degradation, such as sea level rise (Buddemeier, Kleypas & Aronson, 2004).

2.8.1 Coral Bleaching and Sea Surface Temperature

Coral reef bleaching is often associated with high sea water temperatures, a loss of zooxanthellae, the impairment of reproductive capacity, and at times the onset of diseases (Burke & Maidens, 2004). Over the last three decades, the intensity and frequency of bleaching episodes has increased, and has been reported from almost every tropical and subtropical region that supports coral reefs, leaving no region safe from bleaching (Baker, Glynn & Bernhard, 2008; Donner et al., 2005). In the Caribbean, reef bleaching is seen as the most predominant and visual threat from climate change (Burke & Maidens, 2004).

Increasing sea surface temperatures are seen as the primary trigger for coral bleaching (Hoegh-Guldberg et al., 2007; Salm, Smith & Llewellyn, 2001; Fitt, 2001; Hoeght-Guldberg, 1999; Brown, 1997; Glynn, 1993; Atwood, Hendee & Mendez, 1992). In fact, Burke and Maidens (2004) and Baker, Glynn and Bernhard (2008) show that each bleaching episode that has been observed coincided with increases in sea temperatures and thermal anomalies, which once again reiterates how important it is to reduce the stress on coral reefs. Bleaching events typically occur when sea surface temperatures (SST) exceed the maximum monthly mean, which is described as the “climatological mean temperature during the warmest month of the year by 1 degree or more for 1 month or more” (Donner, Knuston & Oppenheimer, 2007). If the exposure to high temperatures is over a short period of time, about two to three days, the bleaching can be triggered if the temperature is 3 to 4°C above the coral’s thresholds (Brown, 1997). However, if

it is a prolonged period of time, such as several weeks, an elevation of 1 to 2°C can trigger a bleaching event, and it is these extended bleaching episodes that impact coral physiology and life expectancy (Spalding, 2004; Hoegh-Guldberg, 2004; West, 2001; Brown, 1997).

Coral bleaching can be defined as an expulsion of zooxanthellae (the algae that lives with the corals) and the loss of pigment (Wilkinson & Souter, 2008; Baker, Glynn & Bernhard, 2008; McWilliam, Cote, Gill, Sutherland & Watkinson, 2005; Glynn, 1996; Glynn, 1993). Iglesias-Prieto et al. (1992) note that the photosynthesis in the zooxanthellae seems to be impaired above 30°C and ceases to function at 34 to 36°C (as cited in Jokiel, 2004). With coral bleaching, the damage starts with the photosynthetic apparatus, before there is a loss of zooxanthellae, meaning that the growth of corals may be stunted (Jokiel, 2004). Bleaching events speed up the photosynthesis mechanisms in corals, meaning production is faster than coral and zooxanthellae can repair the damaged systems, which causes the coral to eject the zooxanthellae from its body because it sees it as invasive algae (Eakin, 2010). This is the proximate cause of the whitening of the coral, and thus the coral bleaching. For this thesis Jokiel's (2004) definition will be used, which states that:

coral bleaching occurs when environmental conditions disrupt the symbiosis leading to the degeneration and/or expulsion of zooxanthellae from the coral host. As a result of photosynthetic pigment loss, the white skeleton becomes visible through the transparent coral tissue, giving the organism a “bleached” white appearance (p. 401).

The corals that are usually the most susceptible to bleaching are those on the upper water levels near the surface, which are subjected to higher temperatures, rather than those in the lower colonies (Baker, Glynn & Bernhard, 2008; Coles, 2001). The link between high temperatures

and coral bleaching raises concerns that climate change and the anticipated continuation of increasing temperatures could lead to an increase in the frequency and severity of coral bleaching events in shallow waters (Hughes et al., 2003; Hoegh-Guldberg, 1999).

One consequence of coral bleaching that has many concerned is the reproductive capabilities of corals after a bleaching event. Hoegh-Guldberg (1999) noted that in field and laboratory research severe bleaching can reduce the reproductive capacity. If reproduction is diminished or lost with bleaching and bleaching events are expected to increase, the future of coral reefs is bleak. During a bleaching event, Glynn (1996) suggests that corals may lose up to 60 to 90% of their zooxanthellae and 50 to 80% of their photosynthetic pigments

Since increasing SST is one of the stressors, the direct measurement of temperature can be used to predict bleaching events. The combination of rising sea surface temperatures with other stressors, such as ocean acidification and pollution act as some of the greatest threats to corals and coral reefs (Bruno et al., 2007). As a result SST has become one of the key indicators for predicting bleaching events.

2.8.2 Ocean Acidification

In addition to coral bleaching, ocean acidification is another major threat to coral reefs. It occurs as a result of a change in atmospheric chemistry due to the rising level of CO₂ in the atmosphere. When atmospheric carbon dioxide dissolves in seawater, it lowers the water's pH level, impacting marine ecosystems like coral reefs (Baker, Glynn & Bernhard, 2008; Wilkinson & Souter, 2008). This can have implications for the tourism industry, as businesses depend on dive tourists being able to see healthy reefs. The changes in ocean acidity is expected to vary from region to region, with areas like the Great Barrier Reef and the Caribbean Sea reaching

critical levels faster than others (Hoegh-Guldberg et al., 2007). This ultimately means that calcification rates will go down.

The biggest problem associated with increased acidification is a decrease in coral calcification rates. This increase in “atmospheric CO₂ poses a threat to coral reefs by causing changes in global seawater chemistry, decreasing the concentration of carbonate ions and thus leading to decreases in coral calcification rates, growth rates and structural strength” (Grimsditch, & Salm, 2006, p. 8). A study on Australia’s Great Barrier Reef corals found that calcification rates had decreased 14% since 1990 (De’ath, Lough & Fabricius, 2009), while Hoegh-Guldberg et al. (2007) found in experimental studies that a “doubling of preindustrial carbon dioxide to 560 ppm decreases coral calcification and growth by up to 40%” (p. 1737). Calcification forms the base of the entire reef structure, meaning that the very foundation on which reefs rest may be in jeopardy. This will have tremendous implications for tour operators and tourists alike.

The implications of reduced calcification in reefs are that there will be a reduction in terms of habitat quality and diversity, along with the reefs' ability to absorb wave energy, which is instrumental for coastal protection (Hoegh-Guldberg et al., 2007). This lack of habitat is detrimental to coastal populations, as fish species may decline and the reefs they depend on for protection and livelihood could be substantially diminished.

According to Cohen et al. (2009) corals may react to ocean acidification in many different ways, including growing or extending at a slower rate; extending at the same rate, but having their skeletal density decrease, leaving corals more susceptible to damage from other stressors; and finally they may redirect their energy from tissue growth or reproduction in order to maintain calcification rates.

2.8.3 Sea Level Rise

Although not a predominant effect of climate change on corals, sea level rise may play a role in depleting some reefs. There are varying opinions when it comes to corals and sea level rise. Brown (1997) believes that reefs can keep pace with the predicted sea level rise, stating that reef growth rates will range from 1 to 10 mm per year, with 10 mm be the absolute most they can grow in a year, which should be satisfactory in order for the reefs to remain competitive. The current rate of growth for corals is 3.4mm per year (Wilkinson & Souter, 2008). The Intergovernmental Panel on Climate Change (IPCC) (2001) notes that this growth rate may not be enough, and that some reefs may even drown because of a lack of light due to the amount of water above them, which decreases the amount of light reaching them. And finally, there are those that say it depends on the rate and extent of sea level rise and other stressors like bleaching and disease, which will determine coral's adaptation to this sea level rise (Kleypas, McManus & Menez, 1999).

2.8.4 Coral Disease

Coral disease is another possible impact of climate change. This can be defined as an “impairment of an organism’s vital organ systems and/or body functions” (Weil, 2004, p. 36). This definition includes non-infectious diseases, under which bleaching is defined as a disease (Weil, 2004). There are also abiotic diseases, which impairs the structure and function of the coral body and leads to environmental stress, such as increased salinity and temperature (Peters, 1997).

Disease outbreaks are often associated with an increase in thermal stress. This rise in temperatures physiologically stresses the coral, which in turn makes the coral susceptible to disease, which may lead to an increase in coral cover loss (Miller et al., 2009; Bruno et al., 2007;

Hoegh-Guldberg et al., 2007; Fitt et al., 2000). These outbreaks do not necessarily have to be due to extreme rises in temperature, but can occur when temperatures are below those often cited as causing a bleaching onset. They, however, can also occur with especially high summer temperatures (Bruno et al., 2007).

Miller et al. (2009) found that corals recovering from a bleaching event are likely to be vulnerable to disease for several months, and with the ever increasing water temperatures occurring as a result of climate change enhancing the likelihood of coral bleaching events this may create a large coral population that is more sensitive to coral disease. Furthermore, while coral bleaching and coral disease are each considered individual threats to coral reefs, the combination of the two can have serious consequences for living coral (Miller et al., 2009).

2.8.5 Tropical Storms

Another effect of climate change comes from tropical storms. These storms are predicted to change in frequency, but there is indication that rising temperatures will increase tropical storm intensity (Knuston et al, 2008). One thing that has been associated with the increase in the number and intensity of tropical storms is the increase in air and sea surface temperatures (Knuston et al., 2008; Mimura et al., 2007; Shein, 2006). This increase in temperatures resulted in 2005 being one of the most active Atlantic storm seasons on record, with 28 tropical storms, including 15 hurricanes, occurring (Miller et al., 2009; Shein, 2006). The year 2005 was also the year of the worst mass bleaching event in the Caribbean, and with the corals being weakened by this event, and then subsequently being hit with a record number of storms, the slow recovery rate of Caribbean reefs has been a matter of concern, particularly since these events are predicted to become more frequent in coming years (Mumby, 2006). The increase in ocean acidification will also serve to weaken the coral reef structures (Vernon et al., 2009). While the coral reefs are

weakened by other climate change factors, like bleaching and ocean acidification, coastlines will be susceptible to the increased tropical storm waves and flooding. When reef structures are constantly being hit with stressors they may no longer be able to resist the impacts of the storms (Vernon et al., 2009; Wilkinson & Souter, 2008).

However, there is evidence that low to moderate power hurricanes can be beneficial to coral reefs, as they can draw cold water from the deep to the surface, limiting the time that corals are exposed to increased SST and potentially reducing the impacts of coral bleaching (Wilkinson & Souter, 2008; Riegl, 2007; West, 2001). Although there is evidence that an increase in tropical storm activity has negative implications for corals, some positive outcomes are possible. It is therefore important to examine the ability of corals to adapt to shifting environmental conditions brought on by both natural occurrences and as a result of human activity, as this may dictate a reef's resilience (Burke & Maidens, 2004).

2.9 Additional Threats to Reefs

Aside from the climate change related threats to coral reefs, these human induced threats also affect a reef's health and ability to survive. These impacts are all symptoms of an increasing human population (Wilkinson & Souter, 2008). Reducing these additional stressors to coral reefs is important for conserving the coastal ecosystems (O'Farrel & Day, 2006).

2.9.1 Pollution

Coral reefs need clear, clean water in order to thrive. Pollution hampers this. Many of the pollutants entering ocean waters are from human activity, which include litter, waste oil, agricultural runoff, such as fertilizers and animal waste, and untreated sewage and wastewater (ICRAN, 2010; Buddemeier, Kleypas & Aronson, 2004; Wilkinson and Buddheimer, 1994). It has been estimated by Souter and Linden (2000) that approximately 20% of the sewage

generated in the Caribbean is treated before it enters the ocean. This pollution can lead to eutrophication, in which corals experience excessive levels of nutrients in the water (Dubinsky & Stambler, 1996).

2.9.2 Sedimentation

Sedimentation is detrimental to coral reefs because it smothers them, leaving them in darkness and without oxygen. This often leads to death, depending on the amount and length of time that the sediment remains on the reef, as photosynthesis can no longer occur (O'Farrel & Day, 2006; Dubinsky & Stambler, 1996). Much of the sedimentation arises from agricultural and domestic sewage and coastal development, and natural resource extraction such as mining and logging (ICRAN, 2010; Wilkinson & Souter, 2008; O'Farrel & Day, 2006). In the Caribbean, nearly a quarter of all land drains into areas which support coral reefs (ICRAN, 2010). Coastal development serves to worsen the effects of sedimentation.

2.9.3 Coastal Development

In the Caribbean much of the population lives within 2 kilometres of the coast, and this population is expected to double in the next 50 years, making coral even more susceptible to development pressures (Moore & Best, 2001). With development comes the construction of infrastructure close to shore, meaning that sediment and other pollutants are finding their way into ocean waters (ICRAN, 2010). Not only does this development produce harmful sediments, but some infrastructure development, such as with the construction of marinas, directly disturb marine habitats (ICRAN, 2010).

2.9.4 Fishing

In regards to fishing and coral reefs there are two threats: old destructive fishing methods and over-fishing. Destructive fishing methods can include fishing with dynamite, cyanide and

other methods that break up the fragile coral reef and destroy the habitat that fish and other marine life dwell in (ICRAN, 2010). These methods generally do not select or target particular fish species, and often result in younger fish being killed in the process (ICRAN, 2010).

Damaging the coral reef habitat on which the fish rely can also reduce the productivity of the area, which further impacts the livelihoods of fishermen (ICRAN, 2010). Conversely, over-fishing is caused by an increasing demand for food fish (ICRAN, 2010). From a subsistence level, those who fish for a living may be in trouble as there is often inadequate fisheries management, which may lead to a decline in fish stock (ICRAN, 2010).

2.9.5 Cruise Ships

Cruise ships can also cause damage to coral reefs. This is a concern in the Caribbean, as cruise ships expel sewage, ballast and bilge discharge as well as any other litter or waste (Mohammed, Torres & Obenshain, 1998). Each ship generates on average 2,000 gallons of bilge and one ton of garbage each day (Mohammed, Torres & Obenshain, 1998). The waste from these ships is a major threat to the marine environment. For example, in 2003 the Ocean Conservancy removed 1,200 metric tons of waste from along 2,100 kilometres of Caribbean coastline (Mohammed, Torres & Obenshain, 1998). Another problem with cruise ships is in regards to anchor damage. Burke and Maidens (2004) and Smith (1988) note that the result of anchor damage on reefs is astounding, as the anchor is sometimes lowered directly onto a reef, and the size of the anchor and chain grinds and pulverizes the coral, making it a fine, unstable material.

Unfortunately, coral reefs are among the most vulnerable ecosystems in the world and with all the human disturbances discussed in this section, the reef ecosystem's ability to adapt and become resilient to change is hindered (Grimsditch & Salm, 2006).

2.10 Adaptation

There are two types of adaptation to consider for corals. The first is autonomous adaptation which the reefs do themselves, which can involve rapid growth, changes in the species composition, or the alteration of a specific coral species to their changing environment (Pittock, 1999). The second type is planned adaptation, where humans assist by helping corals keep the attributes of the reef system that they prefer. This can include re-populating the area with different reef species which are better adapted to thermal stress (Pittock, 1999).

However, the corals' autonomous adaptation to climate change depends on the other stresses present, more specifically human stresses like coastal development and pollution (Burke & Maidens, 2004). Burke and Maidens (2004) also note that those reefs not exposed to human stresses are more resilient to climate change than those that are already stressed. It is anticipated that coral reefs will respond to climate changes, such as warmer temperatures, but some are fearful that the rate of environmental change will outpace the rate at which coral reefs can adapt (Hughes et al, 2003). Others note that there is no evidence that adaptation can occur, and that the ability of corals and their zooxanthellae to genetically adapt is presently unknown (Baker, Starger, McClanahan & Glynn, 2004; Brown, 1997). Resilience is therefore an important aspect of research on coral bleaching.

2.10.1 Resilience and Avoidance

Coral resilience or tolerance can be defined as “the ability of an ecosystem to withstand disturbance without undergoing a phase shift or losing neither structure nor function” (Grimsditch & Salm, 2006, p. 10). An example could be a reef's ability to withstand bleaching and mortality (Grimsditch & Salm, 2006). It has been noted that corals' resilience will vary in

response to the wide array of conditions it will encounter (Done, 1992; Hughes & Connell, 1999).

One type of resilience is the ability of some corals to acclimatize to more stressful environmental conditions (Grimsditch & Salm, 2006). Acclimation is when the coral adjusts its tolerance levels to the stresses that occur in its environment (Grimsditch & Salm, 2006). A second is evolutionary adaptation or as some call it the ‘adaptive bleaching hypothesis,’ where corals may have adapted over time to the rising temperatures. This means they do not bleach during stressful conditions (Grimsditch & Salm, 2006; West & Salm, 2003). One example of this may be that in areas more subject to high temperatures, corals are more tolerant to temperature extremes when compared to those corals that are further down a reef’s slope and were exposed to elevated temperatures on a less frequent basis (West & Salm, 2003). An example of this resilience is when on a reef, during a bleaching episode, there is rarely total elimination of the reef, as there are ‘pockets of resistance’ which are less affected by the high temperatures (West, 2010). Identification of these areas and genetic attributes could help to ensure the continued survival of corals.

One mechanism of avoidance is ocean upwelling, which is a process where warm water is drawn away from the shore, where most corals are located, and is replaced by cooler water, decreasing the chances of bleaching (Grimsditch & Salm, 2006). Small scale upwellings (hundreds of square kilometers) are most beneficial, as they protect the reefs by reducing SSTs or create fluctuating thermal environments that can help coral reefs build thermal resistance (Grimsditch & Salm, 2006).

Resilience can also be broken up into three factors: ecological factors, spatial factors, and shifting geographic ranges.

The predominant ecological factor that aids in coral resilience is species diversity (Grimsditch & Salm, 2006). When a stress occurs on a reef and the reef is incapacitated, there is potential that the reef may become overrun by algae, but because of the reef's biodiversity of having grazing plant eating fish they keep the algae at bay while still allowing the corals to grow (Grimsditch & Salm, 2006).

In resilience, spatial factors are in relation to reproduction and connectivity Grimsditch & Salm, 2006). When a reef experiences mortality, such as in a bleaching event, the reef's capacity to reproduce is severely decreased, so it is important that those corals which have not succumbed to mortality have large amounts of "larvae that read the degraded reefs and then settle and grow" (Grimsditch & Salm, 2006).

Finally, geographic ranges contribute to the resilience of coral reefs. As climate change becomes more prominent, the areas where corals currently are will become intolerable, meaning they will have to move to other locations, most likely moving to the north which will have cooler waters (Grimsditch & Salm, 2006). However, Buddemeier, Kleypas and Aronson (2004) note that "geographic shifts of coral reefs would not mitigate the ecological and economic problems caused by the loss of tropical reefs, but it would partly alleviate concerns about global biodiversity loss" (p. 22). As coral environments become affected by change their natural resilience will lessen, which will impact their biodiversity and functionality (Grimsditch & Salm, 2006).

2.11 Types of Bleaching

Though the general term 'bleaching' is the most often used, it is important to understand that there are different types of bleaching that occur. One type is that of 'mass bleaching', which McWilliam, Cote, Gill, Sutherland and Watkinson (2005) refer to as a type of bleaching that has

been applied to individual countries and reef regions. Although all types of bleaching are important to understanding climate-coral interactions, Buddemeier, Kleypas and Aronson (2004) stated that there are two types of bleaching “particularly relevant to present concerns: algal stress bleaching and physiological bleaching” (p. 15). Physiological bleaching occurs “when there are physiological constraints placed on the size of the population of symbionts living in their host cells” (Fitt, 2001, p. 54). When this occurs it is not the host coral that is intolerant to the heat, but it is the symbiont itself that is less heat tolerant (Fitt, 2001). Algal-stress bleaching refers to “chronic photoinhibition” which is “the term for non-reversible photo-damage, usually involving malfunction of one or more biochemical pathways involved in synthesis or turnover of components of the photo-systems” (Fitt, 2001, p.54).

2.12 History of Coral Bleaching

Mass coral bleaching events are not recent phenomena, with the earliest documented reports occurring in the 1970s (Hoegh-Guldberg, 2004). Before this time, bleaching was unknown in the literature, but after the 1970s, and the documentation of the first mass coral bleaching, the scientific interest and literature expanded rapidly (Hoegh-Guldberg, 1999).

In the 1980s, documentation of mass bleaching expanded considerably as bleaching began to affect reefs on both a regional and global scale (Brown, 1997). Many of these bleaching episodes were associated with elevated sea surface temperatures (Baker, Glynn, Bernhard, 2008; Glynn, 1984). By the 1990s the frequency of bleaching outbreaks accelerated, meaning that the rate at which corals could recover between events was diminished (Hoegh-Guldberg, 1999).

In more recent times, the most prominent and devastating bleaching occurred in 2005, which impacted reefs worldwide. In the Caribbean, it was the hottest year on record, which

caused the reefs to be impacted severely (Wilkinson & Souter, 2008). The 2010 bleaching event was predicted to surpass that of 2005 in scale; however, the overall impact has yet to be assessed.

2.13 Coral Bleaching in the Caribbean

Caribbean coral reefs are often seen as the foundation of part of the region's tourism industry, and any degradation could have negative implications for the area (Burke & Maidens, 2004). There is now a realization in public and scientific circles that Caribbean coral reef ecosystems are under increasing stress (Atwood, Hendee & Mendez, 1992). The first mass coral bleaching in the Caribbean was in 1980, with others occurring in 1988, 1995, 1998 and 2005 (Wilkinson & Souter, 2008). Of these past bleaching events, 1998 and 2005 are often seen as the worst on record (Wilkinson & Souter, 2008). In 1998 the severe coral bleaching event and the impacts of Hurricane Mitch were devastating to reefs, where the combination of the two resulted in a significant reduction in coral cover. For example, Belize lost 62% in its southern reefs (Wilkinson & Souter, 2008). During the 2005 event SST that induced bleaching ranged from 29° and 31°C (Garcia-Salgado et al., 2008)

The coral bleaching event of 2005 extended across the entire Caribbean region and was seen as the most extreme bleaching and mortality event on record. On a Caribbean-wide scale, the “percent cover of bleached coral ranged between 2% and 62%, and bleaching related mortality ranged between 0% and 27%” (Wilkinson & Souter, 2008, p. 46).

The bleaching occurred from June to November 2005, with the most intense period being between August and November when sea surface temperatures were highest (Wilkinson & Souter, 2008). Satellite observations that occurred around the time of the bleaching “noted levels of thermal stress far in excess of the standard bleaching thresholds, the highest in the 21-year satellite record” (Donner, Knuston & Oppenheimer, 2007, p.5484). After data collection of SSTs

the epicenter of the bleaching was placed in the Eastern Caribbean, “where the coral communities saw record breaking thermal stresses” (Steiner & Kerr, 2008).

However, the sea surface temperature was not the only contributing factor, with the 2005 hurricane season also being exceptional, where the region had more than twice the annual average of storms than in the last century and the most ever recorded (Wilkinson & Souter, 2008).

The islands and mainland countries of the Caribbean are very much dependent on healthy coral reefs and the various services they provide, particularly for tourism, fishing and coastal protection (Wilkinson & Souter, 2008) The bleaching event of 2005 has and will continue to have important ecological and economic implication for the region (Wilkinson & Souter, 2008). These implications may not be fully realized as bleaching events continue. The latest mass bleaching episode in the Caribbean, which has to this point been accurately predicted by the NOAA, is expected to surpass that of 2005 in magnitude and severity (Eakin, 2010).

2.14 Predictions of Coral Bleaching

Coral bleaching trends of the past century along with projection models show that bleaching events may become more severe and frequent, increasing the number of reefs, species and coral depth ranges involved (Vernon et al., 2009; Reaser, Pomerance & Thomas, 2000). Modeling assumes that corals need a minimum of five years to fully recover from a mass bleaching event, which is troublesome, as projections are predicting that bleaching may become an annual or biannual event (Wilkinson & Souter, 2008; Donner et al, 2005; Sheppard, 2003; Hoegh-Guldberg, 1999). As the frequency of these events increases, so too will the damage to the corals, as they have little time to recover, ultimately leading to a long term decline (Vernon, et al., 2009).

Once associated with El Nino cycles, coral bleaching will separate from it as ocean temperatures continue to rise, threatening all reefs; even those that are well protected in marine sanctuaries are threatened by this global climate change (Vernon et al., 2009; Reaser, Pomerance & Thomas, 2000).

The future of bleaching events in the Caribbean suggests that the future long term coral reef tourism is not promising, as many of the scenarios used to predict frequency and intensity project that bi-annual or even annual bleaching may become a distinct possibility by the 2020s because of seasonal changes in seawater temperatures (Wilkinson & Souter, 2008). If greenhouse emissions are not stabilized, severe bleaching events will be an annual event by 2100 (Crabbe, 2008; Wilkinson & Souter, 2008; Baker, Glynn & Bernhard, 2008; Donner, Knuston & Oppenheimer, 2007). These episodes of bleaching could become a chronic source of stress for Caribbean reefs as the SSTs increase and the bleaching becomes spread over a larger area (McWilliam, Cote, Gill, Sutherland & Watkinson, 2005).

2.15 Coral Thresholds

Corals are already living close to their temperature related threshold and with increased sea surface temperatures these thresholds are exceeded on a more frequent basis, leading to more severe and frequently occurring bleaching events (Baker, Glynn & Bernhard, 2008; Jokiel, 2004; Brown, 1997).

Most of the thresholds are exceeded during the summer months when the water temperatures can reach 31°C, the sea surface temperature when most corals are expected to bleach (Rosenberg, 2004). However, it should be noted that the temperature at which corals bleach varies across the globe, and although these threshold temperatures serve as a predictor of

when a bleaching event may occur, it will indicate its severity or spatial extent (Vernon et al., 2009; Baker, Glynn & Bernhard, 2008; McWilliam, Cote, Gill, Sutherland & Watkinson, 2005).

2.16 Sustainable Tourism

Sustainable development arose from the 1987 United Nations' World Commission on Environment and Development (UNWCED), entitled *Our Common Future*, more commonly known as The Brundtland Commission. The report brought attention to the fact that the world must lean toward economic development that conserves natural and cultural resources without harming the environment (Bryant, 2007). Put simply, the report defines sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (UNWCED, 1987 p. 43).

Sustainable development is often thought to have laid the foundation for sustainable tourism, as it was recognized that tourism may also have negative impacts on the natural and cultural environment (Horobin & Long, 1996). The World Tourism Organization (WTO) (1998) provides this definition for sustainable tourism:

Sustainable tourism development meets the needs of the present tourists and host regions while protecting and enhancing opportunities for the future. It is envisaged as leading to management of all resources in such a way that economic, social, and aesthetic needs can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity, and life support systems (p. 21).

Essentially, sustainable tourism is about finding a balance between tourism related economic development and appropriate resource management (Hunter, 2002; Bramwell & Lane, 1993).

Sustainable tourism is also an approach that is intended to lessen conflict between the industry,

tourists, the environment and the host communities. This involves working for lasting natural and cultural resources while acknowledging that there are limits to tourism growth (Bramwell & Lane, 1993).

Prosser (1994) cites four areas providing the push for sustainability in tourism: “dissatisfaction with existing products; growing environmental awareness and cultural sensitivity; realization by destinations and regions of the precious resources they possess and their vulnerability; and the changing attitudes of developers and tour operators” (as cited in Liu, 2003, p. 460). Simpson (2001) suggests that sustainable tourism development should be:

- Comprehensive: including social, cultural, environmental, economic, political implications
- Iterative/dynamic: readily responding to environmental and policy changes
- Integrative: functioning within wider approaches to community development
- Community-oriented: all stakeholder’s needs addressed through community involvement
- Renewable: incorporating principles which take into account the needs of future generations
- Goal-oriented: a portfolio of realistic targets results in equitable distribution of benefits

(p. 7)

However, the implementation of sustainable tourism practices is dependent on the willingness and ability of those in the tourism industry to want to move in this direction. Without their willingness to begin implementation, it is much more difficult to move forward. As Bramewell and Lane (1993) suggest, it is easy to discuss sustainability but it is the

implementation that is the problem. With our world in a constant state of flux it is imperative that operators and those involved in the industry begin to understand the urgency of implementing this type of tourism. Sadly Gössling and Hall (2006) have observed that academics have been writing about sustainable tourism for approximately 20 years and evidence around the world is suggesting that the situation has not improved; in fact, it has gotten worse. It is now time, as Bramwell and Lane (1993) say, to “walk the talk” (p. 4).

2.16.1 Sustainable Tourism in the Caribbean

For Caribbean tourism, the future is seen to be dependent on the development of sustainable tourism, as many countries, especially small islands states, rely on the natural environment to drive their tourism industry (Duval, 2004; Jayawardena, 2002). However, the high demands of this lucrative market can often lead to inappropriate use of resources and a decrease in quality experiences. Now, in order to shift the industry away from these occurrences, operators and officials are turning to sustainable tourism practices and development (Duval, 2004; Jayawardena, 2002; Holder, 1996). It is this realization of how detrimental tourism can be to the environment that there has been an increased emphasis and push for sustainable tourism (Duval, 2004). This has not been easy, as many tourism businesses are dependent on natural resources and changing requirements may require a lot of time and effort on the part of all stakeholders involved (Haywood & Jayawardena, 2004). Sustainable tourism also poses a problem with stakeholders, as many operate businesses and look to make a profit, but must do so while meeting the sustainable tourism requirements (Teswarie, 2002). There is still much room for sustainable tourism in the Caribbean nations. There are, however, some nations, such as Dominica and Belize, which have adopted alternative and sustainable tourism and are doing so successfully (Bryan, 2007).

2.17 Climate Change and Tourism

The link between tourism and climate change is now clear. It is also apparent that everyone involved in tourism will be affected by climate change, from operators and regulators right down to the tourist themselves (Gössling & Hall, 2006). Currently, there is general acceptance that tourism and climate change are interrelated because tourism contributes to climate change, for example through air travel to a destination, and tourism will be affected by climate change, an example of which may be coral bleaching or beach erosion (Becken & Hay, 2007; Gössling & Hall, 2006).

As the climate change-tourism interface has developed, so too has the designation of climate-tourism hotspots. These hotspots have two distinct attributes: (1) the importance of tourism to many of their national economies; and (2) the major consequences of climate change, and especially changes in variability and extreme events (Gössling & Hall, 2006). The Caribbean has been identified as one such hotspot, with more specific threats being sea level rise, marine biodiversity loss, an increase in extreme events, and an increase in travel costs (Scott et al., 2008; Gössling & Hall, 2006).

Climate change can also disrupt the tourism system, even if only temporarily. Some of these disruptions most often include impacts to the natural resource base needed for tourism (Gössling & Hall, 2006). For example, coral reefs are an attraction for many tourists and many issues such as climate change are affecting its attractiveness for tourists. It is seen that reducing the stresses on these vital ecosystems is a key climate change adaptation strategy because if the natural resource was lost the competitiveness of a destination will be changed (Scott et al., 2008; Wall, 1992).

One issue arising in tourism is that the majority of operators fall under the small and medium-sized enterprises category, and the concern is that these businesses are unable to adapt to climate change because they have little or no capital with which to implement adaptation strategies to help with the current and upcoming climate change (Turton et al., 2010). As has been shown, the link between climate change and tourism is obvious and it is up to those involved in the industry to help remedy the situation in the uncertain and ever changing future that lies ahead.

Scott et al. (2008) state that “the evidence is clear that the time is now for the tourism community to collectively formulate a strategy to address what must be considered the greatest challenge to the sustainability of tourism in the 21st century, climate change” (p. 180).

2.18 Small Island States and Tourism

For many small islands their economies are directly related to the state of their tourism sector (Scheyvens & Momsen, 2008). For many, if not all, small island nations, tourism as an economic development strategy arose out of necessity, as many of their other economic ventures like agriculture and off shore banking had been threatened by developed countries. This has essentially left nothing but tourism as their future (Bryant, 2007). The small island economies are also in need of foreign exchange earnings, which are often brought in by the tourism industry (Gössling, 2003).

With the tourism industry becoming increasingly globalized, tourism can be seen as a critical part of development and economic sustainability in these small islands states, which is plausible because most island nations are blessed with unique natural and cultural features, making them a desirable location for many to visit (Scheyvens & Momsen, 2008).

Another aspect that island nations have that serve as a draw card for tourists is isolation. Although this is seen as a drawback by some in regards to other trade based industries, for tourism it is beneficial, making the destination more attractive and exotic (Scheyvens & Momsen, 2008). As well, the small size of islands can facilitate coordination and cooperation in tourism development, making it easier to change to market demands by working together on adaptations and new innovations (Scheyvens & Momsen, 2008).

There are some drawbacks to tourism in small islands states, as there are in others. Of concern here are the sensitive environments of these nations. There is often much infrastructure needed for tourism development, such as accommodation, transportation, sanitation and various others, and these developments often occur along the island's coasts, placing undue stress on the natural environment (Bryan, 2007; Gössling, 2003). As well, the natural attractions for tourists, such as beaches, coral reefs and various plant and animal species, are placed under pressure and these are needed intact in order to maintain tourism as a viable industry in the future as much as they do at present (Bryant, 2007).

2.18.1 Climate Change, Tourism and Small Island States

Climate change and its various impacts are seen as a present and future reality for many nations, especially small island states. Climate change will also challenge many societies in the coming decades, but adaptation may be difficult for small economies like island states, as they mostly rely on few economic sources like tourism and fisheries. Adaptation may therefore be seen as a luxury expense when meeting basic needs for citizens is already difficult (Baker, Glynn & Bernhard, 2008; Mimura et al, 2007; Belle & Bramwell, 2005). However, small island states are anticipated to be one of the most affected regions of the world due to climate change because of their small land area, the majority of the population living on the coast and, as previously

mentioned, their small and sensitive economies (IPCC, 2007). This, of course, refers more so to the tourism industry, meaning that they will need to implement adaptation strategies with greater urgency (Mimura et al, 2007; Payet & Agricote, 2006).

For many, if not all, small island states, tourism is a major economic driver. This is tremendously important, as the islands have few if no other economic alternatives as they lack natural resources (Mimura et al, 2007; Belle & Bramwell, 2005). Some of the impacts of climate change for these island nations can be direct and indirect, from an increase in storm frequency and intensity to flooding and coastal erosion (Scott et al., 2008). These can be detrimental, considering most of the tourism infrastructure is located on or close to the shoreline, and can be damaged as a result of these occurrences. This reduces the attraction of coastal tourism and as previously mentioned perhaps an inability to react to such events is troublesome (Scott et al., 2008; Mimura et al, 2007; Belle & Bramwell, 2005).

Climate change may also affect attractive environmental components of small island states, which could also impact their economies. Environmental changes like coral bleaching and beach erosion are some of such changes attributed to climate change which may change the tourism market and infrastructure (Mimura et al, 2007).

2.19 Destination Image

The image of a destination often plays a key role in a tourist's decision to vacation there. The consensus among tourism scholars is that this is often the determining factor in choosing what place to travel to (Lee, 2009; Hamilton & Lau, 2006; Gössling & Hall, 2006; Orams, 1999). The image of a destination refers to a visual representation, the tourists' associated knowledge, perceptions, impressions, prejudice, imaginations and emotional thoughts of a particular place (Jenkins, 1999; Alhemoud & Armstrong, 1996; Crompton, 1979). In short, destination image is

a mental construct that simplifies the process of decision making (Page, 2007). It is a very individualized process, as every tourist may have a different image of the same destination. A study by Hamilton and Lau (2006) found that the most influential media assisting people in forming their image of a destination was word of mouth, with the least important being advertisements.

When these images or perceptions are positive, visitors are more apt to select it as a vacation destination (Alhemoud & Armstrong, 1996). Jenkins (1999) identified some factors that may influence an individual's image of a place, such as tourism marketing; their motivations; personal experiences; the media; their socio-economic characteristics; their perceptions; and, other people's experiences. It has been identified by Um and Crompton (1990) that "travelers generally have limited knowledge about the attributes of a destination which they have not previously visited. For this reason, the image and attitude dimensions of a place as a travel destination are likely to be critical elements in the destination choice process" (p. 433). Once the destination has been selected and travelers visit the site this image also affects the on-site experiences, such as how the visitors behave, the activities they engage in, their attitudes once they arrive and their level of place attachment for future visits (Lee, 2009).

In regards to destination image influencing future behaviour it has been stated that it "is a precursor of predicting tourists' future behaviours" (Lee, 2009, p. 220). If the visitor has a positive and satisfactory experience they are more likely to return than if they had a negative experience (Lee, 2009). For managers destination image can assist them in identifying their various strengths and weaknesses, and with a proper understanding managers may be able to better read the tourism market and instill in travelers a reason to visit the destination (Lee, 2009; Gyimothy, 2006). In regards to climate change and preferred attributes, Gössling, Hall and Scott

(2009) state that “the perceptions of future impacts of climate change at destinations will be central to the decision making of tourists, tourism investors, governments and development agencies alike, as perceptions of climate conditions and environmental changes are just as important to the consumer choices as the actual conditions” (p. 110).

Scott et al. (2008) note that environmental attributes play a role in selecting a destination. Where Gössling and Hall (2006) agree, they also put forth the argument that it “remains unclear when environmental conditions reach a state that no longer appeals to tourists. It also raises the question of whether or not tourists are informed about these environmental conditions before going on holiday – that is, whether they are part of the tourists’ decision-making process or not” (p. 19). Generally, the thought is that tourists more so than others in the tourism sector have the greatest ability to adapt when the destination image no longer fulfills their desires; whether it be attributed to climate change, travel costs or a depletion in the quality of the attraction(s), it impacts those at the destination level (Gössling, Hall & Scott, 2009; Dwyer, Edwards, Mistills, Roman & Scott, 2009; Wall, 1996).

Caribbean tourism relies heavily on natural resource imagery such as sun, sand and clear waters. However, as Wall (1996) states, “global climate change...may modify these resources and how they are perceived by the potential clientele, leading to the need for such destinations to adjust to changing circumstances” (p. 206). Coral bleaching may therefore greatly affect the realities of Caribbean destination imagery because of its high visibility. Haywood and Jayawardena (2004) found that crises influenced people’s impressions of a specific destination, the country or the entire region. For dive tourism in the Caribbean, this point is critical. If one area experiences heavy bleaching, or a substantial amount of coral mortality, it could not only affect that specific destination, but also an entire region.

In the future, there will be more of a focus on the image of destinations and how they are perceived, and unless the image is 'right' for the tourist, the destination may not be able to develop itself the way it may want to (WTO, 2001).

2.20 Caribbean Marine Protected Areas

Protected areas in the Caribbean are an old idea, with the inception of Tobago's Main Ridge Reserve in 1765, to protect the watershed, followed by St. Lucia's Kings Hill Reserve in 1791 (Stanley, 1995). Currently there are over 285 marine protected areas across the Caribbean, each with various levels of enforcement, protection, and financial resources (Burke & Maidens, 2004). In their 2004 study of reefs at risk, Bryant, Burke, McManus and Spalding found that "only 6% of MPAs were rated as being effectively managed and 13% as having partially effective management. An estimated 20% of coral reefs are located inside MPAs, but only 4% are located in MPAs rated as effectively managed" (p. 13). These areas are good in theory, but in developing locations there are many limitations. For example, there is a lack of financial support for the cost of managing MPAs, from staffing to daily operations, and underfunding is often seen as the main reasons MPAs fail (Fabinyi, 2008). Also, managers in developing countries rarely have the luxury to draw upon professional help, such as ecologists and physiologist to ensure their MPA is effective in ensuring the future of the diverse species within its boundaries (Rouphael & Hanafy, 2007; Aronson & Precht, 2006).

2.21 Small and Medium Enterprises

Many dive operators can be categorized as small and medium enterprises (SME), although little attention has been paid to the operation of small firms at tourist destinations (Shaw, 2004). To qualify as an SME in tourism the general guideline is ten or fewer employees (Shaw, 2004). The most popular type of businesses in tourism SME is 'lifestyle entrepreneurs'.

These entrepreneurs often serve markets that were created by demand for specialized tourism products (Ateljevic and Doorne, 2000). The characteristics of these businesses include serving a niche market, being less motivated by profit and often having an interest in environmental issues (Ateljevic and Doorne, 2000). A second type of SME is the ‘constrained entrepreneur,’ which can be categorized by the business having a lack of capital for expansion, or an unwillingness to develop and compromise lifestyle goals (Shaw, 2004).

Even though these small scale operators dominate the tourism industry in developing nations, they often do not have the power to influence politics or the economic environment in which they operate (Roberts, 2008). For small tourism enterprises, it has been suggested that they have limited managerial and planning skills, which could be detrimental during this era of climate change (Roberts, 2008). However, within their networks forms of information circulates, which may influence collaboration between smaller firms (Shaw, 2004). This may lead them towards taking action and trying to persuade decision makers with their larger numbers.

2.22 Conclusion

The prospect of future bleaching events in the Caribbean does not look promising for the region’s corals. Corals are already living close to their temperature-related threshold and with increased sea surface temperatures these thresholds are exceeded on a more frequent basis, leading to more severe and frequently occurring bleaching events (Baker, Glynn & Bernhard, 2008; Jokiel, 2004). It is therefore imperative that more studies are undertaken to examine these environmentally dramatic events.

CHAPTER THREE RESEARCH METHODS

3.0 Introduction

In order to develop an understanding of dive operators' perceptions of environmental change and its potential impact on the future of dive tourism in the Caribbean, Chapter 3 will describe the methods of research used to achieve this goal. It is divided into seven major areas: paradigm; research design; sampling; research sites; data collection; data analysis, and finally strategies for validating findings.

3.1 Paradigm

The paradigm I aligned myself with is pragmatism. Pragmatism is the most common worldview for mixed methods researchers as it utilizes qualitative and quantitative research instruments (Teddlie & Tashakkori, 2009). Pragmatism is defined by Creswell (2009) as “a worldview that arises out of actions, situations, and consequences rather than antecedent conditions” (p. 231). It is more suited to real-world practical research, where researchers look at the ‘how’ and ‘why’ question when researching (Creswell, 2009). It also embraces ideas from research questions and real world circumstances, and rejects the ‘either-or’ choices of other methodologies, giving researchers the freedom to “use all approaches available to understand the problem” (Creswell, 2009). Due to the use of multiple approaches for data collecting and analysis, I have drawn from both quantitative and qualitative research methods, which the following sections discuss in greater detail.

3.2 Research Design

This study was guided by an exploratory, sequential, mixed methods design (Creswell & Plano Clark, 2007). The basic premise of mixed methods is that it combines quantitative and qualitative approaches, which provides a better understanding of research problem than either

approach alone (Creswell, 2009; Creswell & Plano Clark, 2007; Nykiel, 2007). The mixed methods approach “allows the research to measure trends, prevalence and outcomes and at the same time examine meaning, context, and process. Some researchers believe that mixed methods strategies can result in enhanced understanding of phenomena and better, more rigorous methodology” (Creswell & Plano Clark, 2007, p. 175).

The study consisted of two phases. The first phase of the study was a semi-structured interview followed by the second phase, a web-based survey. The interviews were selected for the initial phase in order to gain perspectives and insights from dive operators before the web-based survey was sent out. In this way key elements and questions that may not be apparent in the available literature could be included in a more refined and appropriate survey. The interview phase occurred in January of 2011 and the second phase followed in April 2011.

3.3 Sampling

Purposive sampling was used in both phases of this study. Purposive sampling is seen as selecting “a group of people because you know they have some traits you want to study” (Nardi 2006, p. 119). Purposive sampling is utilized for many mixed methods studies where “the researcher purposefully selects individuals, groups and settings that maximize understanding of the underlying phenomenon” (Onwuegbuzie & Collins, 2007). Since there was no directory, or one single location where a list of all dive operators could be found, a list of Caribbean dive operators was compiled from various internet sources, including PADI, National Association of Underwater Instructors (NAUI), the Association of Tobago Dive Operators (ATDO), scubalinx.com, scubadviser.com, by searching individual country travel and tourism pages, and also by browsing various online dive magazines such as Scuba Diving, Skin Diver, Sport Diver and Cyber Diver. A list of countries and the associated number of dive operators contacted for

each country can be found in Appendix A. Each dive operator on the list was contacted, and was given the opportunity to participate in the quantitative study in Phase 2.

3.4 Research Sites

The data for this study was collected in phases. For the qualitative, semi-structured interview phase Tobago was chosen as its dive industry is substantial, with 54 dive sites and 12 listed dive operators (Association of Tobago Dive Operators, 2010, PADI, 2010, mytobago.info, 2010). In 2006, the direct economic impact of coral reef-related tourism and recreation in Tobago was estimated at US\$43.5 million, where diving itself contributed US\$1.3 million (Burke, Greenhalgh, Rager & Cooper, 2008). Tobago is also home to the renowned Bucco Reef, which is a fringing reef and is most often used for snorkeling. Also, the town of Speyside is home to the world's largest brain coral (Burke, Greenhalgh, Rager & Cooper, 2008). During the 2005 bleaching episode, the overall bleaching in Tobago was 66% (O'Farrell & Day, 2006). The island is 300 square kilometres in size, and is home to 55,000 people (Tobago House of Assembly, 2010). The tourism industry is the largest employer on the island, employing 60% of the workforce (Tobago House of Assembly, 2010). All of these factors made Tobago an ideal case study for the exploratory interview phase.

Figure 4. Map of Tobago and Dive Sites



Source: Tobago Dive Experience, 2007

The participants for the survey in phase 2 were dive operators who conduct business in any of the countries associated with the Caribbean Tourism Organization (CTO). The reason for selecting a large number of countries was in the hope of obtaining a geographically unique perspective. As well as knowing that the response rate was expected to be low and a blanket approach may help garner more responses. Also, the above countries may be affected differently by bleaching events, so the responses would stand to be diverse.

Before data collection began ethics approval from the University of Waterloo was obtained. After the proposal defense in October 2010 one round of revisions was needed from the Office of Research Ethics and clearance was given for both the interview and web-based survey portions of the study in November of 2010.

3.5 Data Collection

For the interview phase of the study face-to-face interviews were conducted with Tobago dive operators. The original intended number of operators to be interviewed was 12; however this was not possible as one operator wished not to be interviewed as he was in the process of selling the business. It should also be noted that although it appeared online that there are 12 operators offering services in Tobago, the reality is there are only eight. All but one were interviewed

Subsequently, the web-based survey link was emailed out to 318 dive operators across the Caribbean region. Initially an email was sent out to let operators know about the study, when the survey link would be coming out, and to ask if they had any questions about the study. This was also done to eliminate any bounce-back emails from the sample size. A second email containing the survey link was sent out four days later. Over the next two weeks two more

reminder emails containing the survey link were sent out. A final reminder email was sent out after the third week of the survey being open online. Although the original intention was to include snorkel operators and dive operators, many emails were received from snorkel operators saying that they did not wish to participate because they were not dive operators. Many of the operators gave positive feedback about the survey, saying that they were happy that such a topic was being addressed and that it needs to be looked into further. They were also more than glad to help. Many sent emails aside from the survey discussing various things and sending pictures of bleached coral in their area.

During the initial email letting operators know about the survey, a dive operator from Belize who also runs an NGO expressed interest in partnering on the project as they were starting up a coral monitoring program and wanted to recruit volunteers. The organization is ECOMAR Belize. A separate survey for Belize was created and had additional questions added at the request of the organization. ECOMAR posted information about the project on their webpage and on their blog asking operators to participate. After this they distributed the survey link to Belize dive operators via their organizations email in order to elicit more responses. Upon the closure of the survey link, ECOMAR was given a synopsis of the results for the Belize operators. The next paragraph is a synopsis of the various initiatives the organization is involved with.

The Environmental Conservation Organization was founded in 1996 to promote "Conservation through Education." ECOMAR coordinates several programs in Belize that aim to engage dive centers, marine guides and fishermen to become involved in monitoring the marine environment that their livelihoods depend upon. Their programs provide support to interested business and individuals who want to learn more about the Belize Barrier Reef ecosystem and they can help monitor the reefs. Some of these programs include: Adopt a Reef,

the Belize Coral Watch Program, the Belize Lion Fish Project, Turtle Watch and Reef Rally. They also support research through St. George's Caye Research Station and Field School (ECOMAR Belize, 2011).

3.5.1 The Interview

For the first phase, a qualitative, semi-structured interview with Tobago operators was selected to help gain insights that aided in the refinement of questions and options that were asked in the web survey. One of the reasons semi-structured interviews were selected is that they can provide detailed information on the attitudes of stakeholders to tourism issues and changes in tourism destination area (Yuksel, Bramwell & Yuksel, 1999). A second is that the nature of the semi-structured interview allows the researchers a great deal of flexibility when conducting the interview. This includes having an interview guide with specific topics to be covered, and the ability to deviate from the questioning order should the researcher pick up on things that the participant says, so long as all the topics are covered and the questions are asked with similar wording (Bryman, Teevan & Bell, 2009). The interview is also meant to probe into some of the responses from the questionnaire to gain further insight and explanation, should the need arise (Creswell, Plano Clark & Garrett, 2008). This phase of the research took place in January 2011. To view the interview guide and the affiliated information letters and consent forms see Appendices B, C, D, E and F. After this phase was complete and the results analyzed the web-based survey was completed and sent out to Caribbean dive operators.

3.5.2 The Survey

Questionnaires are the most common method of obtaining data in the social sciences (Nardi, 2006). They are often inexpensive compared to other data collection strategies, and are less time consuming and easily repeated and can be geographically disbursed (Nardi, 2006). The

type of survey used in this study was a web-based survey, and was been chosen for this study because the participants are in a variety of locations, making this approach easier and more convenient for the researcher and participant. The use of web-based surveys has increased in popularity because of the decreased costs of administering the survey. For example, printing multiple copies and collecting the data by supplying prepaid envelopes can dramatically increase costs. Also, with web-based surveys there is no longer a need to manually enter each survey into a database (Evans & Mathur, 2005; Roberts, 2007). This type of survey is also ideal for dive operators, as they are usually small businesses who have access to the internet. The web survey is also convenient in that they are more aesthetically pleasing, only one question or a set of questions appears at a time, so participants cannot see what questions lie ahead (Bryman, Teevan & Bell, 2009). The web based survey is a quick and efficient way for participants to access the survey and for the administrator to collect the responses. A copy of the survey and its associated letters can be seen in Appendices G, H, I and J.

The survey consists of 42 questions, some of which were adapted from other research but most were developed specifically for this project. Those which were developed for this project were created by looking at the existing literature and by taking out concepts and key words from the Tobago dive operator interviews. As well, many of the interviews served to confirm what the literature stated about coral bleaching and dive tourism. An example of this is question 41, which asks dive operators what they attribute coral bleaching to. Each of the responses that were originally placed in the question before the interviews were brought up by Tobago dive operators, such as warming waters, climate change and geographic location. The one that Tobago dive operators brought up themselves was that of other larger environmental concerns. Another example is questions 6 and 7 which asked operators to rate how important the lists of

threats are to dive tourism now and over the next 5 years. Some of the options came from the literature such as climate change, natural disaster and coral bleaching, and others came from the interviews, such as poor infrastructure and poor promotion of the country as a dive destination.

The questions that were developed specifically for this project were approved by both Dr. Paul Eagles and Dr. Daniel Scott to ensure that they were suitable. As well, before the survey was sent out Caribbean wide it was pre-tested by three dive operators, two from Tobago and one from Belize. It was decided that three pre-tests was suitable to clarify any issues that could perhaps arise during the survey process.

For those questions modified from past research many were taken from Wolfsegger, Gössling and Scott (2008), which looked at Austrian ski operators and their perceptions of climate change and how it will affect their operations. An example of this in the survey is question 25 which asks dive operators how important the issue of coral bleaching is to their dive operation, followed by a five point Likert scale. The wording of the question was modified to reflect coral bleaching instead of climate change. Question 16 asked operators to rank what their most important source of information was. The idea for the question was taken from Wolfsegger, Gössling and Scott (2008), who asked in an open ended question for operators to list where they received their information, whereas question 16 gave options and asked the dive operators to rank them. For questions 30 and 33 the scales were borrowed from the same study done by Wolfsegger, Gössling and Scott (2008). Finally the idea and format of questions 36 and 37, which asked how long the operators felt their businesses would remain economically viable if adaptation measures are and are not taken, was taken from the Wolfsegger, Gössling and Scott (2008) study; however, the question wording and the categories with the number of years the operators could select are different.

Finally in question 29, the scale and the three statements therein were adapted from a study done by Biggs (2011) which looked at the vulnerability of reef based tourism to climate change.

3.6 Data Analysis

The following two sections will discuss both the qualitative and quantitative analysis.

3.6.1 Qualitative Analysis

For the qualitative portion of the study, the first stage of analysis was to transcribe the interviews. Once the transcription process was complete the interview transcripts were transferred into Nvivo. Once placed in the program, the interviews were read line by line and a phrase was assigned to each line. From there, quotations were extracted and placed under various themes that represented the important findings that arose throughout the interviews. These themes were generated by clustering similar topics together (Daly, 2007). From here the data was compressed into four themes which are discussed in greater detail in Chapter 4. Throughout the coding process notes were kept about observations or connections that were noticed when conducting the coding.

3.6.2 Quantitative Analysis

The quantitative data was analyzed using the Statistical Package for the Social Sciences (SPSS), a computer based statistical analysis program. As this was an exploratory study, many of the statistics are descriptive. Initial descriptive measures were conducted to look at the basic characteristics of the sample, such as the number of years the operation has been in business and the number of employees it has. As well, many of the statistics presented in Chapter 5 are based on percentages and mean scores. One ANOVA was conducted to see if the importance of bleaching was impacted by how long the dive operation was in business. The open ended

questions or where operators had the chance to explain their selection of ‘other’ was analyzed by selecting the most frequently occurring answers as well if there were any unique responses they were also mentioned.

3.7 Strategies for Validating Findings

The validation of research results is seen as a strength in both qualitative and quantitative research. There are two strategies used to validate the findings from the research. The first is content validity which is defined by Carmines and Zeller (1991) as the “extent to which a measurement reflects the specific intended domain of the content” (p.20). This was accomplished by pre-testing the online survey with three dive operators, one from Tobago and two from Belize.

The second is peer-debriefing. This was achieved by the study being reviewed by my supervisors as well as a reader who was not involved in any of the processes of the research. By utilizing these techniques, the results and findings of my study have been substantiated.

CHAPTER 4
RESULTS AND DISCUSSION OF SEMI-STRUCTURED INTERVIEWS

4.0 Introduction

Chapter 4 reviews the results obtained from the semi-structured interviews. It reviews and presents findings regarding the perceptions of Tobago dive operators regarding coral bleaching.

As discussed in Chapter Three, the method of collecting data for this phase of the study was semi-structured interviews with dive operators in Tobago. The operators were selected from various internet sources. In total seven interviews were conducted and all of them were used in the analysis. All dive operators' names have been removed and have been replaced using the designations of "Operator 1" through "Operator 7".

The interview participants have lived in Tobago from 4 to 42 years. They have been operating in Tobago from 6 to 26 years and Table 1 shows the break down for each operator. Each interview was conducted face-to-face while being digitally recorded. Notes were also taken by a research assistant in case some of the recordings were inaudible. None of the participants requested a transcript of the interviews; however some expressed interest in receiving the final results of the study.

Table 1
Tobago Operators Years in Business

Operator	Number of Years in Business
Operator 1	6
Operator 2	11
Operator 3	20
Operator 4	6
Operator 5	26
Operator 6	12
Operator 7	15

4.1 Themes

4.1.1 Lack of Government Action

The theme “Lack of Government Action” was the most discussed issue by all the operators. They all expressed that the Trinidad and Tobago government was either aware of the bleaching and coral related issues, but was choosing to do nothing about it, or chose to acknowledge the happening by signing agreements for greater protection, with these often not leading to action. As Operator 2 stated:

“Apart from things like fixed moorings, we can’t get to the government about policies, it’s not worth your breath. The government doesn’t view its corals as significant, they don’t see a correlation between the health of the sea and the health of the corals, any of them, least of all the Secretary of Tourism who is a diver and he doesn’t really care.”

Frustration in dealing with the government was also an issue that arose with nearly every operator. Many felt that because Tobago was still in its developing stages that the economy would take precedence over the environment. Operator 7 expresses concern by saying:

“So we are talking about MPAs it has been 15-17 years. The first draft, where the concept was ridge to reef took seven years to put together and when it went to parliament one minister shot it down and that was it, it had to be redone again. The people are on consulting overload, they have been consulted here at least four times and they are fed up so they don’t believe it’s going to happen and now the NGOs are starting to believe that too. You ask us the same questions every two years and we say you have the answers, it’s all there, do something.”

Another area which is frustrating for the operators is that they as private citizens have to take measures to protect reefs because the government seems unconcerned or is choosing to distance themselves from engaging in reef protection measures. As Operator 6 says:

“It’s how do we stop it, how do we get governments to buy into stop these things from happening. There is, it’s like in Charlotteville at the moment, they’re putting up buoys, the government should be doing it, there should not be private people having to try and get volunteers and money to do this. If you’re serious about the reefs you would be doing it, but they’re not.”

The fact that Tobago is still a developing country, the predominant focus tends to be on economic growth and development and not taking care of its rich natural features both above and below the waters. Again Operator 6 states:

“It’s easy to talk, a lot of ease in talking, but not a lot of action unless there’s something on the bottom line for them. It seems to be, it’s like um you have a lot of people saying what they think you want to hear and we get that a lot typically at times the government will say things they think you want to hear and then do the complete opposite.”

While many feel the same way, in the sense that government-based environmental protection is lacking, there is a realization that the government is not likely to start taking responsibility for the environment. In response many of the operators, concerned NGOs, and citizens groups are taking action themselves to protect these areas. As Operator 5 says:

“That’s what we have to start doing, we have to start putting x’s on environments that the governments are not doing anything to actively protect.”

Operator 1 also feels that the people in government need to change and only then will protection and conservation of coral reefs and the tourism industry change:

“It’s the wrong people in power and that is something that you would have to change before you could ever get in to acknowledge things that need to be changed in order to make tourism, the dive industry, etc better. Anything else is like putting a band aid on a broken arm. It’s going to do nothing, it’s wasting your time.”

4.1.2 Locals and Reefs

The second theme to emerge from the data was that of “locals and reefs,” which addresses the many interactions, frustrations and barriers that the operators come across when interacting with the local population. Many of the dive operators felt that creating awareness and educating the local population about the importance of coral reefs to the island of Tobago is important for the future of dive tourism and the marine environment surrounding the island. As Operator 4 states:

“A lot of us could be more educated. We are so ignorant about what we should be doing. It is a very difficult thing to change, very difficult. I mean when you are trying to tell people about even their own safety they don't pay much attention, much less try to teach them about the reefs, they don't really put much interest in it or if they aren't getting paid for it they get kind of lackadaisical about it, that is a fact.”

After discussing how they involved the local population in decision making and consultation about reef conservation and general environmental issues, some of the operators expressed that certain measures had to take place before the local population would become involved. For example one of the operators said that the locals would not attend a meeting unless it was at a certain time of night, with food and for a certain length of time, usually one to two hours. To combat this, Operator 7 suggests that another way to involve the locals is by forcing them to comply:

“It's force that is going to be required. It's not a nice thing to say but it's required. We have to start fining people heavily and once you hit them in the pocket book they will change. They are forced to change, they may not change up here [pointing to head] but they will be forced to show it. That is the only way to tackle it here, they don't understand anything else. They don't want to.”

Another issue that was raised by the operators was the fact that much of Tobago's population does not know how to swim. This has implications for garnering support in reef management and conservation. As Operator 6 mentions:

“The locals not knowing how to swim, this is a huge problem. So not only do they not appreciate what's under there, but they also can't see the changes, they can't see the drop in fish, the damage on the reefs.”

To combat this, some of the operators mentioned that organizations are now offering swimming lessons in the schools and some of the operators themselves are doing a “Discover Scuba” course with the high school to get the students more acquainted with the marine environment and to show them the role it plays in the many aspects of their lives.

Many of the operators are involved with other organizations, like Environment Tobago or Project Aware. They feel that the more involved they are, the more exposure they can give to their cause. However, some of the local population seems to feel differently. For example, when Operator 6 joined Environment Tobago people expressed concerned as to why they had joined:

“They said to me the only reason you’re interested is because it’s your livelihood and I said, let’s put this into perspective I can take my dive shop and put it anywhere else in the world, what can you do about what your kids are going to inherit? And that’s the difference. When you’re up here they automatically say you’re only interested because you make money, but what they don’t understand is that it’s not just a case of making money, if it’s destroyed it’s going to affect everyone.”

4.1.3 Bleaching and Business

The next theme to arise was “bleaching and business”. This focused on the impact that bleaching had on the operator’s business. All of the operators agreed that bleaching did not impact their business. For example Operator 6 mentions:

“I don’t think it’s impacted the business as such, obviously visitors are not seeing the reef at its best, um I think most divers accept it, it’s happening worldwide.”

The operators feel that some divers often do not realize or understand what coral bleaching is, so in turn this seems to not affect operators. As Operator 4 says:

“It doesn’t really affect the business because people don’t realize what it is or what it can do. Um, so far the business is a little bit slow. It’s still going at a pretty good pace and stuff like that so it’ll be alright.”

Some of the other operators recognize that some divers do in fact understand what coral bleaching is and what it does. For example Operator 5 says:

“I would say only 10 or 15% of the divers have a clue as to what coral bleaching is, most of them just think, hey that’s a nice white coral in general and I like to educate them. Ok maybe 20% will understand because a lot of people who dive don’t know anything about the environment. The average person who comes to dive can’t name 10 types of coral or 40 fish, can’t do it, so that’s just it, most of them just dive once a year, twice a year. They don’t really understand.”

Finally Operator 3 notes that some of his clientele do know about coral bleaching and many of them educate themselves prior to arriving at the dive shop.

“Well [divers] ask if there’s bleaching because they read about it, they are um asking how it happens and how it goes and will it recover and so on. So the few who notice that there is something different from how it was are definitely asking questions and want to know more about it. They are not saying oh, I’m not coming next year because you have dead corals here and going back to Bali or wherever else, but they are definitely asking questions and want to know about it.”

As a whole it seems that the dive operators feel coral bleaching is not detrimental to their business. However, the discussion about what divers themselves notice or are educated about varies from those who know nothing to those who are knowledgeable about the subject. Regardless of the client’s knowledge, the Tobago operators feel that their business remains unaffected.

4.1.4 Moving Forward

The final theme is “moving forward.” This represents how the operators feel heading into the future. This includes what their fears, hopes and thoughts are for coral reefs, marine life in general, humanity, and just general thoughts and concerns about what the future may hold. There are two parts to this theme; the first is that for some of the operators coral bleaching is only an indication of a much larger environmental picture. For example Operator 3 argues that:

“The real picture is more than coral bleaching. For me coral bleaching is only one signal of a lot more which is happening. Perhaps the most obvious one because you can see it immediately, but the things you cannot see like the coral diseases and stuff are much more complex and happen here, some coral has been wiped out in this part. These are also questions which look for answers.”

This idea of coral bleaching being just the beginning or a warning of what else may be in store for the marine environment is also mentioned by Operator 2, who suggests that:

“There are going to be much more problems pressuring people than a little coral bleaching although if you use the coral as a marker for the health of an ocean or a future of an ocean we are up shit creek without a paddle. So what I’m saying is what’s

happening terrifies the shit out of me. I can see the impacts and the impacts it's going to have here and what I can't achieve."

The second part of this theme is about other issues for Tobago dive operators, aside from bleaching. More so it reflects on how Tobago is a developing nation and how the economy is of more importance than environmental protection. This includes not realizing what Tobago has in regards to the natural environment and how perhaps it is underappreciated.

For example Operator 2 states:

"We have something that is natural and as every year goes by it's becoming scarcer and scarcer a commodity and that's where the money or the value is going to go. If we can keep up the pristine rainforest, if we can keep our pristine underwater environment we'll have it made. We don't have very big concrete slabs, I mean sometimes you've got to go away to realize what you've got, um and that really opened my eyes."

Realizing that Tobago is still a developing nation Operator 3 does not seem hopeful for the future of Tobago's reefs or its environment:

"The big problem in this country is that it's a developing country and they don't really give a rat's ass about environment protection and it's just a matter of time until the environment is hurt so badly that it cannot recover anymore and there will be no chance for a re-birthing process. Nothing has happened here in the previous 10 years and I don't see the change of thinking yet. The young people are more environmentally aware than the old people but the need for economical growth is a lot stronger than the push for environment. I don't really have much hope that things will change here."

Operator 3 went further and continued to express concerns about coral bleaching.

"I mean we have concerns but I don't know really what you can do against it. I mean you can reduce the stress levels of corals in a different way, maybe the sediments, but all that will not happen because this is a growing country and the financial interests are a lot higher. My concern is more that I don't believe that there can be anything done short term against coral bleaching. This is a global thing which the whole world has to get their act together to reduce emissions and greenhouse gases."

Finally, to sum up the feelings of many of the operators regarding corals, dive tourism and the environment in general Operator 6 says:

“I mean we’ve got to hope things will get better otherwise you would give up.”

After discussing what Operator 6 meant by this, he mentioned that even though there is a general lack of concern from the government, locals and the like, there still remains hope that someday it will change. He just cannot give up, and maybe someday the environment and everything in it will have a chance to survive and not be suppressed by economic development in oil and gas.

CHAPTER 5
ANALYSIS AND RESULTS OF SURVEY DATA

5.0 Introduction

This chapter presents the results from the web-based survey which was filled out after the link was sent in an email to dive operators across the Caribbean. It discusses data collection and the results that were found. This survey was mainly an exploratory study, which explains the use of basic statistical analysis of the results.

The chapter is divided into three main sections. The response rate is described in the first section, followed by the sample characteristics being described in the second section. The third section will then provide the findings for each of the seven research questions.

5.1 Survey Response Rate

The web-based survey collection took place between April and May of 2011. In total the survey link was emailed to 318 dive operators across the Caribbean region. Ninety surveys were completed, for a response rate of 28%. Some reasons for this could be that the email sent to the operators was in a sense out of nowhere and unexpected. In general individuals are wary of opening emails from those they do not know for fear of information stealing or the infiltration of their computer. Others may not have chosen to take the survey because they feel that the issue is not particularly important or perhaps they feel that they have not been in operation long enough to make comments or observations. Another reason is that web-based surveys are becoming more prominent so people may be less apt to participate in them. Finally, the area that was surveyed is geographically large and perhaps the survey would have had more success had the email been more specifically targeted to an island or individuals in a certain area.

5.2 Sample Characteristics

Table 2 displays the country in which the dive operator's business is located. When the survey link was sent out, it was sent to 37 different countries. The number of countries that responded was 27, or 75% of the total. Although operators from many countries replied, many had very few responses. For example Antigua and Barbuda, Aruba, Bahamas, Dominica, Martinique, Mexico (Cancun), St. Kitts and St. Martin all had only one respondent. Barbados, Dominican Republic, Montserrat, St. Barts and St. Lucia each had two responses. The countries that had three responses were Bermuda, Guadeloupe, Trinidad and Tobago, and Turks and Caicos. Those who had four responses were Grenada and Jamaica. Countries with five respondents included the British Virgin Islands, and the Cayman Islands. Belize, Bonaire, and the United States Virgin Islands each had 7 responses, while Curacao and Puerto Rico had nine and eleven responses, respectively.

Table 2
Location of Dive Operation

	n	Valid Pct. of Sample
Antigua & Barbuda	1	1.1
Aruba	1	1.1
Bahamas	1	1.1
Barbados	2	2.2
Belize	7	7.8
Bermuda	3	3.3
Bonaire	7	7.8
British Virgin Islands (BVI)	5	5.6
Cayman Islands	5	5.6
Curacao	9	10.0
Dominica	1	1.1
Dominican Republic	2	2.2
Grenada	4	4.4
Guadeloupe	3	3.3
Jamaica	4	4.4
Martinique	1	1.1
Mexico (Cancun)	1	1.1
Montserrat	2	2.2
Puerto Rico	11	12.2
St. Barts	2	2.2
St. Kitts	1	1.1
St. Lucia	2	2.2
St. Martin	1	1.1
Trinidad & Tobago	3	3.3
Turks & Caicos	3	3.3
United States Virgin Islands (USVI)	7	7.8

Note: The percentage reflects the valid percent (missing values were excluded)

Table 3 presents the characteristics of the dive operations, more specifically the number of years the dive operations have been in business and the number of people they employ. Most of the operators who responded have been in business from 1 to 5 years and 11 to 15 years, with each having 21% of the survey responses. The next segment is those in business 6 to 10 years, which accounted for 18% of respondents. Next were those in operation for 16 to 20 and 21 to 25 years, with each representing 12% of those who responded to the survey. Finally those in business 26 to 30 and 31 to 35 years made up 8% of the survey respondents for each category.

When looking at how many people the dive operators employ, the size of the business seems to be quite small, with most operators employing 1 to 5 people (61% of respondents). This could be attributed to a dive operation not requiring large numbers of staff, as often the dive operator is also the dive master who leads and trains divers. As well there are usually 1 to 3 additional dive masters to assist the dive operator. Other employees may be needed to captain the dive boat(s). Also, if the operations are relatively new, they may not have the capacity to hire additional employees until their business becomes more developed.

The next largest were those who responded that they had 6 to 10 employees (27% of responses). Next, those who said they employed 11 to 15 people consisted of 7% of those who participated in the survey. Following that the responding operators who employed 16 to 20 and 31+ people accounted for 2.2% of the population respectively. Finally those who employed between 21 to 25 and 26 to 30 persons accounted for 1.1% of the respondents each.

**Table 3
Business Characteristics**

	n	Valid Pct. of Sample
Years in Business		
1 to 5	19	21.1
6 to 10	16	17.8
11 to 15	19	21.1
16 to 20	11	12.2
21 to 25	11	12.2
26 to 30	7	7.8
31 to 35	7	7.8
Number of Employees		
1 to 5	54	60.7
6 to 10	24	26.7
11 to 15	6	6.7
16 to 20	2	2.2
21 to 25	1	1.1
26 to 30	1	1.1
31 +	2	2.2

Note: The percentage reflects the valid percent (missing values were excluded)

Table 4 represents when dive operators first observed coral bleaching in their area of operation by the number of years they have been in business. The earliest observation was in 1975. The year in which the most number of diver operators who responded first saw bleaching was 2005 (8.9%), which is reasonable considering the area was impacted by a mass bleaching event and approximately 40% of the responding operators were in business at the time.

When breaking the numbers down by years in operation, those in business from 1 to 5 years predominantly witnessed bleaching beginning in 2002 and ending in 2011. There were two outliers, one at 1975 and 1980. As well, in this category one of the operators specified that they had not witnessed coral bleaching. For the operators in business 6 to 10 years the results were very similar to that of 1 to 5 years. Again the majority of the operators who responded witnessed bleaching beginning in 2002 through 2011, with two operators having not witnessed coral bleaching. One outlier in this bracket witnessed bleaching in 1990. Those respondents in business from 11 to 15 years first observed bleaching in 1980 followed by four observations in 1998, which was another of the large scale bleaching event in the area. This category then again witnessed bleaching in 2000, 2005 and 2006. For the 16 to 20 year operators the earliest bleaching seen was in 1987, followed by 1995, 1997, 2000, 2001 and finally 2003. For those respondents who had been in business for 21 to 25 years the first sighting of bleaching was 1989, which was followed by 1990, 1995 and 1998 and 2003. Both 1995 and 1998 had two responses each. Operators in business for 26 to 30 years first observed bleaching in 1984, followed by 1997 and 2003. Two respondents first saw bleaching in 2005 and finally one operator in this category had not witnessed bleaching. Finally for those in operation for 31 to 35 years the first observation was in 1975, followed by 1989, 2000, 2007 and 2011, with one response each. Variations in the differences between countries and when they experienced bleaching could be

attributed to each region, country and dive site experiencing bleaching differently, as well as perhaps the length of time the operator has been in business.

Table 4
First Observation of Bleaching by Years in Business

First Observation of Bleaching	Years in Business	1 to 5	6 to 10	11 to 15	16 to 20	21 to 25	26 to 30	31 to 35	Total
1975		1	-	-	-	-	-	1	2
1980		-	-	1	-	-	-	-	1
1984		1	-	-	-	-	1	-	2
1987		-	-	-	1	-	-	-	1
1989		-	-	-	-	1	-	1	2
1990		-	1	-	-	1	-	-	2
1995		-	-	-	1	2	-	-	3
1997		-	-	-	1	-	1	-	2
1998		-	-	4	-	2	-	-	6
2000		-	-	2	3	-	-	1	6
2001		-	-	-	1	-	-	-	1
2002		1	1	-	-	-	-	-	2
2003		1	3	-	1	1	1	-	7
2004		1	1	-	-	-	-	-	2
2005		-	4	2	-	-	2	-	8
2006		2	1	2	-	-	-	-	5
2007		-	-	-	-	-	-	1	1
2010		3	1	-	-	-	-	-	4
2011		1	0	-	-	-	-	1	2
No Bleaching		1	2	-	-	-	1	-	4
Total		12	14	11	8	7	6	5	63

5.3 Operators' perceptions and opinions of past, present and future coral bleaching events

The results in Table 5 show what dive operators attribute coral bleaching to. The operators generally strongly agreed that all of the factors listed contributed to coral bleaching. However, warming waters were perceived to be the main cause of coral bleaching, with 80% of respondents strongly agreeing (M=1.27, SD=0.56) and no responding operators strongly disagreed. This was closely followed by climate change, with 59% strongly agreeing, 3.1% strongly disagreeing and a mean score of 1.66 (SD=0.97). This is not surprising, as many, if not

all, bleaching episodes occur during times of increases in sea surface temperature (SST).

Warming waters are one of the many impacts to oceans as a result of climate change. Following climate change the lack of understanding of the value of coral reefs had 42% strongly agreeing (M=2.19, SD=1.29), whereas 6.4% strongly disagreed. Other larger environmental concerns was next (38%), with a mean score of 2.03 (SD=1.03), which was followed by lacking a commitment to environmental conservation, where 37% of respondents strongly agreed that this was a factor in coral bleaching events (M=2.22, SD=1.23). 7.9% strongly disagreed. Finally, 29% strongly agreed and 8.1% strongly disagreed that land based activities and geographic location were contributing factors to the onset of coral bleaching (M=2.33, SD=1.24).

Table 5
Coral Bleaching Result of

Statement	Category	Frequency	Valid Pct. of Sample	Mean^a	SD
Warming waters	Strongly Agree	53	80.3	1.27	0.56
	Agree	9	13.6		
	Neutral	4	6.1		
	Disagree	0	0.00		
	Strongly Disagree	0	0.00		
Climate change	Strongly Agree	38	58.5	1.66	0.97
	Agree	16	24.6		
	Neutral	8	12.3		
	Disagree	1	1.5		
	Strongly Disagree	2	3.1		
Other larger environmental concerns	Strongly Agree	22	38.0	2.03	1.03
	Agree	19	32.8		
	Neutral	10	17.2		
	Disagree	6	10.3		
	Strongly Disagree	1	1.7		
Lack of understanding of the value of coral reefs	Strongly Agree	26	42.0	2.19	1.29
	Agree	11	17.7		
	Neutral	13	21.0		
	Disagree	7	12.9		
	Strongly Disagree	4	6.4		
Lacking a commitment to environmental conservation	Strongly Agree	23	36.5	2.22	1.23
	Agree	18	28.6		
	Neutral	13	20.6		
	Disagree	4	6.4		
	Strongly Disagree	5	7.9		
Land based activities	Strongly Agree	18	29.0	2.30	1.15
	Agree	20	32.3		
	Neutral	14	22.6		
	Disagree	7	11.3		
	Strongly Disagree	3	4.8		
Geographic location	Strongly Agree	18	29.0	2.33	1.24
	Agree	24	38.7		
	Neutral	10	16.1		
	Disagree	5	8.1		
	Strongly Disagree	5	8.1		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

Table 6 describes if the dive operators were given advanced notice of the 2010 coral bleaching event. Of those surveyed 65.3% said they were not informed, while 34.7% said that they were.

Table 6
Advance Notice of 2010 Bleaching

	n	Valid Pct. of Sample
Yes	25	34.7
No	47	65.3

Note: The percentage reflects the valid percent (missing values were excluded)

The results presented in Table 7 reflect how operators perceived the 2010 bleaching episode in comparison to other bleaching events. Of those who answered this question, 47.1% thought that the 2010 bleaching was not as severe as previous coral bleaching events. Subsequently, the next most popular choice for operators was that the 2010 bleaching was the same as previous coral bleaching events (22%). About 16% of those who answered this question suggested that they did not experience coral bleaching in 2010, while 15% said this was worse than previous events.

Table 7
2010 Bleaching Compared to Previous Coral Bleaching Events

	n	Valid Pct. of Sample
Worse than previous coral bleaching	10	14.7
Same as previous coral bleaching	15	22.1
Not as severe as previous coral bleaching	32	47.1
We did not experience bleaching in 2010	11	16.1

Note: The percentage reflects the valid percent (missing values were excluded)

Tables 8 shows what operators think the frequency of coral bleaching will be over the next 10 years and Table 9 displays how the operators perceive the impact of bleaching on reefs over the next ten years to be. The operators who responded expect the occurrence of bleaching to occur with the same frequency (41%) or for the bleaching events to occur more often (50%). Very few of the operators (8.6%) felt that coral bleaching events would decrease in occurrence.

Table 8
Occurrence of Bleaching Over the Next 10 Years

	n	Valid Pct. of Sample
Occur more often	35	50.0
Decrease in occurrence	6	8.6
Occur with the same frequency	29	41.4

Note: The percentage reflects the valid percent (missing values were excluded)

As for the impact future bleaching will have on coral reefs, over half (67%) of the operators who responded felt that the impact of bleaching to reefs would increase, and 28% expect bleaching to remain the same as present day. Only 6% of the operators felt that coral bleaching events would decrease. Based on responses to the following questions, the operators expect bleaching events to occur more often and with increasingly more damage to reefs.

Table 9
Bleaching Impact on Reefs Over the Next 10 Years

	n	Valid Pct. of Sample
Increase	46	66.7
Decrease	4	5.8
Remain the same as present day	19	27.5

Note: The percentage reflects the valid percent (missing values were excluded)

Table 10 shows how operators view each other's responses to coral bleaching. While 70% of respondents said that they do in fact discuss bleaching with others, 28% suggested that they do not.

Table 10
Discuss Coral Bleaching with Other Operators

	n	Valid Pct. of Sample
Yes	48	71.6
No	19	28.4

Note: The percentage reflects the valid percent (missing values were excluded)

Also, as seen in Table 11, those who responded would strongly agree (14%) and agree (32%) that operators are concerned about and taking action about coral bleaching ($M=2.75$, $SD=1.18$). 14% would disagree and 11% would strongly disagree that this is the case.

When looking at operators who are concerned and take no action those who responded to the question strongly agreed (14%) and agreed (20%) that this was the case. From the other end of the scale 8% disagreed and 2% disagreed with the statement ($M=2.46$, $SD=1.05$).

The next option was that operators were not concerned, of which 6% of respondents strongly agreed and agreed that this was what they observed. Operators who responded to this question also disagreed (17%) and strongly disagreed (11%) that other operators were not concerned ($M=3.37$, $SD=1.18$). Finally operators were asked to respond to the statement “I do not discuss coral bleaching with other operators’. Of those who answered the question 16% disagreed and 17% strongly disagreed with the statement, whereas 4% strongly agreed and 6% agreed ($M=3.60$, $SD=1.23$). So it is fair to say that operators do discuss coral bleaching with each other and that there is concern about it and action is being taken to combat the issue.

Table 11
Other Operators Opinions when Discussing Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
They are concerned and taking action	Strongly Agree	8	14.0	2.75	1.18
	Agree	18	31.6		
	Neutral	17	29.8		
	Disagree	8	14.0		
	Strongly Disagree	6	10.5		
They are concerned but take no action	Strongly Agree	13	14.4	2.46	1.05
	Agree	18	20.0		
	Neutral	22	24.4		
	Disagree	7	7.8		
	Strongly Disagree	2	2.2		
They are not concerned	Strongly Agree	5	5.6	3.37	1.18
	Agree	5	5.6		
	Neutral	18	20.0		
	Disagree	15	16.7		
	Strongly Disagree	10	11.1		
I do not discuss coral bleaching with other operators	Strongly Agree	4	4.4	3.60	1.23
	Agree	5	5.6		
	Neutral	13	14.4		
	Disagree	14	15.6		
	Strongly Disagree	15	16.7		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

After asking operators about their discussions and perceptions of other operators and their actions about coral bleaching, they were asked what impact the 2010 bleaching had on their dive operation. Table 12 shows that 71% of the operators who responded said there was ‘no impact’ on their business. This response could be attributed to coral bleaching as something the operators see, as they see it happen and they see the corals recover. Currently coral reefs are recovering from bleaching events so operators may see this as not having an impact on their business. Another reason may be that many Caribbean islands have multiple dive sites. In the case of Tobago if one area is bleached out, they simply move to another.

The next most popular selection was ‘other’ (11% of respondents). If operators chose the “other” option for this question they once again had the chance to explain their decision. The responses given by the operators were diverse and ranged from “business is so bad anyway and most people who come to dive do not know about the bleaching until they are diving,” to “some regular customers voiced concern and are considering Little Cayman for their next trip instead, since reefs there are healthier.” Other operators suggested that they experienced “no bleaching” or they “reduced the number of divers” they took out. Finally one operator suggested that there are “other issues affecting the business than bleaching.” The options of ‘financial loss’ and ‘reduced the number of dives each day’ were selected the same number of times (8%). Finally, ‘layoffs’ and a ‘plan to sell or relocate’ the operation were the least popular of all the options with each accounting for 1% of the responses.

Table 12
2010 Bleaching Impact on Business

	n	Valid Pct. of Sample
Layoffs	1	1.3
Financial loss	6	7.9
Reduced the number of dives/day	6	7.9
No impact	54	71.1
Plan to sell/relocate	1	1.3
Other	8	10.5

Note: The percentage reflects the valid percent (missing values were excluded)

Table 13 reflects those dive operators’ who responded when asked if they were aware of any other operators that had temporarily or permanently closed their business. For the temporary closure, 97% of the respondents said they did not know of any and 99% suggested that they did not know of any permanent closures. There were some who knew of a temporary closure (3%) and only one respondent (1%) who knew of a permanent closure due to coral bleaching.

Table 13
Temporary & Permanent Closure of Operations Due to Bleaching

	n	Valid Pct. of Sample
Temporary Closure		
Yes	2	2.9
No	67	97.1
Permanent Closure		
Yes	1	1.4
No	69	98.6

Note: The percentage reflects the valid percent (missing values were excluded)

Table 14 shows how operators responded to three statements about coral bleaching and their dive operations. The first statement of ‘Recent bleaching has resulted in greater financial instability for our operation’ resulted in the general consensus being that they either disagreed (38%) or strongly disagreed (22%). Only 7% strongly agreed and agreed (9%) with the statement (M=3.57, SD=1.14). The second option of ‘If bleaching continues, the future of our operation is uncertain’ resulted in 10% of the responding operators strongly agreeing, while 28% agreed. 14% disagreed and 8% strongly disagreed responses, respectively (M=2.77, SD=1.19). The final statement ‘If bleaching continues our operation is better suited to handle this change than other operators’ garnered a neutral response, with 40% of the responding operators selecting this. In the strongly agree and strongly disagree categories the operators were at 9% and 3% respectively. About 20% of the operators agreed with the statement and 7% disagreed (M=2.68, SD=0.94).

Table 14
Bleaching & Business

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
Recent bleaching has resulted in greater financial instability for our operation	Strongly Agree	5	7.2	3.57	1.14
	Agree	6	8.7		
	Neutral	17	24.6		
	Disagree	26	37.7		
	Strongly Disagree	15	21.7		
If bleaching continues, the future of our operation is uncertain	Strongly Agree	9	10.0	2.77	1.19
	Agree	25	27.8		
	Neutral	16	17.8		
	Disagree	13	14.4		
	Strongly Disagree	7	7.8		
If bleaching continues our operation is better suited to handle this change than other operators	Strongly Agree	8	8.9	2.68	0.94
	Agree	18	20.0		
	Neutral	35	38.9		
	Disagree	6	6.7		
	Strongly Disagree	3	3.3		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

In the next question operators were asked “How important is the issue of coral bleaching for your dive operation?” The overall mean score was 2.37, or a moderately high priority. However, once the question was broken down into how long the dive operations have been in business the results were varied, with perhaps the most interesting results being from those in business from 1 to 5 years, where the importance level was a medium priority, whereas those in business from 31 to 35 saw coral bleaching as a high priority. These results are presented in Table 15 and it should be noted that there was no relationship between the variables of length of time the operator had been in business and how important coral bleaching was for their business ($p=0.28$). The reason a one way ANOVA was selected was to see if there was significance between the group’s means (Diekhoff, 1992). As well no further analysis was done between groups as the sample size was limited.

Table 15
ANOVA for Years in Business by Importance of Bleaching to Operation

	n	Mean^a	SD	F	p
1 to 5	12	3.16	1.33		
6 to 10	13	2.38	1.26		
11 to 15	14	2.21	1.31	1.26	0.28
16 to 20	9	2.11	1.26		
21 to 25	9	2.44	1.74		
26 to 30	7	2.28	1.25		
31 to 35	5	1.40	0.54		

^aBased on a 5 point scale where a lower score reflects greater importance

5.4 Dive Tourist’s Response to Coral Bleaching

In the survey, dive operators were asked to rank from one to four what their dive clients are most interested in while diving, with 1 representing most interested. Based on the results in Table 16, most operators believe (67%) that their clients are interested in ‘both marine life and coral reefs’ (M=1.54, SD=0.86). This is followed by ‘predominantly marine life’ (28%), with a mean score of 2.02 (SD=0.82). 16% thought that ‘Predominantly ship wrecks’ (16%) were what their clients were most interested in (M=2.85, SD=1.12). Interestingly, 41% of responding operators also ranked this as fourth on the ranking of one to four. Finally, ‘predominantly coral reefs’ had 6% of the responding operators selecting this as number one. The logic for asking this question was to see what dive clients are interested in, and if they are predominantly interested in coral. This could then perhaps indicate that there would be a larger impact on their business. However, it appears that this is not the case, as looking at predominantly coral reefs was ranked fourth out of four.

Table 16
Dive Client Interest

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
Predominantly marine life	1	14	28.0	2.02	0.82
	2	23	46.0		
	3	11	22.0		
	4	2	4.0		
Predominantly coral reefs	1	3.3	5.6	2.90	0.87
	2	15.6	25.9		
	3	24.4	40.7		
	4	16.7	27.8		
Both marine life and coral reefs	1	47	67.1	1.54	0.86
	2	10	14.3		
	3	11	15.7		
	4	2	2.9		
Predominantly ship wrecks	1	11	15.9	2.85	1.12
	2	16	23.2		
	3	14	20.3		
	4	28	40.6		

^aBased on a ranking from 1 to 4, where 1 is most interested

Table 17 reveals whether or not dive operators noticed a difference in the number of divers they receive during a bleaching event. The general consensus of those respondents was that they “do not notice a difference in the number of divers” (M=2.08, SD=1.08) during a bleaching event, with 28% strongly agreeing and 26% agreeing. The disagree and strongly disagree percentages were 7% and 2%, respectively. When looking at whether the responding operators noticed a decrease in the number of divers 2% strongly agreed and 6% agreed that this was the case (M=3.66, SD=1.06). Those who disagreed and strongly disagreed each accounted for 19% of the responses.

21% of respondents disagreed and 17% strongly disagreed with the statement ‘I notice an increase in the number of divers.’ On the opposite end 3% of the operators strongly agreed and 1% agreed that this is the trend that they noticed (M=3.66, SD=1.01).

Table 17
Impact of Bleaching on Diver Numbers

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
I notice a DECREASE in the number of divers	Strongly Agree	2	2.2	3.66	1.06
	Agree	5	5.5		
	Neutral	17	24.4		
	Disagree	17	18.8		
	Strongly Disagree	22	18.8		
I notice an INCREASE in the number of divers	Strongly Agree	3	3.3	3.66	1.01
	Agree	1	1.1		
	Neutral	13	27.7		
	Disagree	19	21.1		
	Strongly Disagree	15	16.6		
I DO NOT NOTICE A DIFFERENCE in the number of divers	Strongly Agree	25	27.7	2.08	1.08
	Agree	23	25.5		
	Neutral	13	14.4		
	Disagree	6	6.6		
	Strongly Disagree	2	2.2		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

Table 18 shows the result as to what type of diver the operators took out prior to the 2010 bleaching event. This was based on ranking from one to five where one was equal to ‘most often’ and five ‘least often’. Predominantly, their dive clients had intermediate levels of experience (M=1.94, SD=0.91). Those respondents selecting the intermediate category as the type of diver they most often took out was 36%, followed by a number two ranking of 40%. Next was the beginner diver category, where responding operators (40%) suggested that this was the type of diver they took out most often (M=2.14, SD=1.09). Number two in this category was approximately 32%. Finally was the advanced diver categorization. Those who answered that this was the type of diver they took out most often was 22%, with 20% for the number two ranking (M=2.62, SD=1.18).

Table 18
Type of Diver Prior to 2010 Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
Advanced	1	14	21.9	2.62	1.18
	2	13	20.3		
	3	26	40.6		
	4	5	7.8		
	5	6	9.4		
Intermediate	1	24	35.8	1.94	0.91
	2	27	40.3		
	3	14	20.9		
	4	0	0.00		
	5	2	3		
Beginner	1	21	33.9	2.14	1.09
	2	20	32.3		
	3	15	24.2		
	4	3	4.8		
	5	3	4.8		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

Table 19 looks at the type of diver operators have taken out since the 2010 bleaching occurred. It shows that each category of diver was taken out ‘about the same as before’; advanced (64%), intermediate (60%) and beginner (52%). Of interest is the beginner diver category where operators who responded to the question suggested that they took out this type of diver ‘much more’ and ‘somewhat more,’ with 20% each. The classification of diver that responding dive operators suggested they took out ‘somewhat less’ was that of advanced (11%). This appears to show that the more experienced divers were less likely to dive with these operators immediately after the 2010 event. This may show that experienced divers do notice a difference in environmental quality and are therefore less likely to visit damaged environments. This is a very important finding.

Table 19
Type of Diver Since 2010 Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
Advanced	Much More	5	7.8	2.87	0.82
	Somewhat More	9	14.1		
	About the same as before	41	64.1		
	Somewhat Less	7	10.9		
	Much Less	2	3.1		
Intermediate	Much More	8	11.9	2.61	0.81
	Somewhat More	15	22.4		
	About the same as before	40	59.7		
	Somewhat Less	3	4.5		
	Much Less	1	1.5		
Beginner	Much More	13	20.0	2.49	0.93
	Somewhat More	13	20.0		
	About the same as before	34	52.3		
	Somewhat Less	4	6.2		
	Much Less	1	1.5		

^aBased on a 5 point scale where a lower score is associated with much more

The results featured in Table 20 show how dive operators perceive their dive clientele to be reacting to coral bleaching. When asked if divers are concerned about coral bleaching 38% of the operators who responded ‘strongly agree’ and 33% responded ‘agree.’ Those who disagreed represent 9% and the strongly disagreed was 3% (M=2.04, SD=4.07). The most common response to the statement that ‘divers are aware of coral bleaching’ was ‘agree’ (45%), which was followed by ‘strongly agree’ (24%). Those who responded with a ‘disagree’ or ‘strongly disagree’ were 9% and 1.4% respectively (M=2.18, SD=0.94). The statement “divers are asking for more information about coral bleaching’ had 28% disagreeing and 25% in agreement. About 17% strongly agreed with this statement and 12% strongly disagreed (M=2.91, SD=1.30). Finally, when asked if ‘divers are coming to see the bleaching’ 53% of the operators who

responded to the question suggested that they ‘strongly disagree,’ whereas 30% disagreed. Only 4% strongly agreed and 1% agreed that this is occurring (M=4.25, SD=1.01).

Table 20
Diver Reaction to Coral Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean^a	SD
Divers are concerned about coral bleaching	Strongly Agree	27	38.0	2.04	4.07
	Agree	24	33.8		
	Neutral	12	16.9		
	Disagree	6	8.5		
	Strongly Disagree	2	2.8		
Divers are aware of coral bleaching	Strongly Agree	17	23.9	2.18	0.94
	Agree	32	45.1		
	Neutral	15	21.1		
	Disagree	6	8.5		
	Strongly Disagree	1	1.4		
Divers are asking for more information about coral bleaching	Strongly Agree	13	17.4	2.91	1.30
	Agree	17	24.6		
	Neutral	13	18.8		
	Disagree	19	27.5		
	Strongly Disagree	8	11.6		
Divers are coming to see the bleaching	Strongly Agree	3	4.3	4.25	1.01
	Agree	1	1.4		
	Neutral	8	11.4		
	Disagree	21	30.0		
	Strongly Disagree	37	52.9		

^aBased on a 5 point scale where a lower score represents a higher level of agreement

5.5 Operator Response to Coral Bleaching in Comparison to Other Threats

Table 21 presents the mean scores for all the threats listed in questions 6 and 7, which asked the dive operators to compare threats now and over the next five years. The differences between the mean scores, present and future, are also listed. It should be noted that the order of the options are not displayed as they were on the web-based survey. They have been arranged to reflect the greatest difference between the mean scores of present day and over the next 5 years. At the present time, dive operators feel that the greatest threat to dive tourism is a lack of reef

protection (M=1.50, SD=0.89). However, over the next five years coastal development emerged as the most important threat to dive tourism. It is interesting to note that although the lack of reef protection and coastal development are the most important threats to dive tourism, the threat of climate change was projected to have more importance in the future, with a score of 2.05 at present to 1.80 over the next 5 years, for a difference of 0.25. As well, coral bleaching made a jump in importance over the next five years with a difference of 0.23. It should be noted that all of the threats increase in severity over the next 5 years with the exception of “poor promotion of the country as a dive destination”. The mean score of 1.94 remained the same over the next 5 years as it is at present day.

Table 21
Importance of Current & Future Threats

Threat	Present n	Day Mean^a	SD	Next 5 Mean^a	Years SD	Difference
Climate change	75	2.05	1.16	1.80	1.03	0.25
Coral bleaching	76	1.84	0.99	1.61	0.89	0.23
Coastal development	78	1.57	0.81	1.35	0.66	0.22
Water pollution	78	1.58	0.72	1.37	0.56	0.21
Anchor damage	77	1.98	1.09	1.79	1.00	0.19
Natural disaster	78	2.10	1.06	1.92	0.99	0.18
Poor fishing practices	77	1.54	0.71	1.38	0.65	0.16
Caribbean tax on incoming European flights	76	2.68	1.21	2.55	1.20	0.13
Lack of reef protection	77	1.50	0.89	1.40	0.86	0.10
Poor infrastructure	77	1.98	0.99	1.90	0.96	0.08
Poor promotion of country as a dive destination	77	1.94	1.02	1.94	1.05	0.00

^aBased on a 5 point scale where a lower score represents greater importance

After responding to the current and future threats to dive tourism in question 6 and 7, operators were asked in question 8 if there were any threats that were not mentioned in the previous questions that they felt would emerge over the next five years. Several operators responded. This section will address the most prominent and common suggestions. The first threat that was most widely mentioned by the operators was invasive species, specifically the lionfish. The lionfish is an invasive species in the Caribbean region which originated from the

Indo-Pacific region and “has the potential to become the most invasive species in marine history... reducing the abundance of coral reef fishes and leaving behind a devastated ecosystem” (Hixon, Albins & Redinger, 2009). The fish also has very few predators and has been associated with a decrease in the number of native coral reef species (Green & Cote, 2009). It is also important to mention that the impact of the lionfish along with other stresses, such as climate change, overfishing, and pollution, make the invasion of particular concern for the future of coral reefs (Hixon, Albins & Redinger, 2009). Operators felt that the hunting programs that are currently in place are useless unless the entire Caribbean region takes part in the containment of this species.

A second threat that was widely mentioned was cruise ship tourism. Many of the operators mentioned that there has been an increase in this type of tourism and that coastal development, meaning the construction of docks and dredging areas which contain reefs for anchoring, was occurring. As well they felt that there was damage to the reefs as a result of there being too many tourists snorkeling or diving in a small area and that many of them were ignorant and ended up touching many of the reefs or removing sea fans and conch shells from MPAs.

A third threat that was consistently mentioned was frustration with the government. This included suggestions that leaders have no knowledge or an uncaring attitude towards the ocean, that they do not understand how it affects everyone, and that many governments have an “out of sight, out of mind” mentality. Another way frustration with the government arose was that they were doing a poor job of enforcing fishing laws with commercial and government fishermen and that there needed to be the creation and enforcements of MPAs and their laws and boundaries.

Some unique threats that were brought up by operators that reflected their own country were mentioned by dive operators in Grenada and Bonaire. The Grenada dive operator said that

they have experienced an increase in the cost of running their dive operation. For example, gasoline costs have increased by 50% and they fear that many of the operations in Grenada will not be able to compete with other destinations because of the increased costs they have to pass onto their dive clients. In Bonaire one operator mentioned that the threats are unique because there is no anchoring and their reefs are completely protected; however, the thing that will threaten dive tourism is that the industry is not being developed and that there is poor education there, as well as external factors from the “outside world,” such as increasing CO₂ emissions.

5.6 Effective Strategies for Reef Protection

As shown in Table 22, when asked what the most effective strategies for protecting coral reefs from bleaching were 24% of the operators felt that coral monitoring programs were the most effective (M=2.13, SD=1.04). 3% suggested this would be ineffective. Growing coral gardens (24%) and building artificial reefs (29%) (M=2.33, SD=1.14) were seen as ‘moderately effective’. Not surprisingly, 43% felt that the switching to aquarium dives would be ‘ineffective’ (M=4.32, SD=0.97), while 1% suggested this was in fact a ‘very effective’ reef protection strategy. The operators also suggested that shading the reefs was ‘ineffective,’ with 25% in agreement (M=3.55, SD=1.18). Operators were ‘neutral’ (21%) about the remainder of the strategies. These includes moving the industry toward ship wreck diving (M=3.23, SD=1.32) and cooling the waters around the reefs (M=3.13, SD=1.45).

Table 22
Effective Strategies Protecting Reefs from Coral Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean ^a	SD
Transplanting corals	Very Effective	11	16.4	2.47	1.07
	Moderately Effective	29	43.3		
	Neutral	14	20.9		
	Moderately Ineffective	10	14.9		
	Ineffective	3	4.5		
Building artificial reefs	Very Effective	7	25.0	2.33	1.14
	Moderately Effective	26	38.2		
	Neutral	14	20.6		
	Moderately Ineffective	7	10.3		
	Ineffective	4	5.9		
Switching to aquarium dives	Very Effective	1	1.6	4.32	0.97
	Moderately Effective	2	3.1		
	Neutral	11	17.2		
	Moderately Ineffective	11	17.2		
	Ineffective	39	60.9		
Coral monitoring programs	Very Effective	22	31.9	2.13	1.04
	Moderately Effective	24	34.8		
	Neutral	18	26.1		
	Moderately Ineffective	2	2.9		
	Ineffective	3	4.3		
Growing coral gardens	Very Effective	17	26.2	2.33	1.14
	Moderately Effective	22	33.8		
	Neutral	18	27.7		
	Moderately Ineffective	3	4.6		
	Ineffective	5	7.7		
Moving the industry toward ship wreck diving	Very Effective	7	10.8	3.23	1.32
	Moderately Effective	13	20.0		
	Neutral	19	29.2		
	Moderately Ineffective	10	15.4		
	Ineffective	16	24.6		
Shading the reefs	Very Effective	2	3.0	3.55	1.18
	Moderately Effective	9	13.4		
	Neutral	29	43.3		
	Moderately Ineffective	4	6.0		
	Ineffective	23	34.3		
Cooling the waters around the reefs	Very Effective	11	16.4	3.13	1.45
	Moderately Effective	13	19.4		
	Neutral	19	28.4		
	Moderately Ineffective	4	6.0		
	Ineffective	20	29.9		

^aBased on a 5 point scale where a lower score is associated with greater effectiveness
Note: The percentage reflects the valid percent (missing values were excluded)

5.7 Effective Strategies for Protecting Dive Operations

The results presented in Table 23 show what operators felt were the most effective strategies in protecting their dive operation. The choice deemed most effective by the operators was that there needed to be more support for coral reef conservation through MPAs, with 57% of the participants responding that this was ‘very effective’ (M=1.66, SD=1.02) and ‘moderately effective’ (33%). Next was the diversification of business offerings (M=2.86, SD=1.28), which was seen to be ‘moderately effective’ (40%) by some of the responding operators. 18% felt that this strategy was ‘ineffective’. Joining a multinational hotel/resort chain was seen by 38% of the responding operators as “ineffective” or ‘moderately ineffective’ (15%). Of those who responded to this question 8% found this to be a ‘very effective’ method and 6% ‘moderately effective’ (M=3.69, SD=1.25). Finally the suggestion of ‘closing dive operations’ was thought to be ‘ineffective’ (49%) or ‘moderately ineffective’ (21%). None of the operators responding here felt that it was ‘very effective’ and only 6% suggested that this was a ‘moderately effective’ idea (M=4.13, SD=0.98).

Table 23
Effective Strategies Protecting Operators from Coral Bleaching

Statement	Category	Frequency	Valid Pct. of Sample	Mean^a	SD
Joining a multinational corporation	Very Effective	5	7.6	3.69	1.25
	Mod. Effective	4	6.1		
	Neutral	22	33.3		
	Mod. Ineffective	10	15.2		
	Ineffective	25	37.9		
Diversification of business offerings	Very Effective	7	10.4	2.86	1.28
	Mod. Effective	27	40.3		
	Neutral	13	19.4		
	Mod. Ineffective	8	11.9		
	Ineffective	12	17.9		
Closing dive operations	Very Effective	0	0.00	4.13	0.98
	Mod. Effective	4	6.0		
	Neutral	16	23.9		
	Mod. Ineffective	14	20.9		
	Ineffective	33	49.3		
More support for coral reef conservation through MPAs	Very Effective	39	56.5	1.66	1.02
	Mod. Effective	23	33.3		
	Neutral	1	1.4		
	Mod. Ineffective	3	4.3		
	Ineffective	3	4.3		

^aBased on a 5 point scale where a lower score is associated with greater effectiveness

After asking about what adaptation strategies would be most effective, operators were asked in question 32 what actions they planned to take in preparation for future bleaching events. The most frequent answer surrounded ‘education’. Some of the operators simply wrote “education,” whereas others said they were going to educate themselves, people in their community and their dive clients. They planned to educate divers by going over it during the training courses and dive briefings as well as getting them to monitor the reefs on the occasional dive. Some even planned on developing their own educational program focusing on coral bleaching. Another frequent response which arose was that many of the operators plan on doing nothing. Some reasons cited for this were that coral bleaching is not caused by something the

dive industry can change, that all the bleached coral had recovered so there was no need to take action right now, and finally that many of the dive centres felt they were too small to take any action or to be effective.

5.8 Barriers to Adaptation

After asking operators what adaptation strategies they felt were most effective, they were asked what barriers they encountered when applying these strategies. As seen in Table 24 the largest barrier for responding dive operators is financial constraints (54%), while only 6% thought it was no barrier. (M=1.92, SD=1.19). The next largest barrier for dive operators who responded to this question was government regulations (39%). Approximately 11% saw this as a moderate barrier or no barrier (M=2.43, SD=1.39). No support from the local community was seen as the next largest barrier, with 36% of the operators who responded to the questions suggesting this. They also suggested that this was a moderate barrier (25%). Approximately 7% saw this as a minimal barrier and 6% as no barrier (M=2.22, SD=1.19). A dependence on the reef was seen as a large (19%) to moderate barrier (29%). About 11% saw this as no barrier or a minimal barrier (7%) (M=2.61, SD=1.20). The final barrier of unsure of what strategies to use was seen as a large barrier (19%) and a moderate barrier (18%) to those who responded to this question. Approximately 6% of the operators responded that this was a minimal barrier or no barrier at all (M=2.46, SD=1.17).

Table 24
Barriers when Adapting to Coral Bleaching

Barrier	Category	Frequency	Valid Pct. of Sample	Mean^a	SD
Government Regulations	Large Barrier	26	39.4	2.43	1.39
	Moderate Barrier	7	10.6		
	Neutral	18	27.3		
	Minimal Barrier	8	12.1		
	No Barrier	7	10.6		
Financial Constraints	Large Barrier	36	53.7	1.92	1.19
	Moderate Barrier	10	14.9		
	Neutral	15	22.4		
	Minimal Barrier	2	3.0		
	No Barrier	4	6.0		
Dependence on the reef	Large Barrier	12	19.4	2.61	1.20
	Moderate Barrier	18	29.0		
	Neutral	21	33.9		
	Minimal Barrier	4	6.5		
	No Barrier	7	11.3		
No Support from the local community	Large Barrier	24	35.8	2.22	1.19
	Moderate Barrier	17	25.4		
	Neutral	17	25.4		
	Minimal Barrier	5	7.5		
	No Barrier	4	6.0		
Unsure of what strategies to use	Large Barrier	17	18.9	2.46	1.17
	Moderate Barrier	16	17.8		
	Neutral	23	25.6		
	Minimal Barrier	5	5.6		
	No Barrier	5	5.6		

^aBased on a 5 point scale where a lower score is attributed to a larger barrier

After reviewing Table 24, it was not surprising to find that the best way to ease the ‘large barrier’ of financial constraints was to provide the operators with financial support, with 40% suggesting this was most helpful and 7% saying it was the least helpful (M=2.28, SD=1.50). The results presented in Table 25 are based on the operator’s ranking, from one to six, of how helpful the choices are in helping them implement adaptation strategies. A change in government policy was the next most helpful solution, as 38% of the operators who responded to this question said this was most helpful (M=2.40, SD=1.53). 8% found it to be the least helpful.

Support from the local community is ranked as the next most helpful solution (20%), while 2% of the respondents saw this as least helpful ($M=3.14$, $SD=1.36$) for easing some of the barriers. After support from the local community is support from dive associations. Only 5% found this solution to be most helpful and 51% found it to be least helpful ($M=4.96$, $SD=1.45$).

Marketing support was seen as the next most suitable suggestion, as 4% of the operators who responded to the question said this would be most helpful and 9% said it would be least helpful ($M=3.38$, $SD=1.36$). Finally support from other operators saw only 2% suggesting that this would be helpful in easing barriers and 13.5% said it would be the least helpful ($M=4.37$, $SD=1.21$). Therefore more financial, government and local support seem to be the best strategies for helping operators adapt to coral bleaching.

Table 25
Ease of Barriers when Adapting to Coral Bleaching

Ease Implementation	Category	Frequency	Valid Pct. of Sample	Mean^a	SD
Financial support	Most helpful	23	40.4	2.28	1.50
	2	15	26.3		
	3	10	17.5		
	4	2	3.5		
	5	3	5.3		
	Least Helpful	4	7.0		
Marketing support	Most helpful	2	3.7	3.38	1.36
	2	15	27.8		
	3	14	25.9		
	4	11	20.4		
	5	7	13.0		
	Least Helpful	5	9.3		
Change in government policy	Most helpful	23	37.7	2.40	1.53
	2	13	21.3		
	3	14	23.0		
	4	4	6.6		
	5	2	3.3		
	Least Helpful	5	8.2		
Support from the local community	Most helpful	11	20.0	3.14	1.36
	2	6	10.9		
	3	9	16.4		
	4	23	41.8		
	5	5	9.1		
	Least Helpful	1	1.8		
Support from other operators	Most helpful	1	1.9	4.37	1.21
	2	6	11.5		
	3	6	11.5		
	4	9	17.4		
	5	23	44.2		
	Least Helpful	7	13.5		
Support from dive associations	Most helpful	3	5.3	4.96	1.45
	2	3	5.3		
	3	2	3.5		
	4	6	10.5		
	5	14	24.6		
	Least Helpful	29	50.9		

^aBased on ranking from 1 to 6, with 1 being the most helpful

Table 26 shows how many years dive operators feel their operations will be economically viable based on whether or not adaptation strategies are taken. If measures are taken, operators who answered the question are optimistic that their businesses will survive for 26 or more years (42%), followed by 16 to 20 years (20%). The remainder of the year ranges all come in under 15%, with 11 to 15 at 13.3%, 6 to 10 (12%), 21 to 25 (10%) and finally 0 to 5 at 3%.

However, if measures are not taken the dive operators are not as optimistic. About 28% of the respondents felt that their operation would only be feasible for another 6 to 10 years. The second most popular choice was 11 to 15 more years (23%). Two of the five year range periods came in at 17%, that of 0 to 5 and 26 or more. The final two options 16 to 20 and 21 to 25 were at 11% and 3% respectively.

It appears that if adaptation measures are taken dive operators are far more positive about the future of their operation, suggesting that they could last 26 or more years. However, if actions are not taken the majority of operators feel that their operation would only be viable for 6 to 10 more years.

Table 26
Viability of Dive Operation Based on Strategy Implementation

	n	Valid Pct. of Sample
If measures ARE taken		
0 to 5	2	3.3
6 to 10	7	11.7
11 to 15	8	13.3
16 to 20	12	20.0
21 to 25	6	10.0
26 or more	25	41.7
If measures ARE NOT taken		
0 to 5	11	17.2
6 to 10	18	28.1
11 to 15	15	23.4
16 to 20	7	11.0
21 to 25	2	3.1
26 or more	11	17.2

Note: The percentage reflects the valid percent (missing values were excluded)

5.9 Where Dive Operators Obtain Bleaching Information

Another important question asked was how operators obtain information about coral bleaching. As seen in Table 27, by far the operator's most important source of information is from their dives. This was ranked significantly higher than the next highest source. Information from dives came in at 1.59 on a scale from one to nine, whereas the next one, reef monitoring program websites, was selected at 4.51. The least important source of information about bleaching for operators was dive shows (M=6.67). The other sources were ranked as followed: NGOs (M=4.56), university researchers (M=4.61), other dive operators (M=4.83), dive magazines (M=5.17), the local dive association (M=5.77), and government agencies (M=6.32)

Table 27
Where Dive Operators Obtain Bleaching Information

	n	Mean^a	SD
First hand from my dives	69	1.59	1.68
Dive Magazines	57	5.17	2.43
Reef monitoring program websites	56	4.51	2.14
Government agencies	58	6.32	2.52
University researchers	60	4.61	2.28
Dive shows	55	6.67	1.67
NGOs	60	4.56	2.12
Other dive operators	60	4.83	2.49
Local dive association	61	5.77	2.34

^aBased on ranking from 1 to 9, with 1 being the most important source

In Table 27 the most important source of information about coral bleaching was first hand from their dives, so, not surprisingly, the same is true for how the operators were informed of the 2010 bleaching (54.4%), as can be seen in Table 28. As well, in regards to Table 27, dive shows were the option that was least utilized when they were being informed of the bleaching event. The remainder of Table 28 shows the breakdown of the other ways in which operators were informed of the 2010 coral bleaching event. Next to being informed first hand from their dives was that operators were informed by university researchers (22.2%). Following that, reef

monitoring program websites and other dive operators were how operators were informed (18.9%). Non-Governmental Organizations (17.8%) were the next most popular, followed by dive magazines, which came in at 14.4%. This was then followed by the fact that some operators were not informed (13.3%). Finally, the last three options sit at 7.8%, which are government agencies, the local dive association and other.

If operators selected the “other” category when asked about how they were informed of the 2010 bleaching event, they had the option of explaining their selection. There was no consensus in the responses as there had been with previous questions. For example, one operator from Curacao said that “coral bleaching is an annual thing that happens during the periods of the coral spawning, in this period the water gets too warm - hence the coral bleaching.” Another mentioned that they get their information from NOAA, the National Oceanic and Atmospheric Administration, and one operator said they had extensive knowledge of weather and climate. It should be noted that the valid percent of the sample is more than 100% because operators were asked to select all of the options that applied to their situation.

Table 28
How Operators Informed of 2010 Bleaching Event

	n	Valid Pct. of Sample
First hand from my dives	49	54.4
Dive Magazines	13	14.4
Reef monitoring program websites	17	18.9
Government agencies	7	7.8
University researchers	20	22.2
Dive shows	6	6.7
NGOs	16	17.8
Other dive operators	17	18.9
Local dive association	7	7.8
Other	7	7.8
I was not informed	12	13.3

Note: The percentage reflects the valid percent (missing values were excluded)

Displayed in Table 29 are the results of who the operators' preferred partner is when working on coral bleaching related issues. They selected NGOs (M=2.25, SD=1.71) as their primary choice. After this their partner of choice would be reef monitoring programs (M=2.66, SD=1.53). The option of choosing to work alone was the least favourable of the responses (M=4.85=2.55). The other potential partners were in order of ranking: other operators (M=3.33, SD=1.71), dive organizations (M=3.47, SD=1.77), a local dive association (M=3.52, SD=1.78) and finally government agencies (M=3.94, SD=2.00).

Table 29
Preferred Partner when Pursuing Coral Bleaching Related Issues

	n	Mean^a	SD
NGOs	58	2.25	1.71
Other operators	57	3.33	1.71
Government agencies	54	3.94	2.00
Local dive association	55	3.52	1.78
Dive organizations	55	3.47	1.77
Reef monitoring programs	59	2.66	1.53
I choose to work alone	48	4.85	2.55

^aBased on 1 to 7 ranking, with 1 being the most preferred

CHAPTER 6
CONCLUSION AND FURTHER STUDY

6.0 Introduction

The purpose of this study was to explore the perceptions, opinions and adaptation strategies of dive operators in the Caribbean regarding coral bleaching and its effects on their business and dive tourism. The following chapter will present a summary of the semi-structured interviews, followed by a summary and discussion of the web-based survey, and the results to each of the seven research questions. Finally, it will provide an overall conclusion, some limitations and some suggestions for further research.

As a reminder this study addressed the following research questions:

1. What are operators' perceptions and opinions of past, present and future bleaching events?
2. How have coral bleaching events affected dive operators' business?
3. How do operators perceive tourists' response to coral bleaching?
4. How are operators responding to this change of coral bleaching in comparison to other current and future business threats?
5. What strategies do dive operators feel are most effective in protecting coral reefs and their operations from coral bleaching?
6. What are some barriers operators' face when adapting to coral bleaching?
7. What avenues of communication operators use when acting on and obtaining information about coral bleaching?

6.1 Linking Results with Existing Literature on Operators

First, when looking at adaptation measures and whether tourism operators feel that they are beneficial or play a role in the future economic viability of their business the existing literature reveals that there is a need for these measures. When looking at ski area managers in Austria, Wolfsegger, Gössling and Scott (2008) found that the operator's responses suggested that adaptation measures would in fact help to alleviate the impacts of projected climate changes. For example, almost half of the operators interviewed felt that with adaptation measures their ski areas would be feasible for another 75 years (Wolfsegger, Gössling & Scott, 2008). However, when it was suggested how long the ski area would last without the use of adaptation measure 47% suggested that in 15 years their businesses would no longer be economically viable (Wolfsegger, Gössling & Scott, 2008). After analysis of the data collected for this research similar results were found which help to reinforce that in fact tourism operators are open to the ideas and positive outcomes associated with adaptation measures for their businesses. Dive tourism operators suggested that if adaptation measures are taken their operations would be viable for 26 or more years (42%), whereas if no adaptation measures are pursued 28% feel that their dive businesses would cease to be feasible in another 6 to 10 years.

After suggesting that their businesses would be economically viable for a longer period of time with adaptation measures, operators were asked what the biggest barrier is for them in implementing adaptation strategies. For those ski area managers in the Wolfsegger, Gössling and Scott (2008) study financial constraints and government regulations were the largest barriers. Caribbean dive operators also ranked financial constraints (54%) and government regulations (39%) as the two largest barriers when adapting to coral bleaching. One issue associated with dive operators and their inability to adapt because of financial constraints could be that many

tourism operators, especially those in developing areas of the world, fall into the small and medium sized business category (Roberts, 2008). This is true for Caribbean dive operators, where the majority (61%) employ between 1 and 5 people. With operations being so small it is no surprise that financial barriers are the number one constraint, as the operations may have little to no additional resources to spend on adaptation measures (Turton et al., 2010). It has also been suggested that adaptation strategies are perhaps expensive and could be another contributing factor as to why operators cite financial constraints as their number one problem (Dwyer, Edwards, Mistills, Roman & Scott, 2009). Perhaps this is an issue that could be further addressed as it seems these are two areas that tourism operators struggle with in order to sustain their operations.

The results of this study must also be seen in light of the conclusions of Gössling et al. (2008), which stated that in general and at this present time dive instructors do see environmental changes occurring in the marine environment, but that these changes, although being severe at times, were not having a major affect on the dive industry. Although this is also seen in this study in the way of operators not being affected by the 2010 bleaching event and not many operators knowing of other businesses closing down, it should be noted there is still a great concern for the future of the industry, as noted above in the discussion on adaptation strategies. Although there are fewer consequences occurring at the present time the understanding of dive operators based on their observations and perceptions of environmental change is that they still need to be concerned about coral bleaching possibilities.

When looking at where tourism operators obtain information about climate or environmental change once again a comparison can be made with the study done by Wolfsegger, Gössling and Scott (2008) who found that ski area managers obtain most of their information

from media and various ski industry sources. When looking at the dive operators in this study, their main source of information about coral bleaching, a part of environmental change, is in fact the dives that they take on a regular basis, followed by university researchers. This might be because their industry is based less around specific types of weather (ie. winter snow conditions) than ski areas, and also due to the small size of the operations themselves. Different tourism industries require different types of environments, so operators will act according to their own specific context.

6.2 Summary of the Semi-Structured Interviews

Seven face-to-face semi structured interviews were completed with Tobagonian dive operators. The four themes that arose were a ‘lack of government action’, ‘locals and reefs’, ‘bleaching and business’ and ‘moving forward’.

The first and most prominent theme, a lack of government action, discussed frustrations that operators had with the government and their unwillingness to actively pursue or act on environmental issues such as coral bleaching.

Locals and reefs was the next theme to arise and the discussion surrounding this was how the locals are unaware of the value and importance of coral reefs. This is frustrating to the operators because if the local people do not understand or value the reefs they may not see the importance of protecting and maintaining the coral reef ecosystem.

The third theme to arise from the semi-structured interviews was bleaching and business. This discussed what impact coral bleaching has had on the dive operators business. Overall it appears that coral bleaching largely does not impact Tobago dive operators and their business.

Moving forward was the final theme, which suggests how the operators feel about the future of dive tourism, their country and the bodies of water that house coral reefs and marine life. Many of the operators expressed similar concerns within this theme. Some stated that they were not hopeful because things had not improved over the last number of years so hope for the future is almost non-existent. Also, some expressed the concern that Tobago is still a developing country so economic development will take precedence over environmental protection.

6.2 Sample Characteristics of the Web-based Survey

In total 90 survey responses were collected. Since the sample for many of the countries was very small a country analysis, or a comparison of two countries that were geographically close to each other, could not be done. The small size of each country's respondent numbers was expected, as many countries have only a small number of dive operators, so this was not necessarily a negative occurrence.

The size of the business, based on how many people each operation employs, is relatively small, with 60.7% of them employing 1 to 5 people. The number of years the operators have been operational varied, with the largest amount (21%) reporting that it was between either 1 to 5 or 11 to 15 years.

The earliest that some operators began seeing coral bleaching was in 1975. However, the majority first witnessed it in the 2000s, with the year 2005 having the most observations. This is not surprising, since, as previously mentioned in Chapter 2, the 2005 bleaching was one of the worst in recorded history (Wilkinson & Souter, 2008). When broken down by the number of years the operator has been in business and their first witnessing of coral bleaching there is a diverse mix of responses with each range. For those in the 1 to 5 year category all but one of

their observations took place from 2002 to 2011, with one operator selecting they had witnessed bleaching in 1975 and another saying they had not witnessed bleaching in their area of operation.

For those operators in business 6 to 10 years the majority of the operators first saw bleaching between the years 2002 through to 2011. One operator in this category said they first witnessed bleaching in 1990 and two said they had not seen coral bleaching. For those dive operators that have been in the industry for 11 to 15 years, four saw bleaching in 1998, which coincided with another devastating coral bleaching event in the area (Wilkinson & Souter, 2008). Some in this category also first witnessed bleaching in the 2000s, more specifically 2000, 2005 and 2006. For the operators who have been in business for 16 to 20 years the earliest sign of bleaching was 1987, followed by 1995, 1997, 2000, 2001 and 2003. The operators in business over the past 21 to 25 years first saw bleaching in 1989, after which the 1990s were most prominent, more specifically 1990, 1995 and 1998. Only one operator suggested that they had first seen bleaching in 2003. Those operators in business for 26 to 30 years first observed bleaching in 1984, then again in 1997 and 2003. Two of the respondents in this bracket saw bleaching in 2005 and one operator said they had not seen bleaching in their area of operation. Lastly, those in operation the longest, for 31 to 35 years, first began seeing bleaching in 1975 and 1989. However, some in this category did not see bleaching until 2000, 2007 and 2011, respectively. It was thought that the longer an operator has been in business the earlier they would have seen coral bleaching, which would have been before those who are not as well established. This, however, was often not the case, as some of the dive operators in business the longest, 30 to 35 years, did not witness bleaching until the 2000s, which is similar to almost every other category of operator. This fits into the general need within research of this sort to

understand that experiences with coral bleaching can be wide and varied within the Caribbean and even individual countries.

Now each of the research questions will be addressed.

6.3 Research Question 1: What are operators' perceptions and opinions of past, present and future bleaching events?

To begin operators were asked what they thought caused coral bleaching. This was measured on a 5 point Likert scale ranging from 'strongly agree' to 'strongly disagree'. The most common response was that warming waters were the trigger, with 80% of the operators strongly agreeing. The second most popular suggestion was climate change, which 59% of the responding operators agreed with. These two factors are linked, as suggested in Chapter 2. The changing climate of the planet and the release of an excessive amount of CO₂ have increased the frequency and intensity of warming waters and, in turn, coral bleaching events. And, as previously mentioned, each bleaching has corresponded with elevated sea surface temperatures (Simpson et al, 2009; Baker, Glynn and Bernhard, 2008). Clearly the dive operators in the Caribbean accept that coral bleaching is caused by increased water temperature caused by climate change.

The next set of questions were directly related to the 2010 coral bleaching event, as this was the primary focus of the study, considering this was anticipated to be worse than that of 2005 (Eakin, 2010). A simple 'yes' or 'no' was all that was required of the operators when they were asked if they had any advanced notice of the 2010 bleaching. Just over half of the operators stated that they had not. This suggests that many of the dive operators in the Caribbean are currently not aware of the predictions for coral bleaching being made by forecasters such as NOAA.

The next question the dive operators were asked was how the 2010 bleaching compared to other previous coral bleaching events. The options were 'worse than', 'same as', 'not as

severe' and 'we did not experience coral bleaching in 2010.' Generally the operators felt that the 2010 bleaching was not as severe as previous coral bleaching events, with 47% of respondents suggesting that perhaps the 2010 bleaching was not as severe as was predicted by NOAA and others. This was also mentioned by Operator 5 in Tobago, who stated that "*This one isn't as bad as 2005, the percentage [of impacted corals] isn't as bad as other years either.*" This suggests that perhaps the predictions provided by NOAA were not experienced by dive operators or that the area in which the respondent dive operators are located were not impacted on such a large scale.

To answer what operators think the future of coral bleaching will be, they were asked to select what they thought the occurrence and impact to coral reefs bleaching events would be over the next 10 years. The general perception was that those dive operators who responded expected bleaching events to occur more often (50%) and have an increased impact on coral reefs (67%). This shows that the dive operators predict worsening coral health conditions in the Caribbean over the next 10 years. This was also reflected by Crabbe (2008); Simpson et al. (2008) and Wilkinson and Souter (2008), who suggest that in the Caribbean the forecasts for coral bleaching is that they will become much more frequent and perhaps will occur on an annual or bi-annual basis.

Finally operators were asked if they discussed coral bleaching with other dive operators. 72% who responded said that they do. As well, they were asked what they thought regarding other operator's opinions and actions about coral bleaching. This was again based on a 5 point Likert scale ranging from 'strongly agree' to 'strongly disagree'. The general consensus was that operators 'agree' that other operators are concerned about coral bleaching, and that they are taking action to combat it (32%). This shows that dive operators are discussing and

communicating with each other about the issue of coral bleaching, and this talk often turns into taking action against coral bleaching and its related issues.

6.4 Research Question 2: How have coral bleaching events affected dive operators' business?

To begin, operators were asked to respond on a 5 point Likert scale about how important the issue of coral bleaching was to their business. The range was 'high priority' to 'low priority.' Overall, the response was that bleaching is a 'moderately high priority' (M=2.37). Perhaps of interest is how the importance changed based on the number of years an operator has been in business. Looking at the two extreme ends, comprising those in business from either 1 to 5 years or 31 to 35 years, it was found that those operators who have been in business for 1 to 5 years saw bleaching as a 'medium priority' (M=3.16), whereas those who have been in operation for 31 to 35 years bleaching was a 'high priority' (M=1.40). This reveals that the longer term operators are more likely to understand that coral bleaching is a major future problem for their business.

In order to keep the information as recent as possible, operators were asked to answer how the 2010 event affected their dive operation. This question was formatted in a way that the operators could select all the options that applied to their situation. The clear consensus was that there was no impact on the operator's business, as 71% of the responding operators selected this. This again suggests that perhaps the 2010 bleaching and the associated projections were not as severe as predicted. But perhaps if coral bleaching events continue to worsen and become more frequent in the future the response to this question may change.

Next, two 'yes' or 'no' questions were asked to find out if the dive operators were aware of any operators who had temporarily or permanently closed their dive operations. In both instances 'no' was the predominant response. Those who said they were not aware of any

temporary closures came in at 97%, while 99% said they were not aware of any permanent operation closures. Again this suggests that coral bleaching is not a major issue impacting dive tour operators business at this point in time.

Finally, operators were asked to respond to three statements on a 5 point Likert scale ranging from 'strongly agree' to 'strongly disagree'. The first statement was 'recent bleaching has resulted in greater financial instability for our operation,' which the responding operators mainly disagreed with (28%). This shows that once again dive operators at this point in time are not being impacted by coral bleaching. The second was "if bleaching continues, the future of our operation is uncertain. For this 28% of the respondent operators selected 'agree'. They are either not seeing coral bleaching as an impact, or they are just not taking it seriously. The third statement was 'if bleaching continues our operation is better suited to handle this change than other operators,' the response for this was 'neutral' (M=2.68), with 39% selecting this option. This could be that this is not discussed or the operators do not think about this aspect. For example, in Tobago all the dive operators would help each other out. They were not so much in competition with each other so perhaps they are not thinking solely in terms of individual success alone, but the country's dive industry as a whole.

Overall it would appear that bleaching is somewhat of a priority for dive operators, especially for the long term operators, but so far the issue has not impacted their business.

6.5 Research Question 3: How do operators perceive tourists' response to coral bleaching?

To begin to understand operators' perceptions of their dive clients' response to coral bleaching, they were asked to rank from one to four what their dive clientele are most interested in. The consensus was that the visiting divers are predominantly interested in both marine life and coral. 67% of the operators who responded selecting this as their number one choice

(M=1.54). It was thought that perhaps if the divers were predominantly interested in coral reefs then the impact of coral bleaching on dive operators would be greater since diver numbers and the type of divers visiting operations would be affected.

They were then asked what divers' reaction to coral bleaching was. The overall suggestion (45%) was that divers are aware (M=2.18) and are concerned (38%) about bleaching (M=2.04).

The operators were asked if they noticed a difference in the number of divers they took out during a bleaching event. The operators 'strongly agree' (28%) that they do not notice a difference in the number of divers during a bleaching event (M=2.08). Although they may not notice a difference in the number of divers, there was some curiosity as to whether or not the type of diver changed between prior to the 2010 bleaching versus since the 2010 bleaching began.

Prior to the 2010 bleaching event the type of diver the responding operators took out 'most often' (36%) were intermediate (M=1.94). However, since the 2010 bleaching began, the types of diver they now take diving 'much more' are the beginner divers (20%). All three of the dive category's highest percentages were in the category of 'about the same as before'.

Advanced was 64%, intermediate, 60% and beginner 52%. This could be attributed to the intermediate and advanced divers being more knowledgeable of the bleaching events and not being keen to go to areas where bleaching may impact the reefs and indirectly the marine life. As well, beginner divers may not know what healthy coral and marine populations look like and would therefore feel they are not missing anything. In a study done by Gössling et al. (2008) asking dive operators if they felt environmental change would be harmful to the dive industry it

was suggested that it would not because the divers would not be aware of what was there previously and therefore would not be disappointed.

To sum up, dive clients are concerned and aware of coral bleaching; however operators are not noticing a difference in the number of divers they take out. However, it does appear that there is a slight increase in the number of beginner divers who came out since the 2010 bleaching began.

6.6 Research Question 4: How are operators responding to this change of coral bleaching in comparison to other current and future business threats?

To address this question operators were asked to individually rank a list of 11 threats on a 5 point Likert scale from 'very important' to 'very unimportant'. In one question they were asked to rank how important the threats were to dive tourism at the current time, and in the next question they were asked to rank the exact same 11 threats and how important they would be over the next five years. The 11 threats in the questions include: poor infrastructure, lack of reef protection, Caribbean tax on incoming European flights, anchor damage, water pollution, coastal development, poor fishing practices, coral bleaching, poor promotion of the country as a dive destination, climate change and natural disasters. At the current time, dive operators find the lack of reef protection (M=1.50) to be the biggest threat to dive tourism. However, over the next five years that threat changes and coastal development becomes most important (M=1.35). Of note is the threat that increases in importance the most between present day and over the next five years is climate change. The difference in importance between now (M=2.05) and into the future (M=1.80) is 0.25. The threat of coral bleaching among the 11 threats is ranked fifth both now and over the next five years.

There was an additional question which asked operators if there were any threats that were not mentioned in the previous questions that they felt would emerge over the next five

years. A number of the operators responded to this and a few of the most frequently mentioned responses will be discussed. The first was that of invasive species, particularly that of the lionfish. As previously mentioned the lionfish is an invasive species in the Caribbean which is on track to becoming one of the most damaging and destructive marine problems the region has ever seen (Hixon, Albins & Redinger, 2009). The operators felt that the programs in place to help reduce and/or eliminate the fish were ineffective and they felt the only way they could become effective was to ensure everyone in the Caribbean was participating. A second threat was cruise ship tourism. They mentioned how the coastal development of docks and the dredging of areas containing reefs was occurring so large vessels could anchor are essentially destroying reefs. Burke and Maidens (2004) also note that the result of anchor damage on reefs is extensive, as the sheer size and weight of the anchor and its chain simply destroys the reefs. As well, they felt that cruise ship passengers are very ignorant of scuba diving and snorkeling etiquette, with many citing that many touched the reefs and removed things like shells from MPAs.

6.7 Research Question 5: What strategies do dive operators feel are most effective in protecting coral reefs and their operations from coral bleaching?

To address this research question it will be broken up into three sections. The first will address effective coral reef protection strategies, followed by dive operation protection strategies, and finally what plans operators have in preparation for future bleaching events.

6.7.1 Coral Reef Protection Strategies

When asked what adaptation strategies they felt were most effective for protecting coral reefs from coral bleaching operators were given a list of adaptation strategies and were asked to select on a 5 point Likert scale how effective they thought each would be. The options on the scale ranged from “effective” to “ineffective”. The strategies operators decided upon include:

transplanting corals, building artificial reefs, switching to aquarium dives, coral monitoring programs, growing coral gardens, moving the industry toward shipwreck diving, shading the reefs and finally cooling the waters around the reefs. The strategy operators felt would be the best was coral monitoring programs with 32% of responding dive operators suggesting this is 'very effective' and 35% saw it was 'moderately effective'. These coral monitoring programs are becoming more common and are often run by NGOs such as ECOMAR Belize, Reef Check and Project Aware. From the author's experience the NGOs are often run by dive operators themselves, or the operators are very involved. Not surprisingly, the option that operators least favoured was switching to aquarium dives, where 61% of the responding operators said this would be 'ineffective' as this could potentially put the operators out of business and severely hinder the industry.

Operators were asked what they thought the future of their operation would be if adaptation measures are taken to help reduce the impact of coral bleaching. When selecting between 1 to 5, 6 to 10, 11 to 15, 16 to 20, 21 to 25 and 26 or more years, 42% believed that their businesses would be economically viable for 26 or more years. On the other hand, when asked how long they would remain viable if no action is taken against the reduction of coral bleaching through various adaptation strategies the most popular selection was that their businesses would only be viable for another 6 to 10 years (28%). Furthermore, 24 of 61 respondents (39%) revealed that regardless of adaptation there would be no difference in the number of years their operation would be economically viable. However, for those indicating some level of change it is obvious from the dive operators' selection that they are much more confident that the future of their enterprise is more secure should adaptation measures be undertaken when compared to no action being taken.

6.7.2 Dive Operation Protection Strategies

To protect their dive operation operators were asked to select what they thought was most appropriate for the coral reefs. They were asked to select on a 5 point Likert scale ranging from ‘effective’ to ‘ineffective’. The options the operators had to choose from include: joining a multinational hotel/resort chain, diversification of business offerings, closing dive operations, more support for coral reef conservation through marine protected areas. Operators selected more support for coral reef conservation through marine protected areas as the most effective strategy for protecting their business from coral bleaching (57%). This seems logical, as it would maintain the sites operators take their clients to and would allow the industry to sustain itself for a longer period of time. The option the responding dive operators felt to be ‘ineffective’ was the closing of dive operations (49%). This would be effectively reducing the industry, so the operator’s reaction to this only seems rational.

6.7.3 Preparation Plans for Future Bleaching

An open-ended question gave the dive operators the option to explain what plans they had in preparation for future bleaching events. As discussed in Chapter 5, two answers consistently appeared within all the responses; education and doing nothing. Some responses surrounding education included further educating themselves, educating the local population and divers through dive briefings and maybe even getting their dive clients involved in monitoring the reefs on a dive. This is an important response, as increasing education and awareness is often the foundational element for promoting change.

The reasons for doing nothing appeared to be that coral bleaching is not caused by something they can change, that all the coral had recovered from bleaching so there was no need to act, and finally many of the operators cited that their dive centre’s were too small to take any

action, or to be effective. Perhaps this is where an organization could step in and help these small businesses become more effective as a larger cohort and to feel like they really have the power to change things.

6.8 Research Question 6: What are some barriers operators' face when adapting to coral bleaching?

After asking about effective reef and business adaptation strategies, it seems logical to address what barriers operators may come into contact with when trying to implement them. Just as with most of the other questions the operators were asked to select on a 5 point Likert scale how much of a barrier the following options were in preventing them from implementing strategies to deal with coral bleaching. The options included: government regulations, financial constraints, dependence on the reef, no support from the local community, and unsure of what strategies to use. The barrier that poses the biggest problem for operators is financial constraints, where 54% of the operators who responded to the questions were in agreement. As was suggested earlier, many dive operations are small to medium sized enterprises, which could make it difficult for them to take action towards this change of coral bleaching. For example, Dwyer et al. (2009) suggest that perhaps one reason tourism operators are not responding to climate change is that the adaptation strategies can be costly. In regards to helping make implementation easier, the dive operators were asked to rank from 1 to 6, with 1 being 'most helpful' and 6 'least helpful'. Options for this were similar to the previous question and include: financial support, marketing support, change in government policy, support from the local community, support from other operators and support from dive associations. Not surprisingly the best way to alleviate this was through financial support (40%), which is clearly linked to the largest barrier facing operators. This can perhaps be attributed to the dive operations being

relatively small and new in terms of how long they have been in business. This would impact their ability to secure the financial resources, such as loans and lines of credit, they need to adapt.

6.9 Research Question 7: What avenues of communication do operators use when acting on and obtaining information about coral bleaching?

Research question seven will be answered in three parts. The first will be where dive operators get their coral bleaching information, the second is that of how they were informed of the 2010 bleaching, and finally who their preferred partner is when pursuing coral bleaching related issues.

To find out what the operator's most important source of information about coral bleaching is, they were asked to rank from 1 to 9 the options listed in the question, where 1 is the most important and 9 is the least important. The options include: first hand from my dives, dive magazines, reef monitoring program websites, government agencies, university researchers, dive shows, non-governmental organizations, other dive operators and local dive association. By far the operators' most important source of information about coral bleaching is from their dives (M=1.59), which is ranked much higher than the next selection of reef monitoring program websites (M=4.51). It makes sense that they get their information about bleaching from their dives because they are out on the reefs almost every day and can observe the changes themselves. This is very similar to how operators were informed of the 2010 bleaching event.

When asking about how the operators were informed of the 2010 bleaching, the operators were given a list of potential ways of being informed and we asked to select all the options that applied to them. The ways in which they could have been informed is almost an exact replication of the operators' source of information about bleaching, but with the addition of 'I was not informed' and 'other.' Over half of the operators selected that they were informed of the 2010 bleaching from their dives, with the next closest selection being university researchers, at 22%.

Again the operators receive much of their information from their dives because they witness the changes first hand and perhaps this is the easiest and most logical source for them. Why look online or ask NGOs when one can see it happen for themselves?

Lastly, the operators were asked who their preferred partner is when pursuing coral bleaching related issues. The potential preferred partner options include: non-governmental organizations, other operators, government agencies, local dive association, dive organizations, reef monitoring programs and working alone. This question also asked the operators to rank the choices from 1 to 7, with one being the most preferred and 7 the least. Non-governmental organizations are the dive operator's most preferred partner (M=2.25). The least favourable options were government agencies (M=3.52) and working alone (M=4.85).

When looking at what type of NGO the operator's partner with, it appears that organizations almost always have some affiliation with another operator. For example, in Tobago three of the operators interviewed were involved with Environment Tobago. As well, in Belize, ECOMAR, was itself run by two dive operators.

6.10 Overall Conclusion

This section will provide a quick summary of the study as well as some observations. To quickly summarize, the dive operations are generally small and relatively new. Many saw bleaching for the first time in 2005. They attribute the onset of coral bleaching to warming waters. The majority of the operators were not given advanced notice of the 2010 bleaching, and they suggested that it was not as severe as other bleaching events. Dive operators do discuss the issue of coral bleaching with each other; however the consensus is that other operators are concerned, but do not take action. The importance of bleaching to their business is a 'moderately high priority'. Divers, they believe, are aware of and are concerned about coral bleaching;

however they do not notice a difference in the number of divers they take out. At present, the biggest threat to dive tourism is a lack of reef protection and over the next five years that threat changes to coastal development. When it comes to the protection of reefs the best solution is coral monitoring programs. For protecting their business, the best option was to have more protection of the reefs through MPAs. The largest barrier facing operators are financial constraints and the way to alleviate this is obviously, with financial support. When asking about their most important source of information, the clear choice for operators was from their dives. This held true for how they were informed of the 2010 bleaching as well. Their preferred partner to work with regarding coral bleaching issues is NGOs.

Overall it appears that dive operators are passionate about coral bleaching and its impacts to their operation and the marine environment. When the initial email was sent out to ask for dive operators to participate in the study, about 20 emails were responded to asking to have the link within the first day. Of those who did take the survey, we had at least one email conversation about the survey, coral bleaching, what changes they have or have not seen, their government, what other countries are doing, etc. It appears that many are very passionate about the topic because it is their livelihood, but then again some may have chosen not to participate for the very same reason. One example of this is the dive operators from Saba. They were interested in participating in the survey, but they needed permission from the individual who ran the marine protected areas there. It ended up being that they did not take the survey. So there may be other factors at play that permit or hinder a dive operator's participation. Something else of interest was that when the initial email was sent out to see what the idea was about participating, I received bounce back emails from all dive operators listed with major hotel and resort chains like Sandals and Couples. All of the operators who answered the survey were

independent operators who did not belong to a dive operation chain or multinational company. When interviewing in Tobago only one of the operators belonged to a multinational company.

Although the study was exploratory in nature, the idea of the study was to get general information about the dive operators, their business, how the operators perceive coral bleaching in regards to other potential threats to dive tourism, and what types of things are important to them. Finding out, for example, what avenues of communication they use for obtaining information and who they partner with or prefer to partner with is helpful if an agency is trying to get information out to dive operators, as they would now know what avenues to explore and which ones to avoid. As well, it is important to utilize the exploratory research to find out what some of the limitations are for dive operators when adapting to issues like coral bleaching. In this case it appears that the dive operators are small businesses that are aware of the issues facing them, although they feel as if they are not powerful enough to make a lasting impact.

It was also interesting to see that operators do not seem to be looking into the future, or at least not very far into the future. They just seem to be focused on present conditions. This could be because they are small and new so they feel they just need to make it right now and not think too far ahead.

Perhaps one reason that coral bleaching is not ranked as a very high threat to dive tourism at the moment is that coral bleaching is seen as something that is temporary and that the corals tend to recover in a matter of months or at times even a few weeks. If coral bleaching becomes more severe and leads to a higher mortality rate in corals, then perhaps the results to these questions will change. It may be interesting to distribute the survey again in five years time to see how things have or have not changed. I think this study gives a general picture of what

operators think, how they react, what avenues of communication they use, etc., and this study and the results can be used as a building block for further research.

6.11 Limitations

As with every study there are limitations. One of the limitations for this study is that my sample list was collected from online sources, meaning there may be those without a webpage or internet listing who were missed, meaning their responses would not be included in the study. Although the survey will be sent to all member nations of the CTO the survey was only administered in English. This leaves those countries that traditionally speak other languages such as Cuba and St. Maarten, with a chance at having a lower or non-existent participation rate. As well, not all countries surveyed have the same number of operators so they may end up being underrepresented. For example, the United States Virgin Islands has 20 listed operators, whereas Anguilla only has one. Operators who have been put out of business as a result of bleaching events will not be able to partake in the survey, leaving out perhaps some interesting responses. Another limitation of this study is perhaps the seemingly short life span of an online survey. Based on the number of responses to the survey I received, it appears the window of time in which people respond is approximately four days. As well, some of the operators replied saying it was peak dive tourism season so they were not able to fill out the survey, or some responded saying they had just taken over the dive shop and did not feel comfortable answering the questions because they were not aware of the bleaching events in the area or of the current conditions of the reefs.

As well, partnering with ECOMAR had some limitations. The idea of the partnership was great, but when it came to survey implementation they left everything to the last minute. The deadline for their survey completion was extended twice and still they left everything to the last

minute, which was frustrating. But it is always a challenge working with people external to the project.

The overall sample size of 90 left us few options for doing country specific analysis or other measures such as neighbouring country comparisons. Ideally a larger sample size would have allowed for further analysis and perhaps a greater understanding of how each island experiences bleaching.

Another limitation was the use of the web-based survey. As was previously discussed there are many drawbacks to utilizing this methods of data collection. Although an easy tool to develop and distribute to the potential sample, the actual obtaining of the data and getting beyond peoples perceptions of perhaps yet another online survey or receiving an email from an unknown source can and did lead to some difficulties.

Lastly, this research is limited by time and monetary constraints as the researcher cannot go to multiple locations to do initial interviews in order to appreciate and experience different countries' unique bleaching experiences.

6.12 Suggestions for Further Research

Now that the study has been completed, it can be reflected upon and suggestions can be made for future research. As this study was exploratory in nature there was not much of a focus on characteristic data. Perhaps there could be more questions of that nature asked, such as the operators' nationality, if they are from the country or if they are there for only part of the year to run the dive shop. As well, one could ask how long the operator has been with the dive operation they are currently with, how long they have been in the dive industry as a whole, if they have worked for other dive operations, for how long, and were they in the same country as the one they are working in now.

A key suggestion would be to continue with the mixed method approach to flush out the issues and get them in greater context by discussing the issues with operators rather than just having them fill out a survey. Along with doing a mixed method approach it is important to consider doing further studies as case studies. For example, this could include just looking at Puerto Rico and what their operators' suggestions and responses are. The idea of this was brought up by one of the operators in Tobago, who said: *"People try to generalize too much, corals of the Caribbean, corals of the Pacific, you cannot do it you absolutely cannot, right, you cannot generalize and you have to look at the environment where these corals exist."* (Operator 5). It is logical, though, because even on the small island of Tobago there are three very different dive areas and each one has been impacted by and responded differently to coral bleaching and other land based threats like pollution and coastal development. As well, this was seen in the survey respondents by countries who had more than one response that the operators had differing opinions of how severe the bleaching was. In Curacao the total number of responses was nine, but the variation in how they experienced the bleaching was broad. Two said it was worse than previous bleaching, two said it was the same as a previous coral bleaching, one said it was not as severe and one selected that they had not experienced coral bleaching in 2010. Even within the basic context of this question and within one single country the responses and experiences with bleaching are different. This may be somewhat unrealistic and would definitely be a large undertaking, but to truly understand the entire picture I think it would be beneficial to see the differences between operators, as well as dive sites, on just one island.

It is therefore important to look at coral bleaching and its impact on the dive industry but perhaps it is even more necessary to further explore how operators perceive coral bleaching in comparison to other important issues impacting dive operations like coastal development, the

lion fish, cruise ship tourism and lack of reef protection, like the operators in the survey mentioned. It is my hope that this study may serve as a stepping stone for other studies and for agencies, NGOs, government or otherwise to understand how operators think about and approach the matter of coral bleaching. This is an issue that is not going away and is anticipated to progressively get more severe as our planet changes.

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Appendix A: CTO Countries and the Number of Operators Contacted

Country	Number of Operators Contacted
Anguilla	1
Antigua & Barbuda	6
Aruba	6
Bahamas	2
Barbados	10
Belize	15
Bermuda	5
Bonaire	20
British Virgin Islands	15
Cayman Islands	26
Cuba	1
Curacao	19
Dominica	5
Dominican Republic	6
Grenada	8
Guadeloupe	13
Guyana	0
Haiti	0
Jamaica	20
Martinique	20
Mexico (Cancun)	8
Montserrat	2
Nevis	1
Puerto Rico	15
Saba	3
St. Barts	4
St. Eustatius	3
St. Kitts	2
St. Lucia	9
St. Maarten	7
St. Martin	6
St. Vincent & The Grenadines	10
Suriname	0
Trinidad & Tobago	8
Turks & Caicos	12
United States Virgin Islands	20
Venezuela	10
Total	318

APPENDIX B: Semi-Structured Interview Guide for Tobago Dive Operators

1. Can you please state your

Company name:

Position:

Years of experience working in the industry:

2. Can you describe the current state of dive tourism in Tobago?

a) Has this changed in the last five years?

3. What are the biggest threats and opportunities currently facing dive tourism in Tobago?

a) We'll start with threats, ranking the biggest threat as 1 and so on.

(possible threats – anchor damage from boats, pollution, development, agriculture, tourism, recession)

i) What are your opinions about these threats?

ii) Do you think these threats can be minimized? How?

(e.g. conservation/protection (MPA), government policy, is it too late to change them, etc)

b) Now if you could do the same for opportunities that would be great.

i) What are your opinions about these opportunities and how they can be implemented, or explored in greater detail?

4. Based on your responses to the previous question, in the future do you see the threats and opportunities you mentioned changing (e.g. in importance, ranking, are there other issues you think may arise)?

If so, please list and rank them as you did in the previous question, threats ranked first, followed by opportunities.

a) What are your opinions about these future threats?

i) Do you think they can be minimized? How?

b) What are your opinions about these future opportunities?

5. Can you describe the current conditions of the reefs in this area?

(e.g. pristine, impacted, recovering)

6. Can you describe the coral bleaching events in the area? For example, can you comment on when they have occurred; the severity of them, or perhaps if they are occurring more frequently?

7. Do you work in collaboration with others in the industry on coral bleaching related issues? (e.g. monitoring the reef conditions, developing policies surrounding conservation/protection)

8. Did you have any warning to anticipate the bleaching episodes from the government, or did you watch the events unfold?
 - a) If you had warnings, how were you made aware of the bleaching?
 - b) If there was no warning, what type of system would you like to see in place to avoid this from happening again?
 - c)**If the opportunity arises** In Australia they have a monitoring program called BleachWatch (explain it) and they have experimented with other adaptations such as putting shade-cloth over the most vulnerable parts of the reef, and removing warm waters and infusing areas with cooler waters from other areas.
 - i) Do you have programs similar to these here? If so can you tell me about it? If not, can you see that working here? Why or why not?
9. Has your business been impacted by a bleaching episode?
 - a) If so, how did it affect your business? (layoffs, reduced amount of dives per day, financial difficulty)
 - b) If not, how were you able to avoid the impacts when others were affected?
10. When these bleaching events occur, do you receive any support from the government, the tourism industry, or others?
 - a)If so, what type of support did you receive? (money, etc)
11. Are you currently planning any adaptations to future coral bleaching events like the one that is currently happening?
 - a) If so, what are the measures you will take?
12. Are there any actions you would like to take, but cannot for some reason? (e.g. financial barriers, government regulations, a dependence on the reefs, etc)
13. Have you discussed coral bleaching with other operators?
 - a) Do other operators seem concerned with coral bleaching?
 - b) What are their concerns?
14. How are divers reacting to coral bleaching? Do they seem upset, interested?
15. Do you expect the bleaching episodes to worsen, or become more frequent in the future?
 - a) Why or why not?
17. Is there anything else that you think I need to know or have missed during the interview?

APPENDIX C: Email Script for Gaining Interview Participants in Tobago

Hello, my name is Mamie Sealey-Baker and I am currently a Masters student at the University of Waterloo, in Canada. I will be in Tobago from January 10th to 25th, 2011 conducting research for my thesis: Coral Bleaching and Dive Operators in the Caribbean: Observations, Understanding and Response. I am contacting you because I feel that you would be able to provide me with some valuable feedback on this issue. If possible, and if you have the time, I would like to conduct an interview with you relating to this topic. The interview will take approximately one hour to complete. Your suggestion on where to conduct the interview would be greatly appreciated. I will send you the questions that I will be asking, the study information letter, and a consent form to you by email prior to the interview, so you can become more familiar with them. Participation in this study is voluntary and confidential; your name and your company's name will not appear in the thesis or any publication. This project was reviewed and received ethics clearance through the Office of Research Ethics, University of Waterloo.

If you are interested in participating please respond to this email with times that work best for you during the dates previously mentioned. If you are not able to participate could you suggest someone else better suited for the interview?

Thank you for your time,

Mamie Sealey-Baker
MA Candidate
University of Waterloo
Ontario, Canada
msealeyb@uwaterloo.ca

Appendix D: Letter to Interview Participants

November, 2010

Dear Participant:

I am conducting a research study for my Masters degree in Recreation and Leisure Studies, from the University of Waterloo, Ontario, Canada, under the supervision of Dr. Paul Eagles from the Department of Recreation and Leisure Studies and Dr. Daniel Scott from the Department of Geography and Environmental Management. Through my research I hope to determine dive operators observations of coral bleaching; how it has affected their business; and their adaptive responses past, present and into the future.

Participation in this study is voluntary. It involves an interview of approximately one hour to be conducted at your dive shop or a place that is most convenient for you. You may decline to answer the interview questions if you so wish. Further, you may decide to withdraw from the study at any time without any negative consequences simply by letting me know your decision. With your permission, the interview will be audio recorded to facilitate collection of information, and later transcribed for analysis. Excerpts from the interview may be included in the thesis and/or publications that come out of this research. However, the source of these quotations will remain anonymous.

Shortly after the interview has been completed, I will send you a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish. Your name, occupation, and the name of your organization will not be disclosed in the thesis or any publication. All the information you provide is considered completely confidential. There are no known or anticipated risks to you as a participant in this study.

Data collected from the interviews will only be accessible by the researchers associated with this study. Notes and recordings will be kept in a secure location and will be shredded after five years.

If you have any questions concerning the study please contact me at msealeyb@uwaterloo.ca. You can also contact my supervisors; Professor Paul Eagles at 1-519-888-4567 ext. 32716m email. eagles@uwaterloo.ca; Professor Daniel Scott at 1-519-888-4567 ext. 35497, email: dj2scott@uwaterloo.ca.

I would like to assure you this study has been reviewed and has received ethics clearance through the Office of Research Ethics at the University of Waterloo, Ontario, Canada. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at 1-519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca.

I appreciate your participation in this study and if you have any questions please do not hesitate to ask me.

Thank you,
Mamie Sealey-Baker

Appendix E: Consent Form for Interview Participants

I have read the information presented in the information letter about a study being conducted by Mamie Sealey-Baker of the Department of Recreation and Leisure Studies at the University of Waterloo, Ontario, Canada, under the supervision of Dr. Paul Eagles and Dr. Daniel Scott. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted.

I am aware that I have the option of allowing my interview to be audio recorded to ensure an accurate recording of my responses.

I am also aware that excerpts from the interview may be included in the thesis and/or publications to come from this research, with the understanding that the quotations will be anonymous.

I was informed that I may withdraw my consent at any time without penalty by advising the researcher.

This project has been reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. I was informed that if I have any comments or concerns resulting from my participation in this study, I may contact the Director, Office of Research Ethics at 1-519-888-4567, ext. 36005 or by email at ssykes@uwaterloo.ca.

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.
Yes No

I agree to have my interview audio recorded.
Yes No

I agree to the use of anonymous quotations in any thesis or publication that comes of this research.
Yes No

Participant Name: _____ (Please print)

Participant Signature: _____

Witness Name: _____ (Please print)

Witness Signature: _____

Date: _____

APPENDIX F: Letter of Appreciation for Interview Participants

(On Department Letterhead)

Dear (Participant)

I am writing to thank you for taking the time to meet with me last week. It was a pleasure meeting you and I feel that I have gained some valuable insights.

I hope you will get in touch with me if you have any further thoughts or questions regarding this study. You can contact me by email at msealeyb@uwaterloo.ca.

Should you have any comments or concerns you could also contact Dr. Susan Sykes of our Office of Research Ethics at 1-519-888-4567 ext. 36005. This project was reviewed by, and received ethics clearance through, the Office of Research Ethics at the University of Waterloo. I shall as promised, be sending you a typescript copy of the transcript, for your criticism and comments. I expect it to be ready for your review by February.

Sincerely,

Mamie Sealey-Baker

APPENDIX G: Survey Information Letter

Dear (participant),

I am conducting a research study for my Masters degree in Recreation and Leisure Studies, from the University of Waterloo, Ontario, Canada, under the supervision of Dr. Paul Eagles from the Department of Recreation and Leisure Studies and Dr. Daniel Scott from the Department of Geography and Environmental Management. Through my research I hope to determine dive operators' observations of coral bleaching, how it has affected their business, and their adaptive responses past, present and into the future.

Participation in this study is voluntary and involves a 20-minute web-survey. You may decline to answer questions that you do not wish to answer and you can withdraw your participation at any time by not submitting your responses. If you begin the survey and wish to withdraw, simply close the web-browser. All incomplete surveys will be excluded from the results, and erased from the database. There are no known or anticipated risks from participating in this study.

The survey responses are confidential. Survey data will be summarized and no individual could be identified from these summarized results.

If you wish to participate, please visit the Study Website at (insert link).

Your Login: (insert)

Your Password: (insert)

The data, with no personal identifiers, collected from this study will be maintained on a password-protected computer database in a restricted access area of the university. As well, the data will be electronically archived after completion of the study and maintained for two years and then erased.

Should you have any questions about the study, please contact: Mamie Sealey-Baker at msealeyb@uwaterloo.ca, Dr. Paul Eagles by phone at 1-519-888-4567 ext. 32716 or by email at eagles@uwaterloo.ca, or Dr. Daniel Scott at dj2scott@uwaterloo.ca, or by phone at 1-519-888-4567 ext. 3549.

I would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please feel free to contact Dr. Susan Sykes, Director, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or by email at ssykes@uwaterloo.ca .

Thank you for considering participation in this study.

Appendix H: Dive Operator Survey

Title of Project: Coral Reef Bleaching and Dive Operators in the Caribbean: Perceptions, Understanding and Response

You are invited to participate in a research study conducted by Mamie Sealey-Baker, who is conducting this research for a Masters degree in Recreation and Leisure Studies from the University of Waterloo in Ontario, Canada, under the supervision of Dr. Paul Eagles from the Department of Recreation and Leisure Studies and Dr. Daniel Scott from the Department of Geography and Environmental Management. Through this research I hope to determine dive operators' observations of coral bleaching; how it has affected their business; and their adaptive responses, past, present and into the future.

Participation in this study is voluntary and confidential. You can decline to answer any questions and you can withdraw from participation by closing the web-browser. All incomplete surveys will be excluded from the results, and erased from the database. The estimated time to complete the survey is 20 minutes.

This survey uses Survey Monkey(TM) whose computer servers are located in the USA. Consequently, USA authorities under provisions of the Patriot Act may access this survey data. If you prefer not to submit your data through Survey Monkey(TM), please contact one of the researchers so you can participate using an alternative method (such as through an email or paper-based questionnaire). It is important for you to know that any information that you provide will be confidential. All data will be summarized and no individual can be identified from these summarized results.

If you have any questions after the completion of the survey please contact me at msealeyb@uwaterloo.ca. You can also contact my supervisors; Professor Paul Eagles at 1-519-888-4567 ext.32716, email eagles@uwaterloo.ca; Professor Daniel Scott at 1-519-888-4567 ext. 35497, email: dj2scott@uwaterloo.ca.

I would like to assure you this study has been reviewed and has received ethics clearance through the Office of Research Ethics at the University of Waterloo, Ontario, Canada. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at 1-519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca.

If you wish, you may complete this survey in more than one sitting by using the login and password that has been provided to you. Once you have submitted your survey, you will not be able to sign on again.

General Information

Please note: Questions assigned the * symbol require a response.

*** 1. In what country is your dive operation located?**

Please select country:

2. What is the name of your dive operation?

*** 3. How many years has your dive operation been in business?**

*** 4. How many people are employed by your dive operation?**

5. Currently coral reefs in my area of operation are:

- Pristine
- Degraded
- Recovering
- Other (please specify)

Threats & Opportunities for Dive Tourism

6. For the following options please rate how important these THREATS are to dive tourism at the CURRENT TIME.

	Very Important	Important	Neutral	Unimportant	Very Unimportant
Poor Infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Reef Protection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Caribbean Tax on Incoming European Flights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anchor Damage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water Pollution	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coastal Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Fishing Practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coral Bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Promotion of Country as a Dive Destination	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Climate Change	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Disaster (eg. Hurricane)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. For the following options please rate how important these THREATS will be to dive tourism over the next 5 YEARS.

	Very Important	Important	Neutral	Unimportant	Very Unimportant
Poor Infrastructure	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Reef Protection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Caribbean Tax on Incoming European Flights	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anchor Damage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Water Pollution	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coastal Development	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Fishing Practices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coral Bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Poor Promotion of Country as a Dive Destination	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Climate Change	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Disaster (eg. Hurricane)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

8. If there are any THREATS not previously mentioned that you feel will emerge over the next 5 years please list them below.

Threats & Opportunities for Dive Tourism

9. For the following options please rate how important these OPPORTUNITIES are to dive tourism at the CURRENT TIME.

	Very Important	Important	Neutral	Unimportant	Very Unimportant
Increasing Interest in Scuba Diving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance of Pristine Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintaining Healthy Populations of Marine Life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using Coral Bleaching as an Educational Tool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Changing Government's Attitude Towards Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Creation of Marine Protected Areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recovery from the Economic Recession	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance of Marine Protected Areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. For the following options please rate how important these OPPORTUNITIES will be to dive tourism over the next 5 YEARS.

	Very Important	Important	Neutral	Unimportant	Very Unimportant
Increasing Interest in Scuba Diving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance of Pristine Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintaining Healthy Populations of Marine Life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using Coral Bleaching as an Educational Tool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Changing Government's Attitude Towards Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Creation of Marine Protected Areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recovery from the Economic Recession	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance of Marine Protected Areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

11. If there are any OPPORTUNITIES not previously mentioned that you feel will emerge over the next 5 years please list them below.

Diver Interests

12. Please rank from 1 to 4 the features that most interest your dive clients, with 1 being most interested and 4 being least interested.

	1	2	3	4
Predominantly Marine Life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Predominantly Coral Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Both Marine Life and Coral Reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Predominantly Ship Wrecks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Perceptions & Awareness of Coral Bleaching

13. In what year did you first observe coral bleaching in your area of operation?

Please select year:

14. Over the next 10 years I expect coral bleaching events to:

- Occur more often
- Decrease in occurrence
- Occur with the same frequency

15. Over the next 10 years I expect the impact of coral bleaching on reefs to:

- Increase
- Decrease
- Remain the same as present day

16. Please rank from 1 to 9 where you get information about coral bleaching, with 1 being the most important source and 9 being the least important.

	1	2	3	4	5	6	7	8	9
First hand from my dives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dive Magazines	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reef Monitoring Program Websites	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Government Agencies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
University Researchers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dive Shows	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Non-Governmental Organizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Dive Operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local Dive Association	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Perceptions & Awareness of Coral Bleaching

17. Did you have advance notice of the 2010 bleaching episode?

- Yes
 No

18. In what way(s) were you informed about the 2010 bleaching episode? Please check all that apply.

- | | |
|---|---|
| <input type="checkbox"/> First Hand from My Dive | <input type="checkbox"/> Dive Shows |
| <input type="checkbox"/> Dive Magazines | <input type="checkbox"/> Non-Governmental Organizations |
| <input type="checkbox"/> Reef Monitoring Program Websites | <input type="checkbox"/> Other Dive Operators |
| <input type="checkbox"/> Government Agencies | <input type="checkbox"/> Local Dive Association |
| <input type="checkbox"/> University Researchers | <input type="checkbox"/> I was not informed |
| <input type="checkbox"/> Other (please specify) | |

19. How did the 2010 bleaching episode compare to other previous coral bleaching events?

- Worse than previous coral bleaching
 Same as previous coral bleaching
 Not as severe as previous coral bleaching
 We did not experience coral bleaching in 2010

Diver's Perceptions & Awareness of Coral Bleaching

20. How are divers reacting to coral bleaching in your area?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Divers are concerned about coral bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Divers are aware of coral bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Divers are asking for information about coral bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Divers are coming to see the bleaching	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

21. During a bleaching event:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
I notice a DECREASE in the number of divers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice an INCREASE in the number of divers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I DO NOT NOTICE A DIFFERENCE in the number of divers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

22. Prior to the 2010 bleaching event, the type of divers I most often took diving were: (1=most often & 5=least often)

	1	2	3	4	5
Advanced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Intermediate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beginner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

23. Since the 2010 bleaching event began, the type of divers I now take diving most often are:

	Much more	Somewhat more	About the same as before	Somewhat less	Much less
Advanced	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Intermediate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Beginner	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

24. Would you like to help educate visiting divers and snorkelers about coral bleaching?

- Yes
- No

Coral Bleaching & Business

25. Please respond to the following question by selecting 1 of 5 possible responses.

	High Priority	Moderately High Priority	Medium Priority	Moderately Low Priority	Low Priority
How important is the issue of coral bleaching for your dive operation?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

26. How was your dive operation affected by the 2010 bleaching event? Please select all that apply.

- | | |
|--|---|
| <input type="checkbox"/> Layoffs | <input type="checkbox"/> Reduced the number of dives taken each day |
| <input type="checkbox"/> Financial Loss | <input type="checkbox"/> There was no impact on my business |
| <input type="checkbox"/> Merged with Other Operator(s) | <input type="checkbox"/> I plan to sell/relocate my operation |
| <input type="checkbox"/> Other (please specify) | |

27. Do you know of any dive operators who have **TEMPORARILY** closed their business due to coral bleaching?

- Yes
 No

28. Do you know of any dive operators who have **PERMANENTLY** closed their business due to coral bleaching?

- Yes
 No

29. Please respond to the following statements by selecting 1 of 5 possible responses:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Recent bleaching has resulted in greater financial inability for our operation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If bleaching continues, the future of our operation is uncertain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If bleaching continues our operation is better suited to handle this change than other operations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Responses to Bleaching

30. How effective do you believe the following strategies are for protecting coral reefs from coral bleaching?

	Effective	Moderately Effective	Neutral	Moderately Ineffective	Ineffective
Transplanting corals	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Building artificial reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Switching to aquarium dives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Coral monitoring programs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Growing coral gardens	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Moving the industry toward ship wreck diving	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Shading the reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooling the waters around reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

31. How effective do you believe the following strategies are for protecting dive operator businesses from coral bleaching?

	Effective	Moderately Effective	Neutral	Moderately Ineffective	Ineffective
Joining a multinational hotel/resort chain	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Diversification of business offerings	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Closing dive operations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
More support for coral reef conservation through marine protected areas	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

32. What actions do you plan to take in preparation for future bleaching events? Please explain.

33. How much of a barrier are the following in preventing you from implementing strategies to deal with coral bleaching?

	Large Barrier	Moderate Barrier	Neutral	Minimal Barrier	No Barrier
Government Regulations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Financial Constraints	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dependence on the Reef	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
No support from local community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unsure of what strategies to use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

34. Please rank from 1 to 6 what would make the implementation of strategies easier, with 1 being most helpful to 6 being least helpful.

	1	2	3	4	5	6
Financial Support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Marketing Support	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Change in Government Policy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support from the local community	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support from other Operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Support from Dive Associations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

35. Would you be interested in learning more about coral bleaching?

- Yes
 No

36. If measures ARE taken to help reduce the impact of coral bleaching, how much longer will your operation be economically viable? Please select the number of years.

- 0-5
 6-10
 11-15
 16-20
 21-25
 26 or more

37. If measures ARE NOT taken to help reduce the impact of coral bleaching, how much longer do you think your operation will be economically viable? Please select the number of years.

- 0-5
 6-10
 11-15
 16-20
 21-25
 26 or more

Other Operators & Coral Bleaching

38. Please rank from 1 to 7 who you collaborate with when pursuing coral bleaching related issues, with 1 being your most preferred partner to 7 being the least preferred.

	1	2	3	4	5	6	7
Non-Governmental Organizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Government Agencies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Local Dive Association	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Dive Organizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reef Monitoring Programs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I choose to work alone	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

39. Do you discuss coral bleaching with other dive operators?

- Yes
 No

40. What are other operators' opinions when discussing coral bleaching?

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
They are concerned and taking action	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
They are concerned but take no action	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
They are not concerned	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not discuss coral bleaching with other operators	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Personal Response to Coral Bleaching

41. For you coral bleaching is the result of:

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Geographic location	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Land based activities (e.g. development, pollution)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Warming waters	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lacking a commitment to environmental conservation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Climate change	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of understanding of the value of coral reefs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other larger environmental concerns	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Thank You

42. Thank you for taking the time to complete this survey; your feedback is valuable. If you would like a copy of the study's results please leave your email address below.

Appendix I: Email Reminder to Survey Participants

This is a reminder to all those who have not completed the Caribbean **Dive Operators and Coral Bleaching** survey. One week ago, you received an email asking you to complete the survey. The email contained the URL for the survey. If you have not already completed the survey, we would ask that you please consider doing so. If you have already completed the survey, we thank you for your participation.

The survey will take approximately 20 minutes for you to complete. Your participation in this study is entirely voluntary. As a participant, you can decline to respond to any question which you do not wish to answer. If you begin the survey and wish to withdraw, simply close the web-browser. All incomplete surveys will be excluded from the results, and erased from the database. Use the survey link below to complete the survey. The web site is programmed to collect responses and will not collect any information that could potentially identify you. The survey is designed to allow you to complete the survey in more than one sitting. This can be done by re-entering the survey link into your web-browser and continuing the survey from where you last left off. Please complete the survey before May 2, 2011

Without your input, it will be impossible for the researcher to properly understand how you, dive operators view coral bleaching and its impacts.

Link to the survey:

It is important for you to know that any information you provide in the survey will be confidential. All of the data will be summarized and no individual can be identified from these summarized results. The data, with no personal identifiers, collected from this study will be grouped with responses from other participants therefore no individual responses can be identified. The results of the study will be shared with the research community and ultimately it may be possible to provide relevant advice to tourism professionals, elected officials, and policy makers.

We would like to assure you that this study has been reviewed and received ethics clearance through the Office of Research Ethics at the University of Waterloo. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please feel free to contact Dr. Susan Sykes, Director, Office of Research Ethics at ssykes@uwaterloo.ca or 1-519-888-4567 Ext. 36005.

Thank you for participating in this study. If you have any questions or concerns, please feel free to contact me at msealeyb@uwaterloo.ca

Appendix J: Letter of Appreciation to Survey Respondents

Date, 2011

Dear Participant,

We want to thank you for taking the time to participate in the Caribbean Dive Operators and Coral Bleaching survey. By having participated in the study, you have provided insight regarding what dive operators believe to be the greatest threats and opportunities facing dive tourism now and into the future. As well insights into how operators are adapting or are attempting to adapt to coral bleaching has been noted. The results of the study will be shared with the research community, dive operators and various organizations to provide advice to other tourism professionals, government officials or policy makers as to how dive operators are reacting to this important change and what they can do in order to assist further adaptations.

It is important for you to know that any information you provided in the survey is confidential. Data will be summarized and no individual can be identified from these summarized results. If you requested a copy of the study results it will be emailed to you by July, 2011.

I would like to assure you this study has been reviewed and has received ethics clearance through the Office of Research Ethics at the University of Waterloo, Ontario, Canada. However, the final decision about participation is yours. If you have any comments or concerns resulting from your participation in this study, please contact Dr. Susan Sykes of this office at 1-519-888-4567 Ext. 36005 or ssykes@uwaterloo.ca.

Again, thank you for your participation,

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