KEEPING AN 1 (AND 1.9 MILLION OTHERS) ON THE REEF: 
THE SUSTAINABILITY OF TOURISM ON THE 
GREAT BARRIER REEF 
(Full Paper)

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ABSTRACT

Marketed internationally as an iconic tourism experience, Australia’s Great Barrier Reef 
(GBR) faces a range of issues similar to those faced by coral reefs in other parts of the 
world. According to the Reef’s management authority (GRBMPA), 1.9 million tourists 
visit the reef annually, using a range of operators offering different products catering to 
different markets. Management of the tourism industry is based on a zoning system, that 
requires natural and social science input. Data on visitor experiences and satisfaction has 
been collected in the past under CRC Reef research, and more recently a new long term 
reporting system of reef tourist visitation funded under the Marine and Tropical Sciences 
Research Facility (MTRSF) through the Australian Federal Government. The 
sustainability of this industry is believed to be influenced by a range of natural (climate 
change, crown-of-thorns, etc) and social (rising cost of fuel, changing travel patterns, 
emerging markets) issues. In this paper, these issues are reviewed, before analyzing the 
reef tourism experience within the context of these issues; data are collected on socio-
demographics, travel behaviour, motivations; activities on the reef, previous reef tourism 
experience, satisfaction (best and worst experiences) and expectations. The results may 
then be compared over time with the emerging social and environmental issues and 
threats to determine their effect on the sustainability of reef tourism. Finally some of the 
solutions and strategies available to tourism operators are discussed in the light of the 
arguments presented in this paper.

Keywords: reef tourism, Great Barrier Reef

INTRODUCTION

The Great Barrier Reef (GBR) is arguably one of the iconic tourism destinations in the 
world. Listed as World Heritage Area in 1981 and included as one of the seven wonders 
of the world, its status as a must-see destination has recently been confirmed by World 
Tourism and Travel Council when it was voted “best destination” as part of the Tourism 
for Tomorrow awards in May 2007 (WTTC, 2007). According to the Great Barrier Reef
Marine Park Authority (GBRMPA, 2007), the management agency responsibility for one of Australia’s most important natural assets, the tourism industry that has developed around the marine park welcomes 1.9 million tourists each year, and is worth approximately $AU 5 billion, and supports up to 50,000 jobs along the Queensland coast. The importance of the Reef to tourism in Tropical North Queensland has been reinforced by numerous studies which suggest that seeing the Great Barrier is one of the most important motivations for visiting the region (Prideaux et al., 2006). However, whilst they are extremely visually appealing and attractive to tourists, reefs also tend to be rather fragile ecosystems that can suffer as a result of changing environmental conditions (Marshall and Schuttenberg, 2006). In order to ensure the suitability and sustainability of this industry in the face of a dynamic social and natural context, a mid-term monitoring program has been established that identifies key drivers and trends in reef tourism on the GBR. The aim of this paper is to describe this monitoring program, its uses and the research results that are particularly relevant to management, industry and tourists themselves.

THE STRUCTURE AND OPERATION OF REEF TOURISM

Tourism on the GBR is managed through a zoning and permit system that allows for a range of activities in specifically zoned areas. As part of their permits, commercial operators are required to collect an Environmental Management Charge from all visitors to the GBR Marine Park. Currently the charge is $AU $ per passenger and the revenue raised is used to fund Marine Park management including education, ranger patrols, policy development, and to support research into tourism on the reef. As a byproduct of the charge, information is available on the number of visitors carried by the operator each day and the locations visited, providing a good picture of visitation rates through the different areas of the GBR (GBRMPA, 2007).

Current commercial tourism activities on the GBR include (i) day trips on large catamarans to reef pontoons, (ii) a range of day trips to reef sites on a variety of different types of boats, (iii) day trips to islands, (iv) island camping, (v) one day dive trips, (vi) live-aboard dive trips, (vii) longer cruises, (ix) live-aboard sailing (Moscardo at al., 2003). Activities offered to tourists once they reach the reef include swimming, glass bottom boat tours, semi-submersible boat tour, SCUBA diving (as certified divers, trainee divers or introductory divers), reef viewing through viewing platforms and underwater observatories that are located on a number of pontoons and islands, visiting a range of coral islands, participating in guided/adventure snorkels, independent snorkeling, helmet diving and in a limited number of areas fishing. In addition, scenic flights using helicopters and fixed wing aircraft, and sea kayak ventures are available and appear to be growing in popularity (pers. obs).

LITERATURE REVIEW

Given the role that reef tourism has in the North Queensland tourism industry, it is apparent that ongoing research into a range of issues is required. This includes
understanding current forms of reef tourism, the popularity of different activities and the
impacts of these experiences. The GBR, in parallel with other reefs worldwide, continues
to face increasing anthropogenic and natural pressures. Most research into the reef has
had a specific scientific focus with a smaller social science focus emerging in the last two
decades. The research suggests that the Reef may be significantly impacted upon by the
year 2030. One of the main threats facing the GBR is lowered biodiversity through loss
of coral and associated changes in reef ecology. Rising sea temperatures through climate
change has been blamed for coral bleaching events, when corals become increasing
vulnerable to damage by light or increases in water temperature. Based upon predictions
of global warming rates, bleaching events are set to increase in frequency and intensity.
Events as severe as the 1998 event will become commonplace within twenty years and
bleaching events will occur annually in most tropical oceans by the end of the next 30-50
years (Wilkinson, 2002).

In addition to coral bleaching, the GBR has experienced several outbreaks of crown-of-
thorns starfish, _AcansathASTER planci_. This is a large starfish which feeds on corals by
bending its stomach out onto the coral to digest the living tissue layer. Areas of coral
that have been attacked by crown-of-thorns starfish are easily recognizable as dead, white
coral in the middle of otherwise healthy coral. Breakouts of the starfish have become
more common on the Great Barrier Reef and may be linked to increased development and
eutrophication (CRC Reef, 2003). Another significant threat to coral reefs is human
expansion and development. In particular the increasing levels of freshwater run-off and
the high sediment and pollution loads from cleared land that these may carry are a
growing problem. The sediment loads and increased nutrients in the water (causing
eutrophication of the water), decreases in the amounts of light reaching corals may cause
bleaching and speed up the growth rate of competing organisms, such as sponges and
algae. There have also been suggestions that climate change will lead to increasingly
frequent strong tropical cyclones in the Tropical North Queensland region (Watson et al.,
2001) the implications of which will be discussed in the light of the results presented in
this paper.

Compared to natural science, social science has only recently begun to attract substantial
research funding. In particular the Cooperative Research Centre for the Great Barrier
Reef World Heritage Area (CRC Reef) first established in 1994 to provide research to
support reef management has provided funding for social science research with a strong
tourism emphasis. A review by Moscardo et al. (2003) identified a range of tourism
research on the GBR including studies into the economic contribution and other direct
uses of the reef to the regional economy (Drum & Common, 1996); the environmental
impacts of tourism (Dinsdale & Harriott, 2004; Harriott, 2002; Rouphael & Inglis, 1997;
Roberts & Harriott, 1994); investigations of reef experiences at certain sites (Ormsby &
Halter, 1999); perceptions of ideal and actual coral reefs (Fenton et al, 1997); evaluation
of reef pontoons, (Moscardo, 2001) and patterns of reef tourism (Moscardo, 1999;
Moscardo and Woods, 1998; Moscardo et al., 2003). Other research has addressed issues
that include: marketing and promotion of marine tourism (Burns & Murphy, 1998;
Greenwood, 2000); an examination of the limits of acceptable change and crowding
impacts for snorkellers and divers (Roman, Dearden & Rollins, 2007; Inglis, Johnson and

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Ponte, 1999), the role of interpretation and information in reef tourism (Fenton, Young & Johnson, 1997; Green, 1997; Moscardo, Green & Greenwood, 2001; Moscardo Woods & Pearce, 1997; Moscardo, 1998, 1999, 2002; Plathong, Inglis & Huber, 2000) and research directed towards understanding the needs of different markets (Greenwood & Moscardo, 1999; Greenwood, 2000; Kim & Lee, 1998, 2000; Moscardo, Pearce, Green & O’Leary, 2001).

Most of the research outlined above has been based on short-term studies that were not followed up over time to identify emerging trends and drivers. Moreover, data has not been centralised and in many cases is not easily accessible for follow-up research. Little of the work identified above has been directed towards the possible impacts of the future dangers that have been identified in the natural science research. Based on research in other regions, a decline in reef health can be expected to translate into a decline in visitor numbers and serious impacts on regional economies. It is now apparent that there is an urgent need to develop a more rigorous methodology for undertaking social science research that incorporates the findings of natural science and is directed towards identifying possible impacts of these events on visitor patterns and experiences.

To develop a capacity for undertaking long term monitoring of visitor patterns and to identify trends, drivers and threats it is apparent that a baseline needs to be established. Using this methodology it then becomes possible to build a research framework that can inform on a range of issues including lifecycle patterns of reef tourism, changing markets, competing destinations, sustainable experiences (perceived damage, interpretation), and service quality analyses.

In response to these issues and the need for specific tourism focused research the CRC Reef sponsored a range of research projects in the period 1994 to 2006. Following the cessation of the CRC Reef in 2006 the Federal Government, through the Department of Environment and Water (formally the Department of Environment and Heritage) established the Marine and Tropical Sciences Research Facility (MTSRF) to develop a comprehensive social science research program that included tourism research. The tourism program was funded for a four year basis to examine a range of issues including examination of sustainable uses and management of marine resources (Program 4.8), and within this program an analysis of recreational and tourism use and impact on the GBR for managing sustainable tourism (Program 4.8.6).

The project identifies trends of annual visitor use patterns of the Great Barrier Reef, as well as the drivers of these patterns. Within the trends, the research identifies the supply and demand patterns, who is coming to the reef, what they are doing and where are they going, and within the drivers, the research examine both external factors such as destination image (pull factors), competition from other destinations, economic climate, health of the reef, etc. and internal factors, motivations (push factors), time and financial constraints, experience, expectations and satisfaction. The data collected includes socio-demographic variables, travel patterns, motivations, activities on the reef, previous reef tourism experience, satisfaction and expectations, best and worst experiences. This information then enables analyses of the types of tourist that come to the reef (nature-
based, mass, eco-tourist, etc), the correlates of satisfaction, the factors that affect experience and a descriptive analysis of GBR tourism experiences.

OBJECTIVES & METHODOLOGY

This paper describes the reef tourism monitoring program and its uses. Specifically, the paper describes the methodology used to collect useful information on visitor trends and drivers on the GBR; reviews the research results that are particularly relevant to reef tourism stakeholders and highlights some of the issues that will determine the structure of future tourism patterns on the GBR. These results are then used to discuss some of adaptive strategies that can be applied by industry and management to fight of the issues facing reef tourism on the GBR.

To identify drivers and trends of reef tourism a thorough literature review was first undertaken, followed by discussions with key researchers and research providers and meetings with key stakeholders (such as GBRMPA, regional tourism bodies, the Environmental Protection Agency and the Australian Marine Tourism Operators Association, AMPTO). Follow up meetings were held with AMPTO to discuss potential survey distribution methodologies and design a pilot survey based on existing research and stakeholder needs. Due to funding constraints, surveys are distributed by boat crews, not paid survey staff. In exchange for this contribution, boat operators are given a confidential report on the findings of the surveys distributed on their boat.

The pilot survey was reviewed by an external researcher and comments taken into consideration. In preparation for the launch of the survey program, several fieldtrips were undertaken to observe the distribution of the survey to identify any potential distribution issues and to obtain feedback from both crew and passengers. At the same time, participant observation techniques were used to identify and illustrate some of the key elements of reef tourism that contribute towards quality reef tours. The pilot survey was tested over a two week period in October 2006 and involved five operators in the Cairns region. After refinements were made to the survey distribution commenced in the first week of November 2006. The final survey is provided in Appendix A.

The survey is currently distributed by 11 operators across four regions (Port Douglas, Cairns, Townsville and Airlie Beach). The diversity of operators and locations ensures that nearly all the activities that are offered on the reef are represented, including pontoon trips, helicopter tours, all SCUBA diving activities (intro/resort, certified and training), helmet dives, snorkel tours, viewing chambers, semi-submersible tours, glass bottom boat tours, sailing and visiting the islands. The activities that are not represented include fishing, stays at islands resorts, and the dedicated diving liveboard operations such as those offered by members of the Cod Hole and Ribbon Reefs Association (CHARROA). This enables the researchers to be reasonably confident that most types of reef experience are represented and the replication of similar types of operations within and between different regions allows for some comparative analyses to be carried out.
There are however several limitations to this approach. The first is that survey distribution and collection is entirely dependent on boat crews, which creates the potential for surveys to be misplaced or forgotten amongst other crew duties, and may lead to concerns over the randomization of sampling, both in terms of respondents and conditions under which distribution occurs (rough/calm seas, no or lots sunshine, poor/good water clarity). Whilst boat crews have been asked to maximize sampling randomization (e.g. asking the crews to approach every fourth table on the larger boats, or every third seated person on the smaller boats, on set days of the month), it cannot always be guaranteed that staff, particularly new or casual staff, are following these instructions. The issue of randomization can also, to some extent, be addressed through large sample sizes, built up through time.

Additionally, some specific markets might not have been captured, e.g. many operators, such as Great Adventures, market their product specifically to the Asian markets, and whilst the survey is being translated into Japanese it is not distributed in that language. Furthermore, some operators have expressed concern that as the survey is only (currently) available in English, there is a strong bias towards Anglophone respondents. Again, this is a limitation of the methodology as boat crew cannot be expected to carry and distribute surveys in a range of languages, as well as issues of time, financial and human resources in terms of back-translation of open-ended questions. These limitations are acknowledged within the context of the research, and it is noted that whilst general trends may be recognizable and extrapolated, data represent only the respondents that completed the survey (as is the case in much research).

**STAKEHOLDER RELEVANT RESEARCH RESULTS**

As the research progresses, and the total sample size increases, certain trends of reef tourism start to emerge. The results presented represent the first five months of data collection (N = 1000 surveys). Not all the results of the research will be presented here, as they are all available as public goods at the RRRC website (www.rrrc.org.au). Instead some of the more pertinent results that directly affect reef tourism management and development are presented.

One of the first points that can be made is that there has been relatively little change in the socio-demographics of visitors to the GBR over the last few years. Table 1 summarizes some of the similarities between Moscardo et al.’s results published in 2003 and the results of this research. There has been little change in visitor origin (including the proportion of domestic visitors), ages, travel parties, and proportion of repeat visitors, representing a relatively stable market for the GBR. In addition, this research has highlighted the large proportion of locals that use commercial operators to visit the reef, often in the company of visiting friends and relatives.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Moscardo 2003</th>
<th>This Study &amp; O’Connaill 2006/07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Origin</td>
<td>60% Domestics</td>
<td>30% Domestics, 70% Internationals</td>
</tr>
<tr>
<td></td>
<td>40% Internationals</td>
<td>70% from UK, Ireland, North America</td>
</tr>
<tr>
<td>Age</td>
<td>35-45, 20-30 years old</td>
<td>34-39, 20-39 years old</td>
</tr>
<tr>
<td>Repeat Visitation</td>
<td>32% 1st visit</td>
<td>37% first visit</td>
</tr>
<tr>
<td>Travel Party</td>
<td>34% couple, 25% family</td>
<td>36.3% couple, 44.2% family</td>
</tr>
<tr>
<td>Information source</td>
<td>47% Friends &amp; Family</td>
<td>39% friends and relatives</td>
</tr>
<tr>
<td>Satisfaction score</td>
<td>4.6, 51% scored 8 or over</td>
<td>4.56, 75-85% scored 8 or over</td>
</tr>
<tr>
<td>Recommendation rate</td>
<td>Very recommend</td>
<td>Don’t recommend</td>
</tr>
</tbody>
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Perhaps as a result of this VFR market segment, it would appear that the social aspects of the trip are equally as important as natural aspects, such as the health of the coral. This is reflected in the responses to satisfaction influences (28.5% of responses to satisfaction influences concerned the social environment, whilst 17% of responses concerned the natural environment). In fact, it would appear that when asked what they had done during their reef trip, just over a quarter (28%) of respondents mentioned viewing marine wildlife as one of their activities (begging the question what did the remaining 72% see during the trip?), and frequently the marine wildlife that stood out in people’s minds were starfish and sea cucumbers, possibly as these animals are often presented to novice divers and snorkelers to handle as part of their reef experience. Other animals that are sometime mentioned in these cases are turtles and dolphins, whilst corals, fish, sharks and general marine life are mentioned by 26% of respondents as a best experience.

Another interesting point is that the level of staff knowledge of the marine environment and the interpretation offered on board is not frequently mentioned by respondents (4.5% of respondents). This would appear to be the case despite the substantial investment in interpretation programs by management and some operators in interpretive packages, often leading to very sophisticated interpretive experiences. This result is reinforced by participant observation of visitors during the “marine biologist’s talk” or GBR video, often only attended by 25% or less of the total number of passengers on board, and conversations with visitors who often have to be heavily prompted to discuss their evaluations of the interpretation available or what they have learnt that day. Moreover, only 50% of respondents had noticed whether their operator was eco-certified, and only one respondent mentioned eco-certification as the reason that they chose to travel with a given operator.

Other points that are highlighted by the results is that visitor price sensitivity is not high as one might believe; only 16% of respondents gave price as a reason for choosing their operator. According to the industry, however, price sensitivity might be represented instead by recommendation by agents, who will only often recommend a tour that they can sell based on its cheaper price. There is a general feeling that price sensitivity is higher than represented in the results, although 85% of respondents do feel that they got value for money on their reef trip. Moreover, since Moscardo et al.’s last study in 2003,
there appears to have been an increase in the number of respondents who would recommend the trip to others, whilst there has also been a decrease in overall satisfaction score from 8.6/10 to 8.35/10.

In terms of destination image, the results suggest that the GBR may actually be more of a snorkeling destination than a diving destination (remembering the limitations of the sample). Whilst 40% of respondents say that they planned to dive during their trip to the reef, only 29% actually dived that day. This may be accounted for by a variety of different reasons, e.g. medical constraints or the additional cost of diving, but is also reinforced by the proportion of certified divers, and uncertified divers with no previous experience (43% and 28% respectively), the relative inexperience of certified divers (median number of dives was two), and a content analysis of diving magazines that often suggest that the GBR is a good snorkeling or trainee diver destination. When examining the comments of more experienced divers and tourists who had visited other reefs, there appears to be a general consensus that the GBR does not stand out as particularly better reef than any other reef around the world (although respondents are not asked to qualify the terms “better”, “same” or “worse”) (39.5% comparisons suggested that the GBR is the same as other reefs, 26.5% suggest that GBR is better and 22% suggest that GBR is worse).

One last point that needs to be mentioned in the results is the role of seasickness. This research has highlighted that seasickness and sea state/weather is one of the key factors that determines satisfaction on the reef; e.g. when describing their worst experience of the day, “my wife was sea sick and no relief was available onboard the boat i.e. sea sick pills” or “people getting sick all over the place. Looked like a hospital when at dock”. It is results such as this that will have important implications when discussing the future of GBR reef tourism and some of the issues that it faces. One of the aims of this research is to investigate the impact of a range of drivers of visitor satisfaction and expectations. These include water quality, global warming, etc. To explore these issues, the survey has a capacity to examine the impact of issues previously identified. The first stage of this has been to examine water quality. The paper now highlights some of these issues to be investigated in more detail over the next three years, in the light of the results presented above.

SOME OF THE ISSUES FACING REEF TOURISM ON THE GBR

The GBR’s management agency, GBRMPA, is recognized internationally as a leading reef management agency, in particular for its reef tourism initiatives. It, along with the Australian Government, have also made significant advances in regulating fishing (both commercial and recreational) through the rezoning of the GBR Marine Park. However, it may be argued that as a nature-based tourism industry in a tropical, cyclone-prone marine environment, situated off-shore in a location that is relatively geographically isolated from major international tourism markets, reef tourism on the GBR will have to adapt to some emerging issues over the coming years.
As mentioned in the introduction, the GBR is believed to be facing a number of threats that will influence the future of the reef tourism industry. These are discussed in this section, before moving onto some strategies that might be applied by operators and managers to mitigate the effect of these threats. The threats themselves have been grouped into those that occur within the region and lend themselves to local management strategies, and those that fall outside the region and are more dependent on adaptive strategies by local industry.

One of the first major threats associated with the reefs in general is loss of biodiversity. As discussed in the introduction, reefs have already been subjected to two major bleaching events, the first in 1998 and the second in 2002, which reduced much of the live coral cover at various reef sites around the world (Marshall & Schuttenberg, 2006). Placed within a context of reef tourism, this is important for several reasons. Firstly, previous research suggests that live coral cover is a direct correlate with snorkeler satisfaction in Thailand (Roman et al., 2007). It may be that loss of coral cover will lead to lower visitor satisfaction. In the results shown here, it would appear that the quality of the marine life, though still important, was not the only major influence on satisfaction, and instead was one of a suite of influences that also included the professionalism of the staff, the comfort of the boat, the food offered on boat, and sharing the experience with other visitors. Whilst these results may be an artefact of different measurement techniques (in this case, respondents were not directly asked to comment upon the health of the reef and its effect upon satisfaction), it could also be argued that the time budget of a GBR trip is generally considerably different to most other reef tourism products with up to six hours of an eight or nine hour excursion being spent on board the vessel and not in the water.

A second very important consequence of biodiversity loss is public perception of coral reefs, soon to be highlighted with the International Year of the Reef in 2008. Media coverage of this topic suggests that tourists will soon be faced with an aesthetically less appealing reef and recommends that tourists visit the Reef before it dies. As the results of the IPCC report on climate change were leaked in January 2007, coral reef health became a hot topic in the media with a series of articles on the limited life expectancy of coral reefs. An example is Cosmos’ (Salt, 2006) article with its “couldn’t find Nemo” catch phrase that places the GBR among the top 10 attractions to visit before it is destroyed by climate change. Other magazines such as Qantas’ Australian Way, also ran articles on what is being done to protect the reef before it is too late (Southgate, 2007). Whilst no empirical evidence has been collected yet, there is a concern within the industry and management (pers. comm.) that this media coverage is influencing visitation patterns on the reef, e.g. increasing rates of visitation in the short term and a potential decrease in the long-term.

Another result of climate change is the increasing severity of storms expected in tropical areas such as North Queensland. Again, the impacts of these are manifold. For instance, more severe storms can cause large corals to break apart and scatter fragments about the reefs. After the storm, these slow growing corals might easily be overgrown by quicker growing algae. In addition, these storms generally bring heavy rain which increases
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runoff and sedimentation, possibly smothering the reefs (CSIRO, 2007), and again lowering biodiversity with similar results to those described in the previous paragraphs. Also, it was noted in the results that seasickness plays a very important role in visitor satisfaction. An increase in storms and rough seas can be expected to have a detrimental effect on visitor experiences, and may in extreme cases shorten the season that is suitable for long-distance travel to reefs in exposed seas.

Alongside the direct environmental and ecological effects of climate change, other impacts might be felt by the tourism industry. For instance, it was noted that many respondents are from Europe and North America (Table 1). There has been a considerable push amongst certain sectors of society in these nations to reduce carbon footprints of travel by minimizing long-haul flights (Guardian, 2007). Some of these source markets, which according to Moscardo et al. (2003) are also the repeat reef visitors may choose to visit reefs closer to home (Caribbean and Red Sea) which were found to compare favourably with the GBR (50% say that the Caribbean is the same or better and 73% say that the Red Sea is the same or better) or alternatively, may choose to visit the GBR only once “before it is too late”. One implication of this is a changing structure of visitor markets to the GBR and TNQ. Tourism Tropical North Queensland (TTNQ) has suggested the Chinese and Indian markets may become important markets in the near future. These markets will have different travel patterns (usually package tours), different demands and certainly have different attitudes towards the natural environment and environmental interpretation than TNQ’s traditional markets. In this case, it is not unimaginable to envisage a move away from nature-based tourism to some form of mass tourism, with nature as a backdrop.

In parallel to shifting visitor markets to the GBR, a rapid analysis of travel and diving magazines, as well as diving websites reveals the emergence of new reef tourism destinations, with the rise of certain South East Asian destinations such as Cambodia and Papua New Guinea, South Pacific islands, such as Vanuatu, or Hawaii’s Midway Atoll reefs in the world’s largest marine park, and even alternative destinations within Australia such as the rising profile of Ningaloo Reef Marine Park as the longest fringing reef in the world, and the associated number of backpackers visiting that region of Western Australia.

Other issues whose importance is reinforced by the results of this research are the increasing cost of fuel that is already having an impact on the cost of visiting the reef through operator fuel levies. Whilst the price sensitivity of respondents was moderately low, increasing fuel prices may act as a deterrent to certain visitors. This can be monitored over the coming years. Finally, respondents also mentioned the comfort of the boats as an important factor. Whilst this is an important factor to the respondents, some operators suggest that the industry is witnessing an ageing of existing infrastructure, such as boats and pontoons, with decreasing profit margins to reinvest into infrastructure, such as refurbishing boats, upgrading engines, investing in stabilizers and so forth (industry, pers. comm.).
DISCUSSION & CONCLUSIONS

The aim of this paper was to present a medium-term monitoring program of reef tourism on the GBR, and illustrate how some of the issues emerging out of the natural sciences (and other issues such as rising cost of fuel) affect the GBR's reef tourism industry and its sustainability using visitor data. The results presented paint a complex picture that does not always correspond to results emerging out of other reef tourism industries. For instance, the importance of the social elements of the trip as well as comfort, cost and infrastructure were highlighted here and it was suggested that the role of ecotourism, interpretation and reef health may not be as clear as in other reef tourism industries. Results such as these offer industry and management a wide scope of adaptive strategies that can be used to ensure the long-term viability of this reef tourism industry.

For instance, although reef tourism on the GBR is a form of nature-based tourism, the social component seems to be highly important, with an emphasis on staff (friendliness, helpfulness and professionalism), comfort and sharing the experience with others. This can be used to the industry's advantage in situations where the declining health of the reef may otherwise negatively impact on satisfaction. Other solutions include diversifying to include other aspects of marine environment. Most other reef destinations will include whale or dolphin watching in their experience, as well as turtles and sharks (pers. obs.). The economic value of these species can be very high. In the GBR, some operators are taking advantage of this by promoting dwarf minke whale or shark tours. Alternative activities are also important in other destinations, such as Hawaii, the Canary Islands, Western Australia and Malaysia including kayaking tours, parasailing, small boat sailing, scenic or sunset cruises, etc. These could be effectively incorporated into a marine tourism industry in Tropical North Queensland.

Other adaptive solutions include boat upgrades, as many newer boats are investing in stabilizers, and all boats now offer seasickness tablets on sale on board. Engine upgrades may also be an option for some operators, and may become a necessity as controls on carbon emissions become more stringent. Additionally, there have been some initiatives, by e.g. CSIRO to investigate carbon offsetting programs to markets that are more sensitive to their carbon footprints whilst on holidays.

In addition, we are witnessing some areas of specialization where some operators target specific markets that may demand a high level of reef interpretation, or some operators market to mass tourists who are less concerned with the condition of the reef, preferring to meet other demands such as affiliation and fun. Many operators fall in between, however, with tourists who want to see a healthy reef, but have little need of high levels of interpretation. As reef health decreases, these operators may need to rely more on interpretation of the reef to provide a quality experience.

In addition, a range of technical solutions, such as shade cloths that limit light penetration and help to minimize the bleaching (Marshall & Schuttenberg, 2006), crown-of-thorns eradication programs, reef balls to create artificial reefs and so forth have all been suggested as ways of protecting the health of the reef. These solutions fall within the scope of natural scientists and management. However, a medium-term monitoring
program such as this will be able to track changes in visitor trends, needs and satisfaction and allow managers and industry to promote the sustainability of reef tourism on the GBR in the face of a dynamic natural and social environment facing uncertain changes in the next few years.

REFERENCES


