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The Great Barrier Reef World Heritage Area: its 'value' to residents and tourists, and the effect of world prices on it

Natalie Stoeckl, Marina Farr, Diane Jarvis, Silva Larson, Michelle Esparon, Hana Sakata, Taha Chaiechi, Hongbo Lui, Jon Brodie, Stephen Lewis, Putu Mustika, Vanessa Adams, Adriana Chacon, Melissa Bos, Bob Pressey, Ida Kubiszewski and Bob Costanza

Australian Government

Department of the Environment

Reef & Rainforest
RESEARCH CENTRE

The Great Barrier Reef World Heritage Area: its 'value' to residents and tourists, and the effect of world prices on it

Final report

Natalie Stoeckl[1,2], Marina Farr[1,2], Diane Jarvis[1], Silva Larson[1], Michelle Esparon[1], Hana Sakata[7], Taha Chaiechi[1,2], Hongbo Lui[1], Jon Brodie[2], Stephen Lewis[2], Putu Mustika[1,3], Vanessa Adams[8], Adriana Chacon[1,6], Melissa Bos[6,1], Bob Pressey[6], Ida Kubiszewski[4] and Bob Costanza[4]

[1] College of Business, Law and Governance and the Cairns Institute, JCU

[2] TROPWater, JCU

[3] School of Earth and Environmental Sciences, JCU

[4] Australian National University

[5] Great Barrier Reef Marine Park Authority

[6] ARC Centre of Excellence in Coral Reef Studies, JCU

[7] Formerly with College of Business, Law and Governance, JCU; now with University of Technology, Sydney

[8] University of Queensland

James Cook University Australia

Australian National University

Australian Government
Great Barrier Reef
Marine Park Authority

Australian Government

Department of the Environment

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Acronyms Used In This Report

AIMS	Australian Institute of Marine Science
ADF	Augmented Dickey-Fuller
AUS	Australian
AUD	Australian dollars
BOM	Bureau of Meteorology
CATPCA	Categorical Principal Component Analysis
CV	Compensating variation
DERM	Department of Environment and Resource Management
ES	Ecosystem services
EV	Equivalent variation
GBR	Great Barrier Reef
GBRCA	Great Barrier Reef Catchment Area
GBRMP	Great Barrier Reef Marine Park
GBRMPA	Great Barrier Reef Marine Park Authority
GBRWHA	Great Barrier Reef World Heritage Area
GIS	Geographical information systems
JCU	James Cook University
IDS	Index of Dis-Satisfaction
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LS	Life satisfaction
MTSRF	Marine and Tropical Sciences Research Facility
NERP	National Environmental Research Program
NRM	Natural Resource Management
OLS	Ordinary Least Square
PCA	Principal Component Analysis
PP	Phillips-Peron
SELTMP	Social and economic long term monitoring program
SUR	Seemingly unrelated regressions
QOL	Quality of life
QLD	Queensland
RRRC	Reef and Rainforest Research Centre Limited
TE	Tropical Ecosystems
VAR	Vector autoregression
WC	Water clarity
WTP	Willingness to pay
WTWHA	Wet Tropics World Heritage Area

Abbreviations Used In This Report

b	billion
HH	household
k	thousand
m	million
N	number of groups
nb	"note well"
vs	versus

Acknowledgements

Executive Summary

Background

- The project was developed in response to the Great Barrier Reef Marine Park Authority (GBRMPA)'s desire to develop a socio-economic monitoring program. This project is separate but complementary to Project 10.1 (SELTMP), providing additional economic data and modelling/analytical insights.

- There are a vast number of variables (or 'indicators') that could, potentially, be monitored. But monitoring is expensive. The key problem is thus to identify a set of relevant indicators, that are practical to monitor, and that provide one with information which will help meet one's goals/targets.

- The GBRMPA's primary goal is to protect the GBRMP and world heritage area - i.e. to promote reef resilience. So we need to monitor economic indicators that provide information about reef health/resilience. In some situations, it is relatively easy to discern the link between economic indicators and reef resilience, but not always: history abounds with examples of wealthy countries, businesses and individuals who have been environmentally destructive. Knowing that an economy is, or is not 'healthy', does not tell one whether the reef is at risk. To determine that, one needs a better understanding of the interaction between various parts of the economy, and the GBRWHA.

Aims, Objectives and Structure

- This project set out to collect economic data relevant to the GBRWHA and to explore the interaction between economic variables and biophysical variables thought to be related to reef resilience (e.g. indicators of water turbidity). Its overarching aim was to improve our understanding of the way in which the economy and the GBRWHA interact, making it easier to judge (a) which economic variables are most important to monitor, and (b) how to interpret trends in those variables (i.e. whether changes are likely to be 'good' or 'bad' for the reef).

- Operationally, the project comprised three interrelated activities, the specific objectives of which were to improve our understanding of:

    (a) the 'value' of key ecosystem services (ES) that are provided by the GBRWHA to different groups of residents of the GBR catchment area (GBRCA);

    (b) the 'value' of key ES that are provided by the GBRWHA to different groups of visitors to the GBRCA;

    (c) the extent to which variations in beef prices and other socioeconomic variables (in conjunction with biophysical variables) influence water quality and thus (indirectly) reef resilience.

Simplistically, it is as if parts (a) and (b) provide us with information about the way in which the GBRWHA benefits people and the economy, whilst part (c) provides us with information about the way in which the economy affects the GBRWHA. Collectively, the project thus helps us learn more about the way in which the economic system interacts with the biophysical systems of the GBRWHA.

Methods – Activities A and B

- We conducted an extensive literature review, to identify key knowledge gaps. We found that most valuation studies of the GBR and/or the GBRWHA had concentrated on a narrow range of ecosystem services (mostly tourism and fishing), with only a few recent studies that had considered non-use values. No previous studies had explored a comprehensive range of different ecosystem services using a similar method – meaning that comparative information was not readily available. (See section 2.1)

- We ran workshops with a variety of regional stakeholders/managers/decision makers in Cairns, Brisbane and Townsville to (a) identify regionally relevant 'values' for assessment, and to (b) learn more about the issues confronting them and about how they hoped to be able to use the information generated from the project. (Section 2.1)

- Insights gleaned from the literature and workshops were used to develop draft questionnaires, which were tested in several different situations. Tourist questionnaires were also translated into Chinese and Japanese, so we were able to elicit the views of the majority of GBR tourists (most of whom are English speaking, with relatively large numbers of Mandarin and Japanese speakers in the Cairns/Port Douglas region). (Section 2.2)

- The questionnaires sought information about 'values' associated with the GBR, asking questions in a manner that would allow us to use a variety of different economic valuation techniques including, but not limited to: the contingent valuation method, expenditure and contingent behavior, Larson's IDS and life/tourist satisfaction approaches. (Section 2.2)

- Questionnaires were mailed out to a geographically stratified random sample of residents of the GBR catchment during late 2012. Questionnaires were also distributed (in person) to tourists as far north as Port Douglas and as far south as Yeppoon at regular intervals between June 2012 and 2013 (to ensure the sample included visitors across all seasons). More than 30 tourism operators also helped distribute questionnaires by making them available (with pre-paid envelopes for return) to their customers. We received more than 1500 completed questionnaires from residents and more than 2700 from tourists. (Section 2.3)

- Data were summarized using descriptive statistics and geographical information systems (GIS). They were analysed using a wide variety of techniques including, but not limited to simple correlational coefficients, factor analysis, categorical principal components analysis, ordinary least squares regression, ordinal regression, geographically weighted regression, seemingly unrelated regressions, tobit, logit, and hurdle models (Section 2.4).

Methods – Activity C

- We undertook this investigation in two parts

  - First we collated rainfall and temperature data from Australia's Bureau of Meteorology (BOM) and river discharge data from the Department of Environment and Resource Management (DERM) from 1939 to the present day in the Burdekin River catchment. We checked for 'stationarity' using the Augmented Dickey-Fuller (ADF) test, the Phillips-Peron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test, finding it to be so. We then developed and compared several different time-series models explaining the rainfall-discharge relationships, selecting a model and modelling approach that did the 'best' job. (Section 5.1)

- Next we collated data on sediment loads (hind-cast using coral core samples), vegetation and land cover, cattle numbers, beef and gold prices, interest rates, wages, rainfall and extreme events for the Burdekin catchment between 1939 and the present day. The data were combined with data from the BOM and DERM within a Vector Auto Regression (VAR) model, so that we could look for evidence of a price 'signal' in sediment loads, after controlling for other factors (particularly rainfall and extreme events). (Section 5.2)

Key Findings from Activities A and B

- The non-market goods and services provided by the GBR (e.g. having healthy coral reefs, healthy reef fish, clear ocean water, and preserving the reef for future generations) are considered, by residents of the catchment, to be more important to their overall quality of life than recreational values (e.g. being able to go fishing, boating, or spending time at the beach). These recreational values are, themselves, considered to be more important than the jobs and incomes associated with different industries (Larson *et al.,* 2014a, 2014b). (Sections 3.1 & 3.2)

- Environmental and recreational values of the GBR are also considered, by tourists, to have been more important in their decision to visit the coastal area adjacent to the GBRWHA than other market-related 'values' such as good quality accommodation, being able to meet budget, visiting friends and relatives and/or attending to business (Esparon *et al.,* accepted). (Section 4.1)

- Residents and tourists react more negatively to the prospect of degradation of the environment than to the prospect of a 20% increase in prices (Stoeckl *et al.,* 2013; Esparon *et al.,* accepted; Mustika *et al.,* forthcoming). (Sections 2, 4.1 & 4.2)

- As such, our finding that GBR-based environmental values – particularly non-use values – are more important than market values appears consistent across sample groups (residents and tourists) and across methodological approaches (importance, satisfaction, IDS and contingent behavior).

- We generated estimates of several different 'total' values

  o Using novel approaches to control for the problem of inseparable values, we estimate that the collective value of all of the ecosystem services provided by the GBRWHA is likely to be worth at least $15b per annum – possibly as much as $20b (Stoeckl *et al.,* 2014). This figure is not implausible. The tourism industry is 'worth' in excess of $4b per annum to residents of the catchment (Deloitte Access Economics, 2013), and our estimate of 'total' value includes tourism, recreational, cultural and other non-use values (all deemed to be at least, or 'more important' to the overall quality of life of residents than the jobs and incomes associated with reef-based tourism). (Section 3.3)

  o Using other novel approaches, we also generated estimates of the financial value of only non-use values: approximately $7.5b (Jarvis *et al.,* in review). This is consistent with Stoeckl *et al.*'s (2014) finding that non-use values are worth a minimum of $4b. (Section 3.4)

  o We found that total expenditure per visitor per trip was higher for non-business visitors than for business visitors (approximately to $1,760 compared to $1,290) – largely because they spent more time in the region. More than 60% of expenditure is on accommodation and food (at cafes, restaurants, and other retail outlets). (Mustika *et al.,* forthcoming). (Section 4.2)

- We also generated estimates of several different 'marginal' values.

  o We combined responses to our contingent behavior questions with information about tourist expenditure to generate estimates of the potential loss in visitor expenditure that could happen, should various types of environmental degradation occur. Using novel methods to control for hypothetical response bias, we estimate that these amounts could be up to $300 per visitor, or about 17% of current expenditure (Mustika *et al.*, forthcoming). (Section 4.2)

  o After controlling for factors such as income, gender and length of stay, we found that tourists who experienced clearer water and/or maximum daily temperatures that were close to 29 degrees centigrade while in the region had higher levels of overall trip satisfaction than other tourists (Jarvis, forthcoming; Jarvis et al, in review). We were able to use coefficients from our model with water turbidity, to generate estimates of the potential loss of tourism revenues that could occur if sediment increased by 10% (about $400,000 annually across the entire GBR catchment area) – Jarvis *et al.,* (in review). (Sections 4.3 & 4.4)

  o We found that residents were willing to pay about $32 per annum per household to help improve water quality, $27 to reduce the risk of shipping accidents and $29 to protect top predators per household per annum. For tourists these figures were $14.5, $15.5 and $9 per person per visit, respectively. The amount people were willing to pay, however, was contingent upon 'others paying too' (respondents did not want to be the only person paying). In the case of water quality and tourists, the amount people were willing to pay also depended upon the importance of water quality to the respondent and upon their perceptions (not actual measures) of its quality (Farr *et al.*, 2014a). (Section 4.5)

- Averages aside, our results confirmed that different people 'value' things differently, finding consistent patterns across samples (tourists and residents) and methodological approaches. Most notably the relative importance of environmental non-use, recreational, and industry 'values' (assessed using importance scores, Larson's IDS, contingent behavior and Willingness to pay (WTP) questions) differed for people of different gender, education, income (and, in contrast to expectations, this did not always have the same effect as education), ages, industries of association, places of origin/birth, places of residence/region being visited, and (to a lesser extent), marital status.

Key Findings from Activity C

- We found that between 1938 and 1983 (when the Burdekin dam was built), extreme events and cattle numbers had most impact on sediment loads. In this pre-dam model, beef and gold prices had a statistically significant impact on sediment loads, but the magnitude of these impacts was negligible. Wages did not have statistically significant influence on sediment loads. (Section 5.2)

- The full-period model shows more price (cost) sensitivity: in this model lower beef or higher gold prices and/or higher wage costs are all associated with lower sediment loads. Readers are cautioned that these results are an average of responses before and after the dam, so do not provide detailed information about what is likely to happen in the current (post-dam) era. But the fact that the full model (an 'average' of pre and post-dam reactions) shows more price sensitivity than the pre-dam model (larger, and more statistically significant

coefficients) indicates that land holders may be becoming more mindful of prices (and costs) over time. (Section 5.2)

Conclusions and recommendations

- Multiple lines of evidence suggest that residents of, and visitors to the GBRCA feel that environmental non-use values are more important, to their overall quality of life or as a 'draw-card' to the region, than recreational or market-based values. As such, developments or changes which degrade those values are likely to be met with some resistance.

- Changes in the environment have a real impact on people and on the decisions of people, which affects the broader economy.

    o Degradation of environmental values are likely to have real financial impacts in the tourism industry, with reductions in tourist satisfaction and hence less repeat visitation, reduced numbers of tourists visiting the region and/or tourists staying for shorter periods of time.

    o It is possible that reductions in aesthetic and/or recreational values could also have a financial impact on non-tourism related businesses (Chen and Rosenthal, 2008). A significant body of literature suggests that workers will trade-off wages for lifestyle, so businesses located within the GBRCA may be enjoying a wage 'discount', largely attributable to the regional environmental amenity and attractive 'lifestyle' offered to workers. Degradation of lifestyle values may mean that businesses need to pay workers higher salaries in compensation. Whether or not this is occurring in the GBR region is an issue worthy of further investigation.

- Multiple lines of evidence also suggest that different groups of people have different 'values'. There are many differences between individuals, but our work suggests that 'on average', those born in QLD, males, those with relatively less education, and those whose primary source of income is the mining and manufacturing industry, are likely to feel that recreation and industry values are relatively more important to their overall quality of life, and that environmental non-use values are relatively less important to their overall quality of life than other people. As such changes to the economic and demographic composition of the population will likely change prevailing values, and this will affect the broader economy as well as the priorities and decisions about future developments.

- More direct links exist: changes in the broader economy such as increases in the price of beef and/or in wages, affect sediment loads (albeit with a lag). Clearly, the economic system is inextricably linked with the environment, with multiple, dynamic feedbacks.

- Monitoring systems should thus keep track of:

    o The demographic composition of the population, and its economic structure.

    o The 'values' of different demographic groups and of those associated with different industries within the region (particularly in regions undergoing rapid economic and or demographic change).

    o Changes in the broader economy (particularly the prices of commodities produced in and around the region).

    o Variables that describe key linkages between the economy and the environment (e.g. water use, pesticide and fertilizer use, land clearing)

- Moreover, our research indicates that:

  o It may not be necessary to require people to 'value' long detailed lists of different ecosystem services. Many of these ecosystem services are viewed, by respondents, as being all but inseparable, suggesting that the 'valuations' could be done at a fairly coarse level (asking people, for example, to assess industry, recreational, cultural and non-use values, and giving broad examples/descriptors of each). That would leave more 'room' within questionnaires (since long ones tend to induce survey fatigue) to elicit other potentially very useful information (about, for example, expenditure, water or chemical use, or other behaviours likely to impact the GBR).

  o Different types of valuation approaches generate quite different types of information (e.g. the dollar value associated with an entire ecosystem, the relative importance of different groups of ecosystems, peoples stated reaction to hypothetical scenarios, or WTP to improve the environment). But in this study, we have found that the methods generate similar information at a 'big picture' level (e.g. that the environment is more important to most people than industry, but that there are recognizable/predictable differences between people). There is often considerable resistance, by respondents, to questions about WTP. Recent decades has seen a substantive growth in the literature about ways to deal with 'protest votes', and (in the related choice modelling literature) 'non attendance to attributes', so those wishing to obtain specific information about WTP can do so. But our research suggests that it might be possible to use more respondent-friendly importance/satisfaction and contingent behavior type questions to monitor values across time and people instead (perhaps comparing findings to those of more traditional valuation approaches at irregular intervals for calibrative / quality-control purposes).

1 Introduction

1.1 Project overview and aims

The National Environmental Research Program (NERP) Tropical Ecosystems (TE) Hub is the largest of the Commonwealth Government's five NERP hubs. The hub involves 38 research projects, divided into three Themes organised around twelve Research Programs.

This particular research project is associated with Theme 3 *Managing for Resilient Tropical Systems*, within the program entitled *Socio-economic value of the GBR goods and services.*

The project was developed in response to the Great Barrier Reef Marine Park Authority (GBRMPA)'s desire to develop a socio-economic monitoring program. This project is separate from and complementary to Project 10.1 (SELTMP), providing additional economic data and modelling/analytical insights.

Our thinking was underpinned by recognition of the fact that there are a vast number of variables (or 'indicators') that could, potentially, be monitored. Indeed, since the 1987 Brundtland report called for 'monitoring' there has been an *indicator explosion* (Riley, 2001). As such, there is little problem with finding an indicator; the key problem is to find an appropriate one. Moreover, because monitoring is not a costless exercise, it is important to ensure that the variables/indicators selected for 'monitoring', are ones which

- provide reliable, relevant information (Parkinns *et al.,* 2001) that is clearly associated with the main goal of the agency desirous of the monitoring program
- are feasible to measure and can be obtained in a cost-effective manner on a regular basis, using a systematic method (Larson and Smajgl, 2006)
- are few in number so that users can become familiar with their presentation and with the 'signal' they give as well as its significance – ideally being linked to formal targets or indicative reference values (Larson and Smajgl, 2006)
- are scientifically credible (Larson and Smajgl, 2006)
- measure interactions between sub-systems – e.g. the economic and biophysical (Gallopin, 1997)

The GBRMPA's primary goal is to protect the Great Barrier Reef Marine Park (GBRMP) and world heritage area - i.e. to promote reef resilience. In some situations, it may be relatively easy to discern the link between economic indicators and reef resilience, but the relationship between the 'health' of an economic system and that of a biophysical one can be ambiguous. For example, wealthy people are often more willing (and certainly more able) to pay for environmental goods and services than poor people; they are also likely to have more adaptive capacity. So on the surface, it seems sensible to assume that 'healthy' (wealthy) socio-economic systems are likely to be resilient, adaptive and able to generate, or protect 'healthy' biophysical systems. But 'values' differ significantly across different individuals and some wealthy people may not want to contribute to or participate in programs that protect the reef. Moreover, many income earning activities generate (unintended) negative environmental impacts. Whether the net effect of increases in income (and/or of changes in many other socio-economic indicators) is 'good', 'bad' or indifferent' news for reef resilience is thus an empirical question.

This project set out to collect economic data relevant to the GBRWHA, and to explore the interaction between economic variables and other variables (e.g. indicators of water turbidity) thought to be associated with reef resilience. The conceptual model that underpins the investigation (Figure 1) explicitly recognizes that economic and biophysical systems are interrelated: changes in the economy impact the environment (either positively or negatively),

and environmental changes impact the economy. Simplistically, this project thus set out to improve our understanding of the way in which the environment (the GBRWHA) benefits people and the economy; and also of the way in which the economy affects the environment.
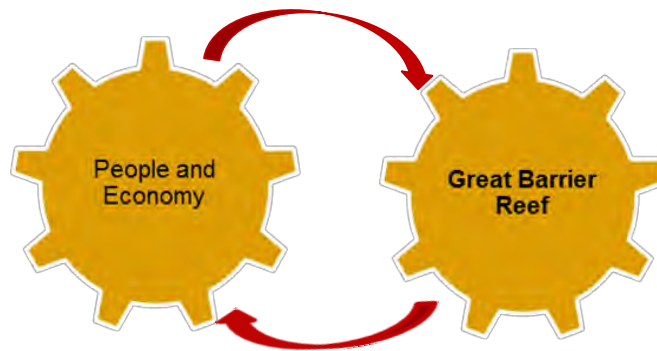
Figure 1: Interaction between people, economy and the environment

Operationally, the project comprised three interrelated activities, the specific objectives of which were to improve our understanding of:

    (a) resident views about the 'value' of key ecosystem services (ES) that are provided by the GBRWHA

    (b) tourist views about the 'value' of key ES that are provided by the GBRWHA

    (c) the extent to which variations in beef prices and other socioeconomic variables (in conjunction with biophysical variables) influence water quality and thus (indirectly) reef resilience.

The project has generated information that is useful by, and of itself (a list of outputs is provided in Appendix A). It has also helped to identify key variables that are likely to be worthy of further monitoring, has developed methods for measuring and analyzing those variables, and has provided a valuable baseline of data for reference in a longer-term socio-economic monitoring program.

1.2 Structure of report

Most of the work untaken as part of this project has already been published in the peer-reviewed literature, is available on-line (through e-atlas) and/or is under review (see Appendix A for details). This report thus provides a synthesis of findings – presented according to the structure depicted in Figure 2; we encourage interested readers to consult the related documents which provide much more detail.

Chapter 1: Introduction

Chapter 2: Background to activities A and B
- Identifying benefits for assessment
- Selecting appropriate valuation techniques
- Developing questionnaires
- Collecting data
- Description of respondents

Chapter 3: Resident 'values'
(Activity A)
- How do residents 'benefit' from the GBRWHA?
- The link between resident activities and benefits
- The total economic value of the GBRWHA
- The preservation value of the GBRWHA
- Resident Willingness to pay to protect the environment
- Potential impact of environmental degradation

Chapter 4: Tourist 'values'
(Activity B)
- The importance of the GBR for destination competitiveness
- The potential impact of reef degradation on the tourism industry
- The potential impact of climate change on the tourism industry
- Water clarity, visitor satisfaction and repeat visitation
- Willingness to pay for improvements in water quality
- Willingness to pay for other improvements

Chapter 5: The broader economy and the GBRWHA
(Activity C)
- Relationship between rainfall and river discharge in the Burdekin River Catchment
- Is there evidence to suggest that prices affect the GBRWHA?

Chapters 6 & 7: Synthesis, Conclusions and recommendations

References and appendices (including a full list of project outputs)

Figure 2: Structure of the report

NB: In 2007, MTSRF provided funding to a team of researchers, led by Bruce Prideaux, to conduct regular visitor exit surveys at Cairns Airport. The TE NERP provided funds for those surveys to continue, through this project. Since 2007, researchers have been visiting Cairns airport at least once a month, collecting data from 8050 departing visitors (although data were not collected during 2010). There have been a consistent set of questions asked of every visitor since 2007, and each year the questionnaires have also sought to investigate a different issue pertinent to the local tourism industry. The long-term Cairns Airport visitor Exit team have already synthesized and reported on their activities and there are several related publications (a book chapter, and three conference papers - Appendix A). We do not report on that material (again) here.

2 Background to activities A and B

The material presented in this section summarises material reported on, in detail, in

> Stoeckl, N., Farr, M., & Sakata, H. (2013). *What do residents and tourists 'value' most in the GBRWHA? Project 10-2 Interim report on residential and tourist data collection activities including descriptive data summaries.* Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns, pp. 112. Available at: http://www.nerptropical.edu.au/publication/project-102-technical-report-what-do-residents-and-tourists-'value'-most-gbrwha

2.1 Identifying 'benefits' for assessment and appropriate valuation approaches

There are different frameworks for thinking about the way in which the environment benefits people all highlighting the fact that:

- the GBRWHA has value far above and beyond that which is reflected in the market place.
- there are likely to be many different ways in which people relate to, interact with and benefit from the GBRWHA – i.e. there are many different types of environmental 'values' (also referred to in this report as ecosystem services).

If interested in the 'value' of the GBRWHA to residents and tourists, it is thus important to begin the process by identifying a set of regionally relevant ecosystem services (ES) for assessment.

First we conducted a substantive literature review. The review revealed that historically, most valuation studies have concentrated on a narrow range of ecosystem services (Stoeckl *et al.,* 2011) such as recreation (Carr and Mendelsohn, 2003; Hundloe *et al.,* 1987; Knapman and Stoeckl, 1995; Kragt *et al.,* 2009) or fishing and boating (Farr *et al.,* 2014b; Prayaga *et al.,* 2010). More recently, researchers have sought to improve our understanding about some of the region's *non-use values* (Rolfe and Windle, 2012a; Rolfe and Windle, 2012b; Windle and Rolfe, 2005), but significant knowledge gaps remain (see also Stoeckl *et al.,* 2014). The review also revealed an absence of comparative information. No assessments existed that simultaneously valued numerous different ecosystem services using the same methodological approach. Different valuation techniques produce different types of estimates (e.g. marginal prices or expenditures) and may not be comparable or additive. If managers are required to make decisions about potentially competing values (e.g. fishing versus tourism versus aesthetic/cultural values), then the lack of comparable information about these different values may stand as a significant knowledge gap.

Second, we conducted workshops with a variety of regional stakeholders/managers/decision makers in Cairns, Brisbane and Townsville. In these workshops we sought to (a) identify a set of regionally relevant community-defined benefits of the GBRWHA which stakeholders required more information about; and (b) learn more about the issues confronting these people and about how they hoped to be able to use the information generated from this project. The workshops highlighted the fact that participants were interested in a broad range of different community benefits (some of which related directly to various ecosystem services provided by the GBRWHA, and some of which related to the economy in general). It also revealed that people wanted to be able to use our research results in a variety of different ways. Some

wanted to simply raise public awareness of the importance of the GBRWHA; others wanted to be able to use the results to help them assess the way in which people and/or the economy might be impacted by particular management changes which could impact the reefs ecosystem services (e.g. further reductions in water quality). In other words, some stakeholders were looking for information about (in economic jargon) the 'total' value of the GBRWHA; others wanted information about 'marginal' values (or trade-offs).

Having determined which community benefits to focus on, and that we needed to look at both total and marginal values, our next task was to choose a valuation technique. Over the years, economists have developed many different valuation techniques to estimate the (monetary) value of a variety of different ecosystem services (see, for example, Bateman *et al.*, 2002; Getzner *et al.*, 2005), but only stated preference approaches are capable of assessing a full range of benefits including existence/bequest. Since stakeholders were interested in those benefits, we chose to focus on stated preference approaches.

Choice modelling and contingent valuation are, arguably, the most popular stated preference methods, but there is a substantive body of literature on subjective wellbeing and overall life satisfaction (LS), which offers an alternative way of looking at the 'value' of the environment (see Kristoffesen, 2010). LS studies have been done at both an aggregate level – e.g. using national measures of happiness, indicators of environmental quality and income (Welsch, 2006) – and at an individual level (MacKerron and Mourato, 2009; van Praag and Baarsma, 2005). In most cases, researchers have regressed measures of overall quality of life (QOL) against other potential contributors, to ascertain the relative importance of those contributors. Others have successfully trialed systems that simply ask people to indicate how important various goods and services are to their overall QOL and compared ratings (Larson, 2009; 2011; Larson *et al.*, 2013). It is that general approach, which we used here, although we decided to also include questions that would allow us to use some of the more 'traditional' valuation techniques (i.e., contingent valuation, expenditure and contingent behavior).

More specifically, we decided to develop a questionnaire that would allow us to use

   a) a variation of the life-satisfaction approach to assess

      i. the 'value' of a wide variety of ecosystem services (benchmarked against some market goods and services);

      ii. the effect that changes in those ecosystem services would have on overall quality of life (benchmarked against market changes).

   b) the contingent valuation approach to assess marginal changes (i.e. willingness to pay) for three of the key issues identified in (a ii); and

   c) visitor expenditures and contingent behaviour questions to assess the potential financial impact on the tourism industry of changes to the environment.

2.2 Development of the questionnaires

Information gathered from the literature review was combined with information collected during workshops to develop a set of preliminary questionnaires that were pre-tested with peers, during additional stakeholder workshops and at the Cairns airport. We analysed responses to the Cairns airport pilot test, finding that the response rate for some questions was relatively low; people noted that the format of the questionnaire almost reminded them of an examination paper. We thus spent considerable time re-formatting the questionnaires, adding pictures and colours to increase the visual appeal. We tested the revised version of the questionnaire in more face-to-face encounters at the Cairns airport and in a mailout to 200

residents living in 100 different postcodes within the GBR catchment area (GBRCA), finding no need for further changes.

The final version of our ***resident questionnaire*** included questions about:

- The socio-demographic background of respondents (age, income, education, etc.)

- How often residents go to the GBRWHA, and what they do while there

- The importance of various community benefits associated with the GBRWHA to their overall quality of life and their satisfaction with those benefits (Table 1)

- Satisfaction with their overall quality of life

- People's perceptions about the way in which their overall quality of life would be affected by changes in various community defined benefits and other market factors (e.g. higher prices, reduced water clarity).

- Their willingness to pay for improvements in various community defined benefits

Importantly, respondents have been shown to be highly sensitive to the order in which one presents questions – particularly if asked to evaluate a long list of items (Cai *et al.*, 2011; Lasorsa, 2003). So we produced 24 different versions of the question about the 'importance' of, and 'satisfaction' with, various community defined benefits: all containing the same list of benefits, but presented in a different order.

When developing the ***tourist questionnaire***, we sought to keep questions similar (to enable comparisons) but altered the wording of some segments. The final version of visitor questionnaire thus included questions about:

- The socio-demographic background of respondents and background about travel party and origin

- How often visitors had been to the GBRWHA in the past and what they did (or planned to do) while on this particular trip

- The importance of various 'goods and services' to their overall decision to come to the region (Table 1) – in comparison to residents who were asked about importance to overall quality of life

- Their satisfaction with the trip overall (rather than, for residents, life overall)

To ensure that tourist questionnaires were not too long, we decided to use a split sample, approach, asking one half of all tourists to tell us about expenditure while in the area and the way in which their decision to come to the region would have been affected by changes in various environmental and market factors. The other half were instead asked about their WTP for improvements in various community defined benefits (as per residents, although questions were framed as willingness to pay per trip rather than per annum).

Table 1: Community-defined benefits that were selected for assessment – the terms in brackets are the abbreviations used hereafter

Residents	Both	Tourists
	Being able to:	
	Eat fresh locally caught seafood (Seafood)	
	Go fishing, spear-fishing or crabbing (Fishing)	
	Spend time on the beach, go swimming, diving, etc. (Beach/Swimming)	
	Go boating, sailing or jet-skiing (Boating)	
	Having/experiencing/seeing:	
	Undeveloped and uncrowded beaches & islands (Undeveloped)	
	Beaches and islands without visible rubbish such as bottles & plastic (No rubbish)	
	Healthy coral reefs (Coral reefs)	
	Healthy reef fish (Reef fish)	
	Healthy habitats for marine plants & animals including whales, dugongs, turtles (Iconic marine species)	
	Clear ocean water with good underwater visibility (Clear ocean)	
	Healthy mangroves and wetlands that clean polluted water from land (Mangroves)	
		The Wet Tropics World Heritage rainforest (Wet tropics)
		Iconic land species: kangaroos, cassowaries, etc (Iconic land species)
	Other:	
Protecting Indigenous traditional and cultural values (Indigenous)		Experiencing Indigenous traditions and culture (Indigenous)
"Bragging rights" – being able to say "I live near the GBR" (Bragging)		"Bragging rights" – being able to say "I have been to the GBR" (Bragging)
Preserving the GBRWHA either for its own sake or for future generations (Future generations)		Sunshine and warmth (Sunshine)
Benefiting from		Visiting friends and/or relatives (Friends)
low prices associated with cheap shipping transport (Cheap shipping)		Attending to business, going to a meeting and/or conference (Business)
the jobs and income related to:		Visiting a place which is close to where I live (Close)
the reef-based tourism industry (Tourism)		Finding a place where the price matched my budget (Budget)
the commercial fishing sector (Commercial fishing)		Having good quality accommodation, shops and restaurants (Accommodation)
the mining and agricultural sectors (Mining/Agriculture)		

(Table adapted from Larson *et al.,* 2014a; Esparon *et al.,* forthcoming)

We had both versions of our tourist questionnaires translated into Chinese and Japanese (and checked, using back-translations).

A copy of (one version) of the resident questionnaire and the two different tourist questionnaires are provided in Appendix 3 and 4, respectively, of Project 10-2's *Interim report* (Stoeckl *et al.,* 2013).

2.3 Data collection

2.3.1 Tourists

When developing sampling strategies, we were mindful of the fact that more than 90% of visitors to the GBRMP go to either the Cairns/Cooktown or the Townsville/Whitsunday management areas (GBRMPA, 2013), thus we decided to concentrate most data-collection effort in those areas.

We sought permission from various airports, ferry/boat operators, caravan-park owners and local governments in Cairns, Port Douglas, Townsville, Bowen, Airlie Beach, Rockhampton and Yeppoon to collect data from visitors at those locations. We collected data at those locations at regular intervals throughout a 12 month period (to control for seasonal differences in type of tourists). The Japanese and Chinese questionnaires were distributed by native speakers of those languages.

We also enlisted the help of a stratified random selection of tourism operators between Cooktown and Gladstone to distribute questionnaires to their customers. When selecting operators, we started by using the yellow-pages and tourism web-sites to compile a list of 673 tourism operators between Cape Tribulation and Gladstone. We divided those operators between the accommodation sector (further subdivided by type – e.g. backpacker hostel, bed and breakfast, 3 4 or 5 star motels), tour operators (marine and terrestrial) and tourism 'attractions' (e.g. museums, information centres, skyrail). We randomly selected two of each group, in each location, and then contacted the operators to see if they would be willing to make our questionnaires (with reply paid envelopes) available to their customers. In total, 36 operators agreed; we sent a random selection of the different versions of our questionnaire to them and received a total of 203 completed questionnaires in the mail from their customers.

In total we collected 2743 tourist questionnaires – 225 from Chinese speaking visitors and 243 from Japanese speaking visitors. Nearly one-half of all respondents had been visiting the Cairns/Cooktown tourism management area when they completed our questionnaire; 40% were visiting the Townsville/Whitsunday management area, while only 8% were recorded in the Mackay/Capricorn. This is very similar to the visitation patterns evident from the GBRMPA Environmental Management Charge data (GBRMPA, 2013). Compared to data collected by Tourism and Events Queensland (2013) and Tourism Research Australia (2013a) our sample is slightly overrepresentative of international visitors (excepting those from Japan and China who may be slightly under-represented), and it under-represents domestic business visitors (Tourism Research Australia, 2013b).

2.3.2 Residents

For the residential sample we aimed for a geographically stratified random sample. We started by identifying postcodes ($\approx$ 100) that lay either partially or entirely within the GBRCA, sending an even number of questionnaires to each ($\approx$ 48[1]). We estimate that 3977 reached their intended recipient and we received 902 completed questionnaires, giving an overall response rate of 22.7%. Being aware of non-response bias to postal surveys we ensured that when research assistants visited airports, lagoons, ferries etc. to intercept tourists, they also had residential questionnaires, so that we could take advantage of incidental intercepts. We also engaged an Indigenous researcher to help collect data from within Indigenous communities.

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[1] We also ensured that the 24 different versions of the questionnaire were sent to each postcode ($\approx$ 2 of each version to each postcode).

These extra activities gave us an additional 663 responses, so in total we received 1592 completed residential surveys.

2.4 Overview of respondents and responses

Our *Interim report* (Stoeckl *et al.,* 2013) provides detailed diagrams and charts with descriptive statistics from our residential and tourist data hence only a short summary is provided here.

Our residential sample has a good geographic representation in comparison to the actual population distribution in the GBR region (Government Statistician, 2013) and is reasonably representative in terms of gender and Indigenous people in the sample. It is overrepresented by participants with a university degree (31% in our sample compare to 16% of population). Just over one quarter of all respondents indicated that their household depends upon the Government, Health or Education sectors for its main source of income while the OESR statistics shows this to be 29% for the GBRCA population. The Mining and Manufacturing sectors were slightly overrepresented (20% of our respondents were dependent upon this sector for their income; but only 16% of employed people within the catchment area work within these industries).

In total, 50.3% and 54.9% of residential and tourist respondents, respectively, were female. Approximately 6.6% of residential respondents self-identified as either Aboriginal or Torres Strait islander or both; the figure was higher for tourists (13.5%). More than half of the visitors (53%) who answered the survey were between 20-40 years old while 44% of residents were aged between 40-60 years. About 30% of residents and 50% of tourists had completed a university degree. A slightly larger percent of tourists were in the highest income bracket than were residents. More than one-quarter of both residents and tourists noted that the Government / Health / Education sector was their main source of income. Mining, Agriculture and, to a lesser extent tourism, were much more important sectors (in terms of income dependency) for residents than they were for tourists.

Almost 55% of tourists were international visitors. The majority of international visitors (659 out of 1506) came from Europe. Most domestic visitors were from Queensland (41%). More than one-third of tourists (36.24%) were travelling as a couple; almost 20% were travelling with friends. The median number of nights visitors spent along the coast near the GBRWHA was 5.

Almost 40% of residents had spent about a day on their most recent trip to the GBRWHA; 18% had spent 2-3 nights on their most recent trip, and nearly 22% had spent 4 nights or more. Their most common activity involved spending time on the beach, although the majority of resident respondents (65%) had been involved in more than one recreational activity involving the GBRWHA during the last 12 months.

3 Residential 'values'

3.1 How do residents of the GBR catchment 'benefit' from the GBRWHA?

Abstract

Improvements in human wellbeing are dependent on improving ecosystems. Such considerations are particularly pertinent for regions of high ecological, but also social and cultural importance that are facing rapid change. One such region is the Great Barrier Reef (GBR). Although the GBR has world heritage status for its 'outstanding universal value', little is known about resident perceptions of its values. We surveyed 1545 residents, finding that absence of visible rubbish; healthy reef fish, coral cover, and mangroves; and iconic marine species, are considered to be more important to quality of life than the jobs and incomes associated with industry (most respondents were dissatisfied with the benefits they received from industry). Highly educated females placed more importance on environmental non-use values than other respondents; less educated males and those employed in mining found non-market use-values (i.e. recreational values) relatively more important. Environmental non-use values emerged as the most important management priority for all.

Keywords: Australia, GBRWHA, IDS, Perceptions, Quality of life, Values

Methods and main findings

Using the residential sample, we examined the stated importance, to overall quality of life, of 18 community defined benefits associated with the GBRWHA (Table 1). We identified those which were deemed most/least important and those which people were most/least satisfied with (Figure 3). Having no visible rubbish, healthy reef fish and healthy coral reefs were the three most important factors. Satisfaction was significantly lower than importance for all values except recreational fishing, boating, and bragging rights. Residents were most dissatisfied with their (perceived) benefits from low prices associated with cheap shipping, the mining, agricultural, and commercial fishing sectors, the level of protection of Indigenous traditional and cultural values, and the chances of preserving the GBRWHA either for its own sake or for future generations.

Next we used regression (both ordinary least squares [OLS], and seemingly unrelated regressions [SUR]) to look for statistically significant relationships between various socio-economic and demographic descriptors of people (Table 2) and the importance (IMP); and Index of Dis-Satisfaction (IDS) scores they assigned to different factors (grouped using Principal Component Analysis [PCA]) (Table 3).
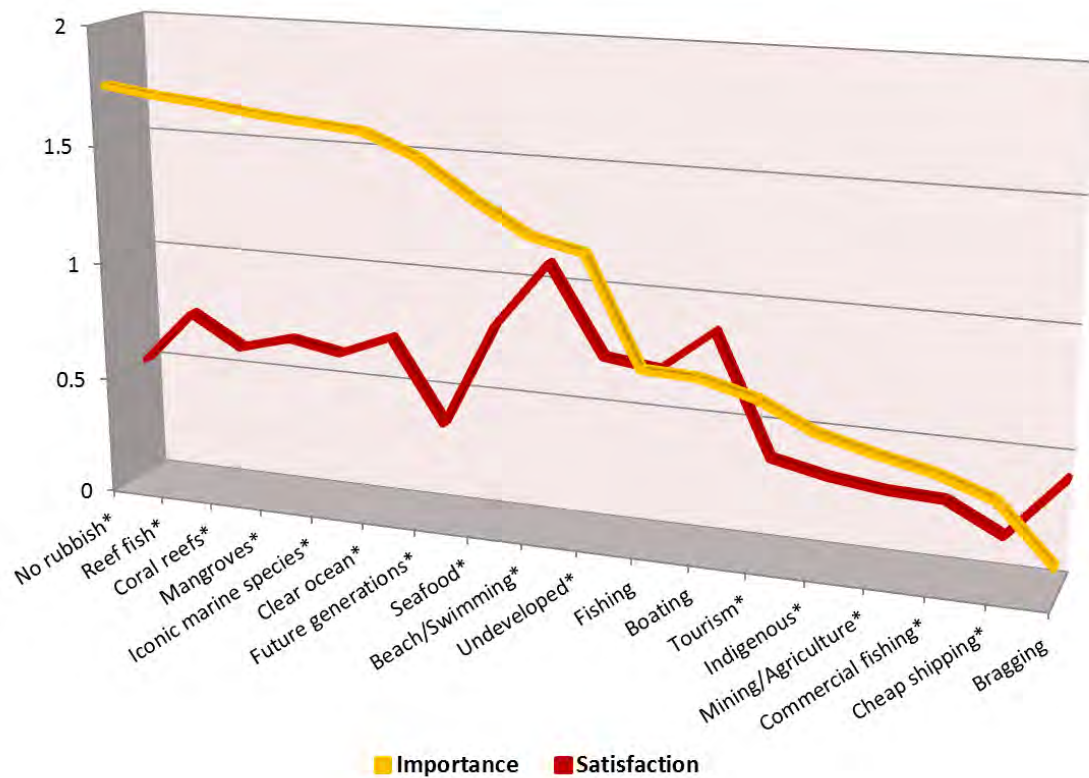
Figure 3: Stated importance of and satisfaction with 18 community defined benefits associated with the GBRWHA, residents
(* indicates a statistically significant difference between the distribution of responses to questions about importance and satisfaction)

(Figure adapted from Larson *et al.,* 2014a)

Highly educated females and people dependent upon the government sector for income allocated more importance and were less satisfied with the current condition of non-use values than other respondents. Relatively less educated males and people whose households were dependent upon the mining and fishing industries placed more importance on non-market use values such as fishing and boating than other participants. People on higher household incomes, with families and with lower levels of education placed more importance on the Industry group of values than their single, better educated, poorer counterparts.

Table 2: Variables used in subsequent analyses – descriptors and abbreviations

Variable of interest	Description	Abbreviations used in this report
Age	Respondent's age	Age
Gender	=1 if respondent is male, 0 otherwise	Male
Marital status	=1 if respondent is single, 0 otherwise	Single
Indigeneity	=1 if respondent i is Indigenous, 0 otherwise	Indigenous
Education	Respondent's highest level of education completed in five different levels ranging from primary school to higher education at university	Education
Household size	Number of people in respondent's household	HH size
Household Income	Respondent's household annual pre-tax income ranging from $6,500 to $285,500	Income
Dependence on various sectors for household income		
Tourism	=1 if the main source of respondent's household income is Retail, Accommodation, cafes & restaurants, and Tourism, 0 otherwise	Tourism
Commercial fishing	=1 if the main source of respondent's household income is Fishing, 0 otherwise	Fishing
Mining, manufacturing &/or ports	=1 if the main source of respondent's household income is Mining, Manufacturing and Ports, 0 otherwise	Mining
Government, Health or Education	=1 if the main source of respondent's household income is Government, Health and Education, 0 otherwise	Government
Agriculture	=1 if the main source of respondent's household income is Agriculture and Forestry, 0 otherwise	Agriculture
Place of birth	=1 if resident born in QLD, 0 otherwise	Born QLD
Not prepared to pay unless all GBRWHA users pay too	=1 if not prepared to pay money to protect the GBRWHA unless all GBRWHA users pay too, 0 otherwise	Not prepare to pay unless all users pay too
Only people who live near or visit the GBRWHA should care for it	=1 if strongly agree or agree with the statement that only people who live near or visit the GBRWHA have a responsibility to care for it, 0 otherwise	Only people who live or visit should care
Not prepared to pay unless all Australia pay too	=1 if strongly agree or agree with the statement that if not prepared to pay money to protect the GBRWHA unless all Australia pay too, 0 otherwise	Not prepare to pay unless all Australia pay too
WTP bid range	WTP bid range ranging from $500 to $2,000	WTP Bid range

Conclusions

Environmental non-use values such as healthy corals, reef fish and mangroves, absence of visible rubbish and iconic marine species are of highest importance to the quality of life of local residents. Evidently, the GBR is well recognized by local residents for its 'outstanding universal value' and the things that matter most to residents of the GBR region are clearly of a non-monetary nature. Respondents are most dissatisfied with their ability to benefit from various industries along the coast. Non-use values are at the top of the "Action List" for management (derived using the IDS methodology).

That said, people with different levels of education, of different gender, Indigenous status and those dependent upon different industries for income had statistically different 'values'.

Changes in the economic and demographic composition of the population will thus likely see a change in overall social construct of 'values', highlighting the importance of monitoring such changes in the community.

The fastest growing demographic group in the region is of young lesser educated males working in the mining and associated industries receiving relatively high incomes (Deloitte Access Economics, 2013). If this segment of population continues to increase, environmental 'use' (recreation) values and market values could become relatively more important compared to environmental non-use values. Consequently, it might become more difficult to find public support for policies to protect, as required by both international and national statutory obligations, the non-use values of the GBRWHA at the expense of other things.

Table 3: Characteristics of respondents determining importance (IMP) and Index of dissatisfaction (IDS) scores for groups of values tested

Environmental non-use values		Non-market/ Recreation use values		Industry use values		Indigenous culture		Bragging/ Recognition	
IMP	**IDS**	**IMP**	**IDS**	**IMP**	**IDS**	**IMP**	**IDS**	**IMP**	**IDS**
Male (-)	Male(-)	Male (+)	Male(+)			Male (-)	Male(-)	Male (-)	Male(-)
Education(+)	Education(+)	Education(-)	Education(-)	Education(-)					
				Single(-)	Single(-)	Single(+)		Single(+)	Single(+)
						Age(-)	Age(-)	Age(-)	Age(-)
				Income(+)				Income(-)	Income(-)
						Indigenous(+)	Indigenous(+)		
						Born QLD(-)	Born QLD(-)		
Main household income from									
		Mining(+)	Mining(+)		Mining(+)	Mining(-)	Mining(-)		
		Fishing(+)				Fishing(+)			
Government(+)								Government(-)	
								Tourism(+)	

Note: Only significant variables reported. A plus sign (+) indicates that the variable was found to have a positive and statistically significant relationship with the score assigned to the corresponding value; a negative sign (-) indicates negative and statistically significant negative relationship

(Table adapted from Larson *et al.,* 2014a)

3.2 The link between resident activities and benefits

The material presented in this section summarises material from

> Larson, S., Farr, M., Stoeckl, N., Chacon, A., & Esparon, M. (2014b). Does Participation in Outdoor Activities Determine Residents' Appreciation of Nature: A Case Study From the Great Barrier Reef, Australia. *Environment and Natural Resources Research*, 4(3), 211-226. Available at
> http://www.ccsenet.org/journal/index.php/enrr/article/viewFile/39015/21817

Abstract

Different people engage in different activities for different reasons. This paper contributes to literature examining participation in various outdoor activities and its association with the perceived importance of environmental values. Using data from a survey of more than 1500 residents living adjacent to the Great Barrier Reef World Heritage Area (GBRWHA) in Australia, we examine (1) residents' participation and frequency of participation in a number of GBRWHA-related outdoor activities; (2) if a range of socio-economic characteristics played a role in determining participation in these activities; and (3) the linkages between participation in outdoor activities and a range of environmental values related to the GBRWHA. Going to the mainland beaches and swimming were reported as the most frequent activities. Males, residents with higher income, and those with the main household income from fishing and tourism industries, are more likely to participate in outdoor activities than others. There is a link between participation in activities and the perception of values. We found that occasional participation in an activity does not necessarily change perceptions of importance of the GBRWHA values. However, frequent participation in consumptive activities such as fishing was linked to higher appreciation of use values. With the non-consumptive uses, such as beach and island visitation, the association extends to a whole range of use and non-use values. Findings have implications for management as they indicate that those who frequently participate in outdoor recreation place higher importance on environmental values and may therefore stand as stronger environmental stewards than others.

Keywords: ecosystem services, quality of life, recreation, values, wellbeing

Methods and main findings

Using data from our residential sample, we looked at the number of times people participated in different GBRWHA-based recreational activities each year. We found that nearly 65% of local residents were frequent beach users, 37.5% go recreational fishing and 31% go motor boating frequently. Sailing and going on a paid boat were undertaken the least often (Figure 4).
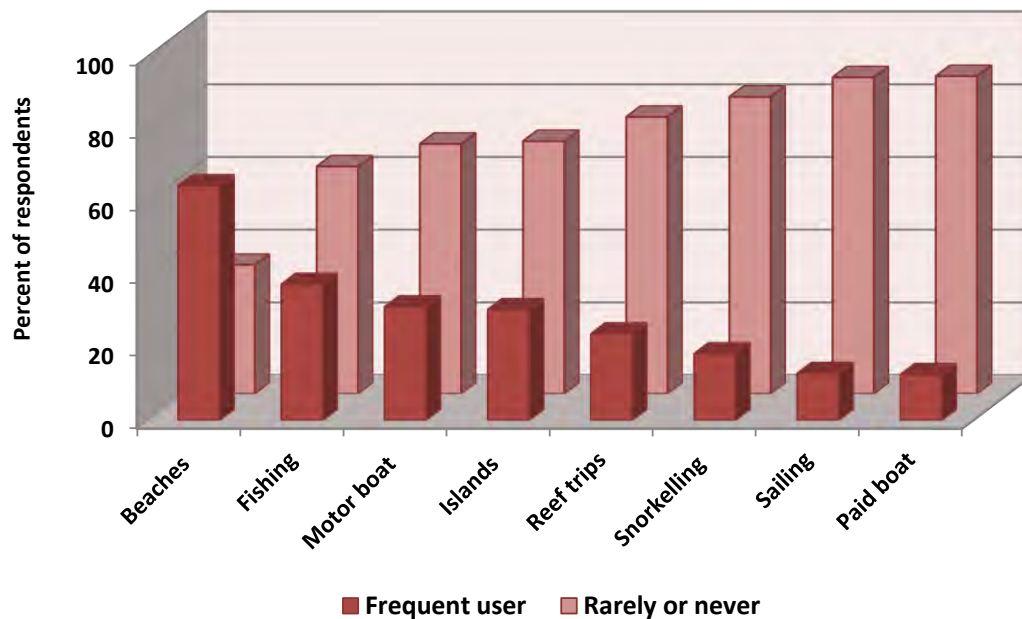
Figure 4: Frequent vs. non-frequent participation in the GBR related activities
(Figure adapted from Larson *et al.,* 2014b)

We used a hurdle model to look for statistically significant relationships between various socio-economic and demographic descriptors of people (Table 2) and the frequency with which they undertook various activities (Table 4). We found that residents with higher household incomes and those who were dependent on tourism and fishing industries were more likely to participate in recreational activities related to the GBR than others. Older people were less likely to go to reefs, islands, snorkelling and to go on a paid boat than their younger counterparts. Indigenous residents and those with small households were more likely to be frequent beach goers than others, and the most frequent recreational fishers were males, single people, those born in QLD, the relatively less educated and those dependent upon the tourism or fishing industries. Those dependent upon the mining industry were less likely to go to the beach, the islands or the reef than those dependent on other industries – i.e. this group of people were generally less 'connected' (recreationally) to the GBRWHA than others.

Table 4: Characteristics of most frequent participants in the GBRWHA related outdoor activities

Activities	Characteristics of most frequent users of the GBR										
Beaches	High Income	Indigenous	Not Males		Small HH size				Not mining	Tourism	
Fishing	High Income		Males	Single		No degree	QLD born			Tourism	Fishing
Motor boat	High Income		Males							Tourism	Fishing
Islands								Young	Not mining		Fishing
Reef trips	High Income								Not mining		
Snorkelling	High Income			Single							Fishing
Sailing	High Income									Tourism	Fishing
Paid boat		Non-Indigenous									Fishing

Note: Only significant variables reported (Table adapted from Larson *et al.,* 2014b)

We also used stepwise OLS regression to look for a relationship between the importance scores and the frequency with which people participated in various activities. We found that residents who frequented beaches were likely to place a higher value on all benefits than their non-beach-going counterparts. Those who went fishing frequently felt that many lifestyle and recreational values (e.g. eating fresh locally caught seafood, fishing, boating, and sailing, in addition to spending time at the beach) were more important than other people. Those who went to the islands frequently were more likely to place a high value on boating, 'bragging', and preserving the reef for future generations.

Conclusions

Frequent participants in outdoor recreation activities place a high importance on environmental values and may therefore stand as strong environmental stewards. As such, frequent island and beach visitors might be the best group to target and mobilise for various environmental activities and actions.

3.3 The total economic value of the GBR

Abstract

Estimating the value of entire ecosystems in monetary units is difficult because they are complex systems composed of non-linear, interdependent components and the value of the services they produce are interdependent and overlapping. Using the Great Barrier Reef (GBR) as a case study, this paper explores a new 'whole ecosystem' approach to assessing both the importance (to overall quality of life) and the monetary value of various community-defined benefits, some of which align with various ecosystem services. We find that provisioning services are considered, by residents, to be less important to their overall quality of life than other ecosystem services. But our analysis suggests that many community-defined benefits are overlapping. Using statistical techniques to identify and control for these overlapping benefits, we estimate that the collective monetary value of a broad range of services provided by the GBR is likely to be between $15b and $20b AUS per annum. We acknowledge the limitations of our methods and estimates but show how they highlight the importance of the problem, and open up promising avenues for further research. With further refinement and development, radically different 'whole ecosystem' valuation approaches like these may eventually become viable alternatives to the more common additive approaches.

Keywords: Great Barrier Reef; Ecosystem Services; Economic Valuation; Total Economic Value

Methods and main findings

Using ideas from a number of different methodological approaches and data from our residential sample (of more than 1500 residents of the GBRCA), we trialed an entirely new way of estimating the 'value' of the GBR, controlling for the perplexing problem of 'separability'. First we looked at how people's stated importance of 18 different community defined benefits (Table 1) contributed to their overall quality of life - Figure 5.

We then used correlation coefficients and the PCA to identify groups of benefits that were likely separable and compared the average importance scores assigned to each group of separable benefits. The analysis is conceptualized in Figure 6. The vertical 'height' of each group of separable benefits indicates mean importance. Arrows show how benefits contribute to overall quality of life – directly (red dotted line from item to quality of life), indirectly (black solid line to another item), or both.
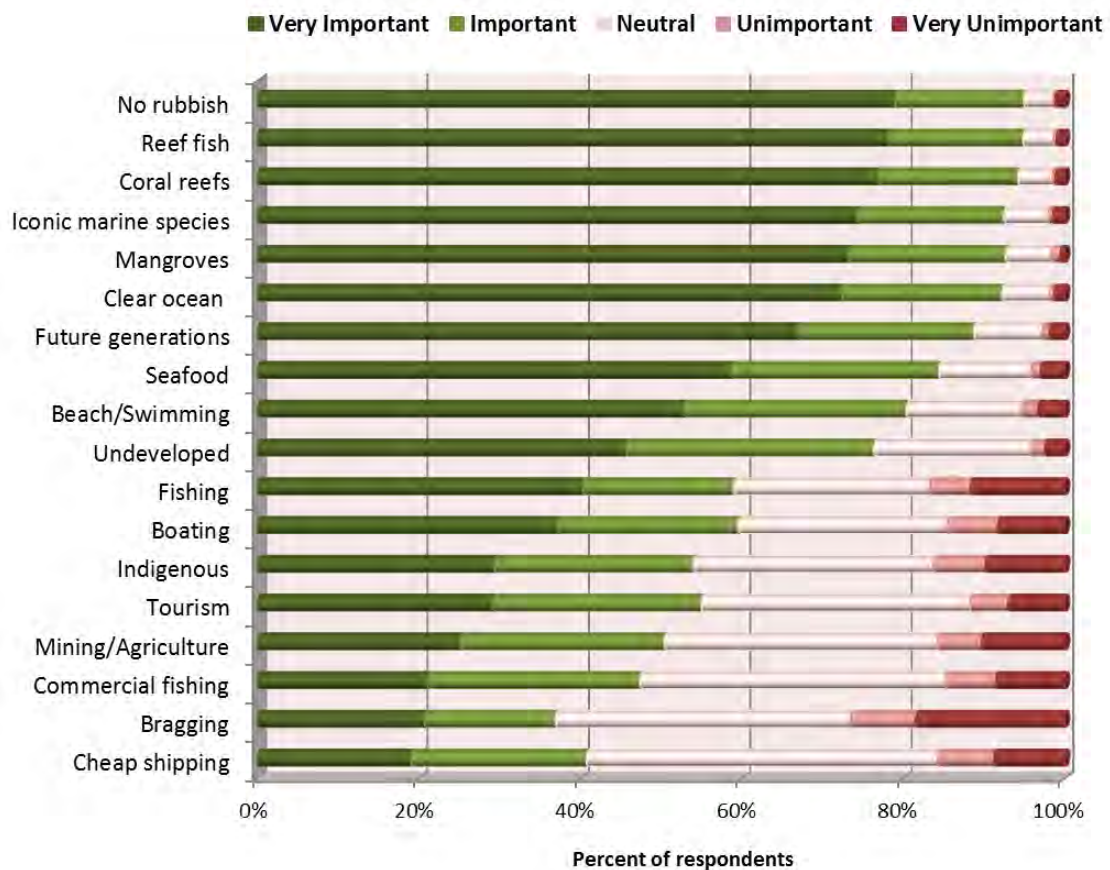
Figure 5: Resident perceptions of the Importance of 18 different benefits to their overall quality of life

(Figure adapted from Stoeckl *et al.,* 2014)

One of the separable benefits relates to the jobs and incomes associated with reef tourism – known to contribute in excess of $4b to the local economy (Deloitte Access Economics, 2013). In the economics literature, the value of a good is tied to the concepts of compensating and equivalent variation (CV or EV) (Mitchell and Carson, 1989). Formally, CV is the amount of money required to compensate an individual for the loss of a good or service (i.e. to ensure there is no reduction in overall *utility).* If the tourism industry were to collapse, residents would need to be compensated for that loss (i.e. $4b). By extension, if other benefits, which are deemed more important than the tourism industry, were to also disappear, then we can infer that residents would need to be compensated by more than $4b for their loss. In other words, the 'separable' groups of benefits which are deemed more important to overall quality of life than the tourism industry must also be 'worth' more than $4b.

There may be some 'overlap' between the most important group of benefits, which we have termed 'primary' benefits, and other groups of benefits which depend upon them (as shown with the dotted lines). But we also collected data from people who have no connection at all to the reef (through culture, lifestyle, or livelihood) and who had never been to the region – so we knew they received no 'recreational', 'indigenous' or 'industry' benefits from the GBRWHA. They still indicated that primary benefits were more important to their overall quality of life than all other listed factors. As such, it seems that these primary benefits do not entirely overlap with other values.

When assessing the collective value of all (separable) groups of community-defined benefits, we assumed that if any group of benefits were deemed to be less important than our market benchmark (here, the tourism industry), then its value was zero (an extremely conservative estimate). If a group of (separable) benefits was deemed more important, then its value was assumed equal to the market benchmark – i.e. $4b (also conservative). We then counted the number of separable groups (N) that were more important than the market benchmark. The collective value of all separable groups (N) of benefits was thus calculated as $4b*N. We conclude that the total value of all benefits defined by the community and assessed in this case study will certainly exceed $16b (even if all primary benefits are deemed to overlap other benefits) and may be closer to $20b (if no overlap – likely to be a closer representation).
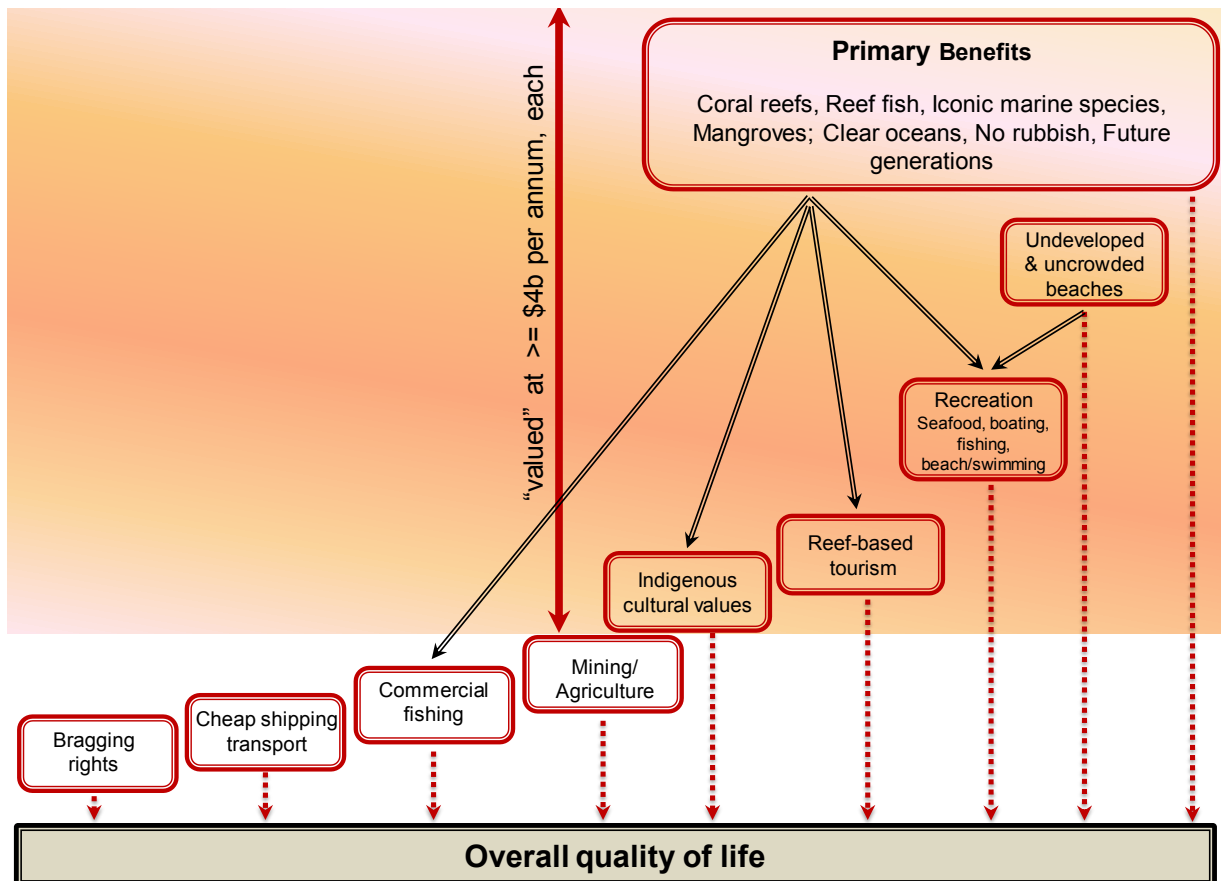
Figure 6: Diagrammatic representation of the way in which various community defined benefits contribute to the overall quality of life of residents in the GBR catchment area – using correlation coefficients to group.

The vertical 'height' of each separable group of benefits indicates mean importance. Arrows show how benefits contribute to the overall quality of life – directly (red dotted line from item to quality of life), indirectly (black solid line to another item), or both.

(Figure adapted from Stoeckl *et al.,* 2014)

Conclusions

The collective value of a wide range of ecosystem services provided by the GBR is likely to be between $15b and $20b per annum. Even though the methods and estimates in this study have limitations, our findings highlight the importance of overlapping problem and offer one method of dealing with it. This type of whole-ecosystem valuation method may, with further refinement, offer itself as a viable alternative to the more common additive approaches.

3.4 The preservation value of the GBRWHA

The material presented in this section summarises material from

> Jarvis, D., Stoeckl, N., Liu, H. (in review). Can the life satisfaction technique be used to estimate non-use values? A case study of the Great Barrier Reef.

Abstract

There are numerous methods of generating financial estimates of the 'value' of the environment, but these techniques suffer from a range of problems. In this study we consider whether the emerging life-satisfaction (LS) approach offers itself as a viable alternative, testing to see if it can be used to estimate non-use values in the Great Barrier Reef (GBR). We use geographically weighted regression to investigate factors explaining the LS of residents of the GBR catchment area, finding that income is a more important explanatory variable in the south than in the north. We also find that those who feel that the GBR is being 'satisfactorily' preserved for future generations have higher LS scores, after controlling for other factors. We use the model coefficients to draw inferences about how much income would be required, as compensation to keep overall LS constant, should residents become less satisfied that the GBR is being preserved for future generations. This is in the order of $7.5bn annually. We acknowledge the imperfections of our approach, but feel it demonstrates that with further refinement the LS approach could prove a suitable alternative or supplement to the more common stated preference techniques that seek to measure non-use values.

Keywords: Bequest values; Geographically weighted regression; Life satisfaction approach; Non-use values; Spatial analysis of satisfaction with life; Subjective well-being; Valuing environmental assets.

Methods and main findings

The life-satisfaction approach has been used to 'value' different features of the environment, but to date, has focused on use-values. In this paper we use resident responses to a question about how satisfied they are that the GBRWHA is being preserved for future generations as an admittedly imperfect proxy for non-use values. We test for the statistical significance of its association with overall LS. Our proxy is based on perceptions, rather than on objectively verifiable data.   The justification for this relies on previous research indicating that individuals' perceptions of reality are better at explaining their behavior than objective indicators (Cummins, 2000).

Using both OLS and geographically weighted least squares regression, we found that the statistically significant determinants of satisfaction with life overall were: age, gender, marital status, education, income and perceptions about whether the GBRWHA is being 'satisfactorily' preserved. Our results also indicated significant spatial differences, with a very distinct north to south pattern (Table 5 and Figure 7). Age and income effects are stronger in the south; gender, marital status, education and preservation effects are stronger in the north. We were able to use coefficients from these models to estimate how much extra income residents would need to be 'compensated with' to keep life satisfaction constant, if they became less satisfied with the preservation of the reef. This is a very rough estimate of the 'non-use' value of the GBRWHA: about $7.5 billion per annum. It is consistent with findings from previous paper (section 3.3; Stoeckl *et al.,* 2014) which highlighted that non-use values are considered, by respondents to be more important to their overall quality of life than the jobs and incomes associated with the tourism industry (worth just $4.2 b to the local region).

Table 5: Determinants of overall satisfaction with life and spatial differences between the regions

Determinants of life satisfaction	Cairns	Townsville	Mackay	Fitzroy
Age (Older=>happier)			Age effect stronger in the south	
Male (males less happy)	Gender effect stronger in the north			
Married (married happier)	Marital effect stronger in the north			
Education level (completed year 12 => happier)	Education effect stronger in the north			
Income (higher income => happier)			Income effect stronger in the south	
The level of satisfaction that the GBRWHA will be preserved for future generations (positive impact on LS)	Preservation effect stronger in the north			

Note: Only significant variables reported   (Table adapted from Jarvis *et al.,* in review)

Figure 7: Spatial differences across the GBR Natural Resource Management (NRM) regions – preservation effect is stronger in the north
(Map produced by Diane Jarvis, JCU)

We found that residents of the GBR region who feel that the reef is being satisfactorily preserved for future generations have higher levels of overall LS than those who feel differently. There is also a spatial dimension to this relationship; the further north one goes, the more significant our proxy for non-use values to LS, and the less significant the contribution of income. We estimate that residents non-use values related to the GBRWHA could be about $7.5 billion per annum Our research findings thus demonstrate that the LS approach can, in principal, be used to estimate non-use values (although further research is clearly needed to refine methods).

3.5 Additional insights

The material presented in this section is based and builds on data reported in

> Stoeckl, N., Farr, M., & Sakata, H. (2013). What do residents and tourists 'value' most in the GBRWHA? Project 10-2 Interim report on residential and tourist data collection activities including descriptive data summaries. Report to the National Environmental Research Program. Reef and Rainforest Research Centre Limited, Cairns, pp. 112. Available at: http://www.nerptropical.edu.au/publication/project-102-technical-report-what-do-residents-and-tourists-'value'-most-gbrwha

3.5.1 Resident willingness-to-pay to protect the environment

Residents were also asked how much they would be willing to pay each year, to improve water clarity, to reduce the risk of shipping accidents and to protect top predators. Despite the fact that responses to other questions indicated a strong environmental ethic, a relatively large proportion of respondents were not willing to pay anything at all for protection (Figure 8).

We used the hurdle model to look for statistically significant relationships between various socio-economic and demographic descriptors of respondents and their WTP. The hurdle model is appropriate because analysis is done in two steps. First it simply divides respondents into two groups, those who are not willing to pay anything at all, and those who are willing to pay something. It identifies characteristics of respondents that are most/least likely to fall into one of those two categories.   Second, it focuses on only those who are willing to pay something, and identifies characteristics of those willing to pay most/least.   Results are shown in (Table 6), a key point being that determinants of WTP for all three items are very similar.
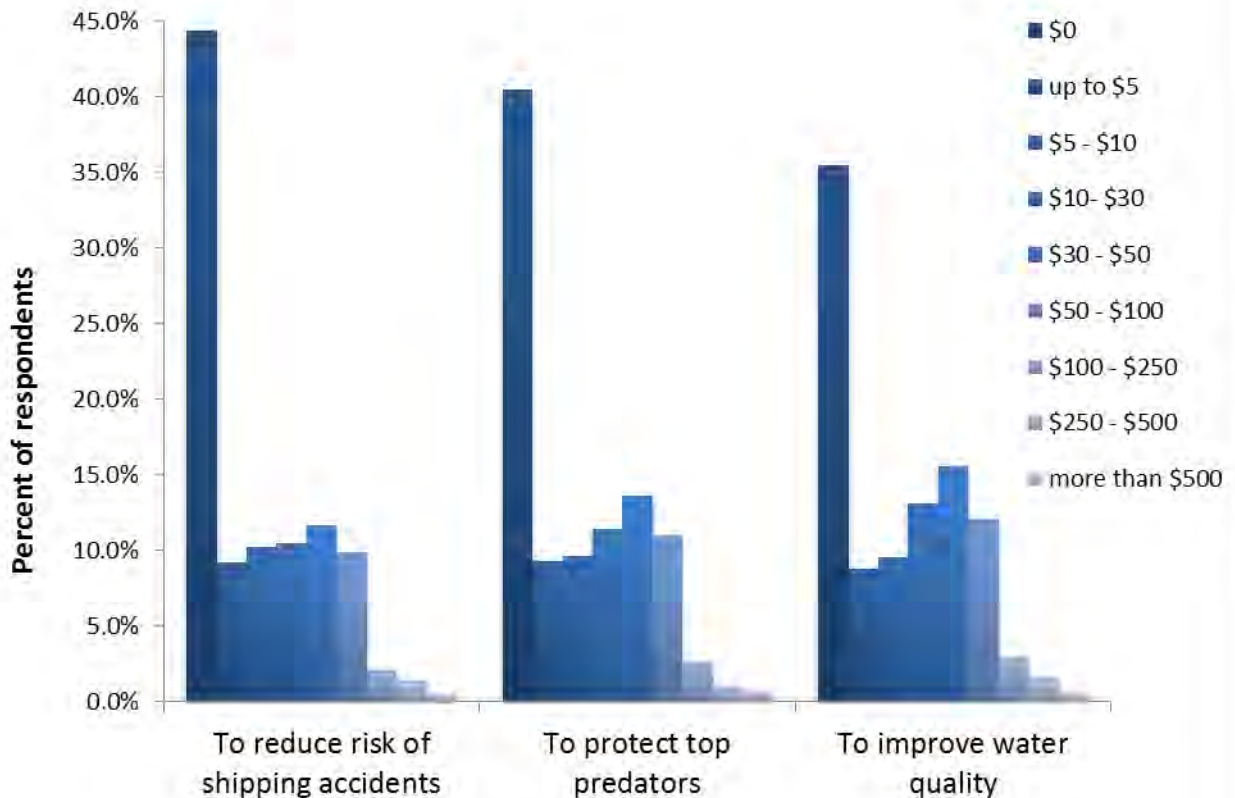
Figure 8: Distribution of residents' responses to questions about willingness to pay for environmental improvements

(Figure adapted from Stoeckl *at el.,* 2013)

In summary, this analysis establishes that residents who are most likely to be willing to pay something to protect the environment were:

- Relatively young
- Females
- Those with a university degree
- The higher income earners
- Those who were employed in Retail; Accommodations, cafes and restaurants; and Tourism-related industries
- Those who were happy to pay to help protect the GBRWHA, providing that other users pay too
- Those given questionnaires with low dollar values on the 'bid card (we generated 24 different versions of the WTP question, presenting the items for assessment – e.g. water quality, shipping, top predators – in four different orders, and presenting 6 different payment cards, each with a different top price. The order in which items were presented made no difference to responses, but the dollar values presented did).

The 'equity' issue seems particularly interesting: evidently people do not mind paying to help protect the environment, as long as they are not the only ones asked to do so.

Table 6: Statistically significant relationships between various socio-economic and demographic descriptors of residents and their Willingness to Pay to protect the environment

Residents					
Water Clarity		**Shipping**		**Predators**	
To pay or not to pay amount >$0	How much to pay (if agreed to pay >$0)	To pay or not to pay amount >$0	How much to pay (if agreed to pay >$0)	To pay or not to pay amount >$0	How much to pay (if agreed to pay >$0)
Age (-)		Age (-)		Age (-)	
Male (-)		Male (-)	Male (+)	Male (-)	
Education (+)		Education (+)		Education (+)	
Income (+)	Income (+)	Income (+)	Income (+)	Income (+)	Income (+)
WTP Bid range (-)		WTP Bid range (-)		WTP Bid range (-)	
Tourism (+)	Tourism (-)	Tourism (+)		Tourism (+)	Tourism (-)
Not prepare to pay unless all Australia pay too (+)		Not prepare to pay unless all Australia pay too (+)		Not prepare to pay unless all Australia pay too (+)	
	QLD born (-)		QLD born (-)		QLD born (-)
Estimated WTP = $32.29		Estimated WTP = $27.63		Estimated WTP = $29.68	

Note: Only significant variables reported. A plus sign (+) indicates that the variable was found to have a positive and statistically significant relationship with the score assigned to the corresponding value; a negative sign (-) indicates negative and statistically significant negative relationship

3.5.2 Potential impact, on overall quality of life, of environmental degradation

Residents were asked how a series of eight hypothetical 'changes' (Figure 9) would affect their QOL. Responses support previous messages that environmental factors are very important to QOL. Indeed some forms of environmental degradation (e.g. twice as many oil spills, twice as much rubbish, and reduced ocean water clarity) would have a much stronger impact on overall QOL than a 20% increase in local prices compared to elsewhere in Australia.
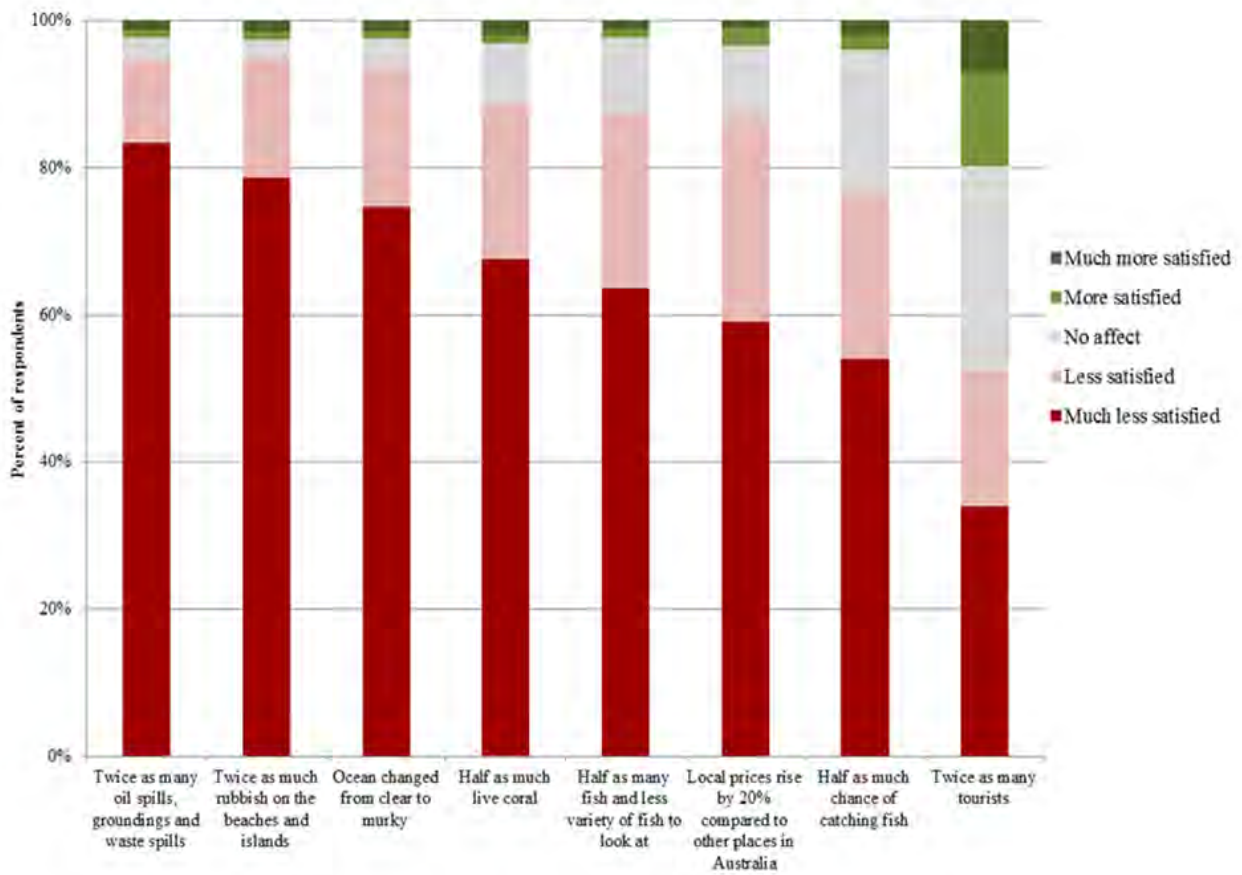
Figure 9: Residents' stated response to hypothetical changes in the GBRWHA

(Figure adapted from Stoeckl *et al.*, 2013)

4 Tourist 'values'

4.1 The importance of the GBRWHA for destination competitiveness

The material presented in this section summarises material from:

> Esparon, M., Stoeckl, N., Farr, M., & Larson, S. (forthcoming). The significance of environmental values for destination competitiveness and sustainable tourism strategy making: Insights from the Great Barrier Reef World Heritage Area. *Journal of Sustainable Tourism.*

Abstract

Sustainable destinations must deliver products that perform better than their competitors and at the same time protect key environmental drawcards. This research explores the environmental – economic interface of a major destination, both as a case study in how to approach this complex relationship, and as a contribution to the methodology of tackling the need for understanding competitive pressures as part of sustainable tourism strategy creation. Using the Great Barrier Reef World Heritage Area (GBRWHA) as an example, the paper assesses 21 key environmental values, including indigenous culture, against market-based factors, in terms of their importance for visitors as regional drawcards, satisfaction with them and the way in which changes in them might affect trip numbers and duration across different regions. While the natural values of the GBRWHA are found to be the most important drawcards, satisfaction scores were significantly lower than importance scores for a number of these values. Visitors responded more negatively to the prospect of environmental degradation than to the prospect of a 20% increase in local prices: the detailed impact depends, however, on location and visitor mix. Clear ocean, healthy coral reefs, healthy reef fish and lack of rubbish were the top four most important values.

Keywords: Great Barrier Reef World Heritage Area, destination competitiveness, environmental values, visitor perceptions, importance, satisfaction

Methods and main findings

We used a sub-set of our tourist data (on 996 visitors, all of whom answered all questions about importance, satisfaction, likely response to changes in hypothetical scenarios and demographic descriptors) to learn more about how important various ecosystem services provided by the GBRWHA were as a regional drawcard, and at how satisfied visitors were with those services when here. Clear ocean, healthy coral reefs, healthy reef fish and no visible rubbish were found to be the most important drawcards and were ranked by visitors as the top four (out of 21) most important values. Clearly it is these values that attract tourists to the GBRWHA. When comparing importance and satisfaction scores (see Figure 10), the majority of environmental importance scores were significantly higher than the corresponding satisfaction scores.
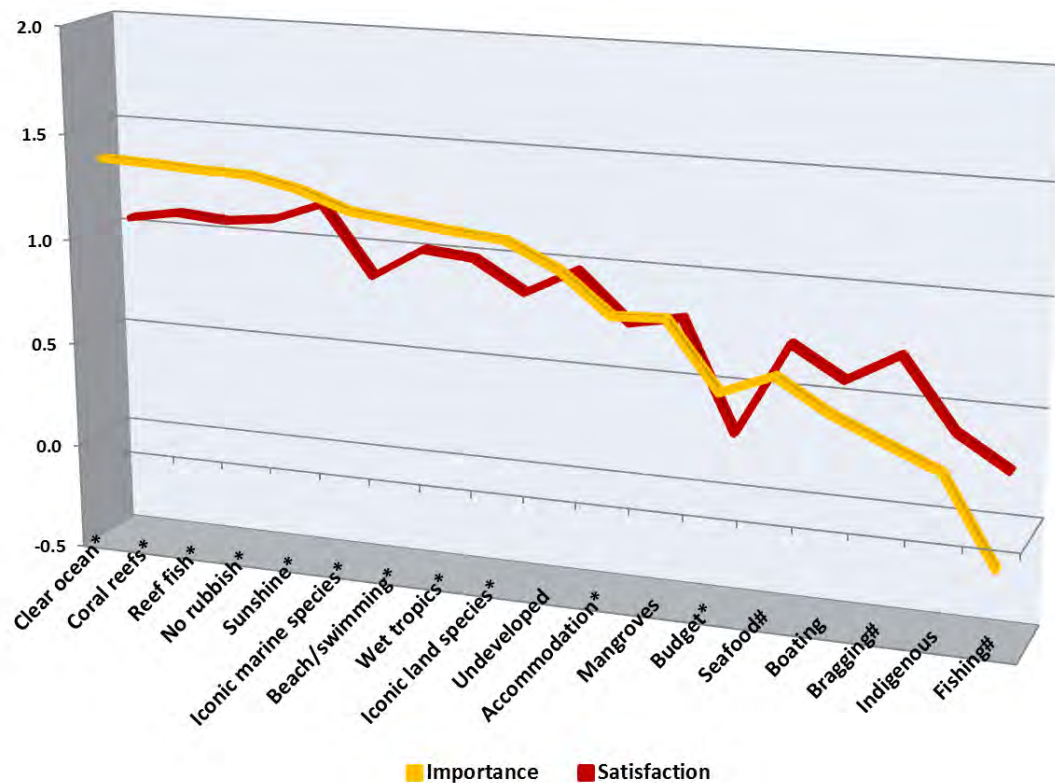
Figure 10: Mean importance and satisfaction scores compared, tourists

∗ denotes statistically significant differences between the distributions relating to importance and those relating to satisfaction
denote statistical significance of the difference between the distributions relating to satisfaction
(Figure adapted from Esparon *et al.,* forthcoming)

We used Categorical Principal Component Analysis (CATPCA) to identify which importance scores grouped together. The twenty one original items (Table 1, Figure 10) generated three groups of factors:

- 1st group – Nature, culture, seafood and recreation- included all environmental values (e.g. coral reefs, coral fish, clear ocean etc.) as well as sunshine, seafood, indigenous, boating and bragging.
- 2nd group – Business- included values associated with attending to business, going to a meeting and/or conference
- 3rd group – Socialising and value for money – grouped those who preferred to be somewhere close where they live, to suit their budget, to visit their friends and go fishing, and to have a good quality accommodation.

We then used OLS and seemingly unrelated regressions (SUR) to look for statistically significant relationships between the socio-demographic and economic characteristics of visitors (Table 7) and the 'importance' assigned to these grouped factors. The results revealed that different people attach different importance to different things (Table 8).